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MACHINE IMAGINARIES AND COMPUTING CLIMATES: KNOWLEDGE INFRASTRUCTURE AT THE UK MET OFFICE

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Climate science projects a view of the Earth's future from a rarefied set of institutions, predominantly located within the Global North. This article examines the role of computational infrastructures in the production of contemporary climate knowledge through a study of the UK Met Office and its high-performance computing facilities in Exeter. Climate knowledge is not simply derived from the observation of atmospheric phenomena but is materially and institutionally produced through interconnected networks of data, modelling, computation, and environmental control. Tracing the historical development of numerical weather prediction from Lewis Fry Richardson's speculative forecast factory to contemporary supercomputing systems, the article situates climate science within a broader knowledge infrastructure that concentrates computational capacity, scientific expertise, and political authority in a small number of institutions.

Exploring the architectural and thermodynamic conditions required for climate modelling, analysis demonstrates how climate supercomputers depend upon systems of mechanical cooling and environmental regulation, revealing a paradox at the heart of climate science: the prediction of planetary climate relies upon the prior production of controlled indoor climates. It concludes by questioning the predictive and managerial logic that underpins dominant climate modelling practices and argues for greater critical attention to the situated, political, and infrastructural conditions through which climates become knowable.

Figure 1. The Met Office HPC 3 Cray XC40 system, view of rear data and cooling. Photograph by the author (2022).

Driving down the M5 motorway near the junction for Exeter in south-west England, one passes within fifty metres of reputedly the 'world's most powerful supercomputer dedicated to weather and climate'.[1] Home to the UK Met Office and its interconnected suite of Cray XC40 supercomputing systems (Fig. 1), this suburban campus is a critical centre in an unevenly globalised network of climate knowledge production and prediction. This network was once characterised, prophetically, by the Victorian polymath John Ruskin as a 'vast machine' that wishes 'its influence and its power to be omnipresent over the globe'.[2] The machine is now largely realised, through two centuries of work constructing the infrastructures of meteorology and climate science — it observes, calculates, and reproduces planetary climate and weather phenomena in silico. The machine locates climate as a process that occurs primarily within the environs of the silicon processors of the computer. This implicates architecture: both to house and tend to the material needs of the machine and to organise its spatial relationships.

The desire, as expressed by Ruskin, for a systematic knowledge of global atmospheres at the outset of meteorology as an organised scientific discipline also exposes a core condition within the conception of climate: as a set of averages across spatial and temporal scales, climate can never be directly accessed through human experience.[3] It is inherently a beyond-human concept, not only because it refers to dynamic geophysical systems, but also because it can only be made knowable through hybrid social and technological processes.[4]

Climates — historical, contemporary, and projected — are now rendered legible at the Met Office and a select number of national weather and climate institutions operating primarily in the Global North. Moreover, this network of institutions attempts to make the changing climate somehow governable through the scientific and political practices that surround climate data, computation, and modelling.[5] Historian of climate science Paul N. Edwards describes this as a knowledge infrastructure comprising instrumentation, computational capacity, scientific labour, international standards, and technopolitical resources — all of which generate and maintain centralised and consensual scientific understanding of climate.[6] The UK Met Office is an historically significant institution within this knowledge infrastructure. It is one of a small number of centres contributing to the World Climate Research Program's Coupled Model Intercomparison Project (CMIP) as well as publishing the HadCRUT global surface temperature database via the Hadley Centre for Climate Science and Services, amongst a plethora of other scientific and technical work. Established as a national agency in service to British mariners around the world in the nineteenth century, the Met Office emerged as a weather forecasting service within the milieu of military, colonial, and imperial projects. This was in a similar vein to the development of other European meteorological organisations and it later grew with the development of numerical weather prediction models in the context of cold war tensions between the US and USSR.[7] However, the Hadley Centre as a dedicated climate research unit at the Met Office was founded only in the 1980s during a shift towards the long term assessment of Earth's climate system, with a specific goal to measure, quantify, understand, and project (anthropogenic) climatic changes.[8]

Sensing and making sense of long-term climate change requires planetary-scale knowledge. As a project, it brings together a multitude of actors, amassing climate observations and modelling simulated climates.[9] Within this work though, one element stands out as critical to the development of the contemporary view of climate from the Global North: computational capacity. Cultural geographer of climate Mike Hulme goes as far to suggest that for the

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[1] Met Office, 'Supercomputing Leap in Weather and Climate Forecasting', Met Office, 22 April 2021 <https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/corporate-news/2021/met-office-and-microsoft-announce-supercomputer-project>.

[2] Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data and the Politics of Global Warming* (MIT Press, 2013), p. vii.

[3] Richard Staley and others, 'Making Climate History: Rationale', University of Cambridge, n.d. <https://www.hps.cam.ac.uk/research/projects/making-climate-history/rationale>.

[4] Bruno Latour, *We Have Never Been Modern*, trans. by Catherine Porter (Harvard University Press, 1993), p. 13.

[5] Paul N. Edwards, 'Is Climate Change Ungovernable?', *London Review of International Law*, 12.1 (2024), pp. 351–372.

[6] Edwards, *A Vast Machine*, pp. 17–18.

[7] Deborah R. Coen, 'Climate', in *Encyclopedia of the History of Science* (Yale University, 2024), pp. 16–21.

[8] Chris Folland, David Griggs, and John Houghton, 'History of the Hadley Centre for Climate Prediction and Research', *Weather*, 59.11 (2006), p. 317.

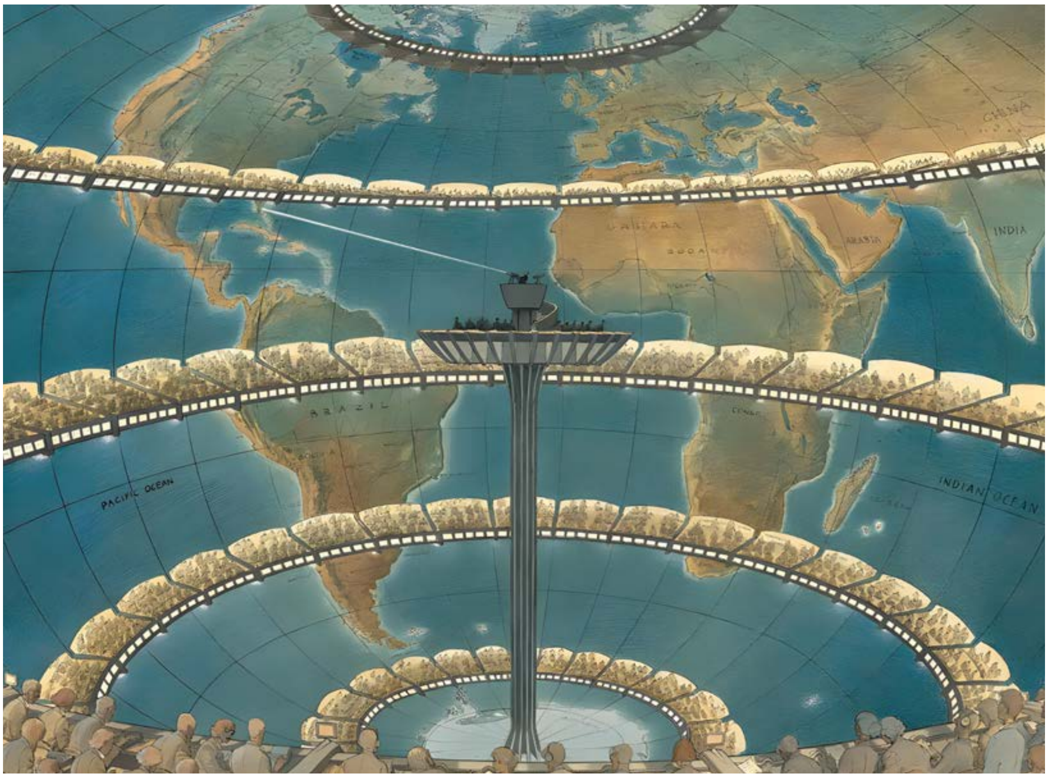

Figure 2. Lewis Fry Richardson's 'forecast-factory' as illustrated by François Schuiten (2020). Courtesy of the artist.

Figure 3. The Met Office's Ferranti computer, Meteor (1961). Courtesy of Science Photo Library.

constituency of climate scientists, climate is primarily a numerical phenomenon 'that exists virtually above all else'.[10] However, the primacy of supercomputers to the production of climate knowledge is historically contingent. Given the complexity of fluid global circulatory systems and the challenge of gathering worldwide climate information, only an apparatus such as the digital computer — and its subsequent developments — proffered a resolution to the problem of recording and modelling global climate data.

A FORECAST FACTORY

In the period following the birth of early digital computers during World War II, climatology rapidly became a science intimately connected to the growth of computational capabilities. Mathematician John von Neumann explicitly supported the application of the first Electronic Computer Project, as well as the initial use of the prototypical Electronic Numerical Integrator and Computer (ENIAC) and Electronic Discrete Variable Automatic Computer (EDVAC) machines, to the problem of numerical weather prediction (NWP).[11] Weather and climate models presented an example par excellence for early computing applications that fulfilled three key criteria: mathematical and scientific interest; operational military value; and a use that would demonstrate the power of computers to the widest possible audience. Initial weather and climate modelling projects received strong backing from government and military resources through Von Neumann's advocacy.[12] At this point the previously empirical science of climatology had already been supplemented by theoretical methods in meteorology, which had begun to explain the fundamental physics of the atmosphere. Through the work of figures such as Vilhelm Bjerknes — who managed to delineate a set of fluid dynamics equations describing atmospheric movement in just seven variables — a workable prerequisite in the physical science for computational modelling was established, one which presented an analytic method that would be impossible to solve without exceptionally large-scale calculation.

A contemporary of Bjerknes, Lewis Fry Richardson, saw the issues in the application of Bjerknes' equations to the reality of calculating weather and climate however.[13] In attempting a finite difference calculation that could be initiated from data taken during an international balloon day in 1910, Richardson was confronted with the stark reality of the scale of the mathematical task. It was impossible to calculate the weather faster than it was actually happening, making any predictive capacity fanciful (it took him six weeks' worth of calculations to complete a single 'retrospective weather forecast' of a six-hour period).[14] Given this puzzle, Richardson proposed a speculative image of a panoptic, global centre of calculation that foreshadows the later concentration of computing power within institutional weather forecasting and climate research facilities.[15] He proposed a forecast factory (Fig. 2) occupying the spherical interior of a global theatre, consisting of 64,000 human computers, overseen by clerical conductors on an elevated podium managing the manual calculation of regional results.[16] These would be collected within the central pulpit and transported pneumatically to a separate room, whereby the weather forecast could be communicated to the world through means of telegraphy.

This description augured the global scope of early twentieth century climatology. It fundamentally recognised the planetary resolution required for an accurate forecast, or at least a more comprehensive understanding of weather and climate dynamics. Beyond the sheer calculating capacity that was imagined, the organisational requirements of such an apparatus are also apparent from Richardson's hypothetical world weather forecasting system. It followed that the improbability of such an operation of human computers stymied the application of

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[9] Paul N. Edwards, 'Knowledge Infrastructures for the Anthropocene', *The Anthropocene Review*, 4.1 (2017), pp. 34–43.

[10] Mike Hulme, *Weathered: Cultures of Climate* (Sage Publications, 2016), p. 1.

[11] George Dyson, *Turing's Cathedral: The Origins of the Digital Universe* (Lane, 2012), p. 154.

[12] Frederik Nebeker, *Calculating the Weather: Meteorology in the 20th Century* (Academic Press, 1995), pp. 134–151.

[13] Dyson, *Turing's Cathedral*, p. 162.

[14] Edwards, *A Vast Machine*, p. 94.

[15] Daniel Barber, 'The Thermoheliodon: Climatic Architecture at the End of Calculation', *ARPA Journal*, 1 (2014).

[16] Lewis F. Richardson, *Weather Prediction by Numerical Process* (Cambridge University Press, 1922).

numerical prediction methods to weather and climate. Richardson's dream lay dormant until the advent and rapid advancement of the electronic, digital computer in post-war America through programmes at the Institute for Advanced Study, Princeton, and the subsequent arrival of commercial manufacturers like IBM. The expense and scarcity of machine time in mid-century computing from 1948 to 1960 meant that initial experiments in numerical weather prediction and climate modelling were constrained to a very few laboratories in the United States and, through academic connections, in Scandinavia. The UK Met Office also pioneered the use of computing in the 1950s, employing the first stored-programme electronic computer at the University of Manchester and later a commercially available Ferranti Mk1 (Fig. 3). The Met Office did not acquire a dedicated digital computer until 1955, which came to be named Meteor.[17]

Deploying what was initially developed as a military technology, albeit with potentially universal applications, meant that a particularly technical culture emerged between groups of highly skilled mathematicians and trained meteorologists. The nascent discipline of computer science for numerical weather prediction created an esoteric academic community defined by the work of a handful of initial modelling projects based in the US, Europe, Japan, and Australia.[18] Edwards states 'the concentration of computing resources at a few institutions probably affected no field more than it affected climatology'.[19] This was true throughout the early stages of the introduction of digital computing technologies and is equally the case today. In describing the inescapable gravitational mass of computer technologies and their zenith in current high-performance parallel computing, Edwards explains that as 'modelers sought to increase model resolution and include more physical processes directly in the models, their models required more and more computer power. Every group building GCMs [General Circulation Models] either owned or had access to the largest, fastest supercomputers available'.[20]

To compose accurate reproductions of the Earth's atmosphere within a simulated computer model, the exigencies of General Circulation Models required globally representative atmospheric and oceanographic data. As computational power increased inexorably, the paucities in the distribution and quality of climate data posed a challenge. Could the long-desired omniscient view of planetary circulation and its driving effect on climate variability ever be determined? Averaged climate data in a form that could become readable by machine only existed in a patchwork across temporal and geographic windows, with improving but generally problematic characteristics that made reconciling data from many different sources a substantial task in its own right. This compounded the underlying issue that most weather and climate observations had only documented the more populace Northern Hemisphere and that there were significant regional omissions in the international record owing to political discord between nation states. This presented a difficult setting for what can be referred to as the dual projects of 'making global data' and 'making data global'.[21] To make global data, denser networks of observation with more reliable standards of collection were installed to capture details from the Earth's upper atmosphere and the less well-covered land and ocean surfaces. To make data global however, computer models had to take on a new aspect, implementing processes for 'objective analysis' to create structured, 'gridded data' across the complete spherical surface of the globe and ascending in a series of pressure layers vertically through the atmosphere.[22] Generating high quality, global, gridded data derived from the locally variable measurements of radiosonde stations, weather ships, and high-altitude flight paths created the necessity for data models. More than just a collection

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[17] 'The Met Office and supercomputers: a timeline', *Archives of IT*, n.d. <https://archivesit.org.uk/the-met-office-and-supercomputers-a-timeline/>.

[18] Edwards, *A Vast Machine*, p. 171.

[19] Edwards, *A Vast Machine*, p. 139.

[20] Edwards, *A Vast Machine*, p. 171.

[21] Edwards, *A Vast Machine*, p. 283.

[22] Edwards, *A Vast Machine*, p. 259.

of calibrated observations, data models produced a complete, synthetic image of the Earth's climate or weather by an iterative process of interpolation and by re-analysing past data sets. One caveat to the advance of this putative God's-eye image was that of resolution, the coarseness of the gridded data, and the fidelity to climate behaviour that it implied.[23]

Gridded data models posed a dilemma. Increasing density in the observing networks that seed data for NWP models provides diminishing returns past a certain station separation, approximately five hundred kilometres.[24] Therefore, relatively sparse observational data is interpolated into complete gridded data models at resolutions which cover very large physical areas and can contain a diversity of human geographies. Gridding climate models to make them efficiently calculable or computable within reasonable timeframes means that a process called parametrisation is necessary in order to simulate a multiplicity of 'sub-grid scale physics' which are often highly consequential at the human scale: such as rainfall, landforms, and cloud cover.[25] Further, certain geographies such as small island states often end up being represented solely as ocean within coarsely gridded, but consequential, long-run climate simulations. The technical trade-offs inherent in modelling planetary climate have political knock-ons for human lifeways, often more acutely affecting climate-vulnerable nations in the Global South.

Reporting within the technical, political, and scientific aegis of institutions such as the World Meteorological Organization (WMO) and the Intergovernmental Panel on Climate Change (IPCC) offers a potential corrective to structural imbalances in the process of climate knowledge production. Profoundly imperfect inclusions and negotiations, through the Conference of Parties (COP), are offered to countries who are excluded from climate modelling by the very high human and material resource threshold that persists in the work of climate science. There is:

> a widespread perception that the issue of climate change 'belongs' to the developed [Global North] countries, not only because they are the initial (and still principal) sources of fossil fuel emissions but also because they are the 'owners' of knowledge about the problem.[26]

Climates derived through computation are exclusionary in their creation. They foment a critique of climate knowledge generated in a mode that embodies a Western modernity formed by, and uncritical of, dominant technoscientific practices.[27] These practices consist of those which make changing climates knowable, but also those which have made climates change through industrialised economies and extractive and emitting modes of production.[28]

SITUATING THE MET OFFICE

The continued dominance of this oligoptic knowledge is shown in the morass of scientific, social, and technical relations at institutional sites like the UK Met Office. The exclusionary trajectories of the knowledge infrastructure of climate science are evidenced in situ at the Met Office's headquarters building in Exeter. Here, the role of the supercomputer as the locus of the climate model becomes clear.

Planetary climate knowledge is not diffuse or distributed. It is made through specific relationships between spatial arrangements, energetic armatures, and human labour. The Met Office operates a linked set of three Cray XC40 high-performance computers (HPCs), with two focussed on modelling for operational, daily forecasts and a separate system that occupies an ancillary building known only

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[23] Robert McSweeney and Zeke Hausfather, 'Q&A: How do climate models work?', *Carbon Brief*, 15 January 2018 <https://www.carbonbrief.org/qa-how-do-climate-models-work/>.

[24] Edwards, *A Vast Machine*, p. 265.

[25] Edwards, *A Vast Machine*, p. 145.

[26] Edwards, *A Vast Machine*, p. 171.

[27] *A Critical Assessment of the Intergovernmental Panel on Climate Change*, ed. by Kari De Pryck and Mike Hulme (Cambridge University Press, 2022).

[28] Andreas Malm, Fossil Capital: *The Rise of Steam Power and the Roots of Global Warming* (Verso, 2016).

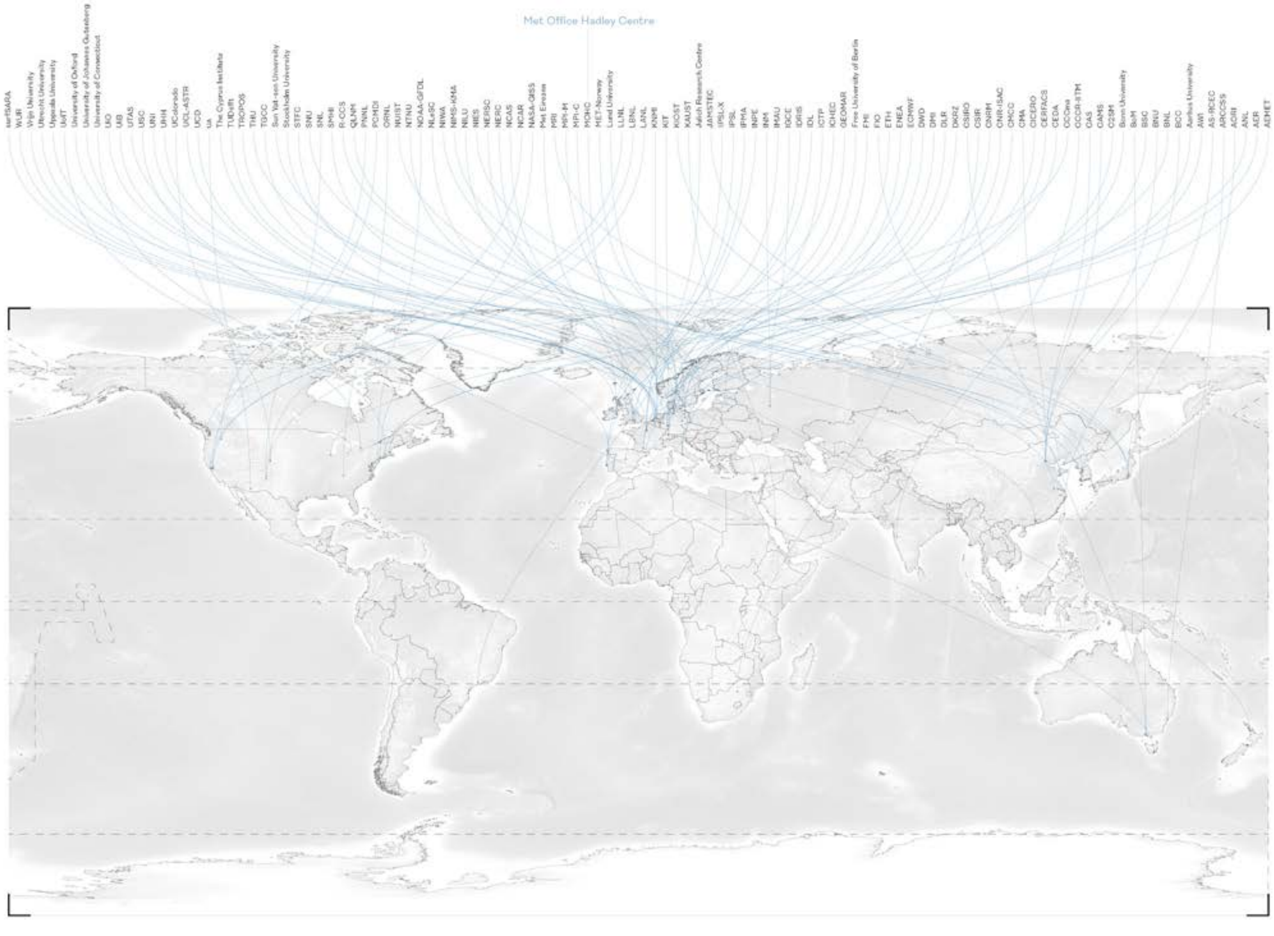

Figure. 4. Global distribution of CMIP 6 Contributors.
Drawing by the author (2023).

Figure 5. The air chiller units for the HPC Facility.
Photograph by the author (2022).

Figure 6. HPC 3 Data Hall Interior. Photograph by the author (2022).

descriptively as the High-Performance Computer Facility and dedicated to climate modelling research.[29] In the hall that accommodates this supercomputer, the significant servicing requirement for thermally conditioning processing capacity can be seen through a panoply of ducts, vents, dials, and electrical units that serve the central hardware of the machine stacks. The investment in these physical infrastructures illustrates the complexity of the supercomputer as a sited and co-productive apparatus for contemporary climate science. The spaces of the supercomputer localise and situate the research and observational network of climate science. In viewing the data halls and HPC facility at the Met Office as nodal point in a global web, a view of the supercomputer as an instrument that engenders concentrations of power in the Global North is reinforced.

The exterior of the data hall housing the climate research supercomputer appears as a blank mass without apertures. The interior is devoid of permanent human occupation, with only transitory visits by approved technicians. In this modern spatialisation of climate computing, the Cray supercomputer and its attendant systems manifest Richardson's fantasy of global computation in a manner which is wholly opposite to the whimsical scale, colourful cartography and polite ushering of results by human clerks suggested in the original, human, forecast factory. Instead, the data hall is a nondescript space of machinic infrastructure: architecture without people (Fig. 5, Fig. 6).[30] Yet this outward appearance belies the importance of this site. It translates complex, global earth processes into predictive models — vital tools in understanding the dynamics of climate and its accelerating degree of crisis around the world.

The HPC facility does not outwardly portray its interconnections to climate observing systems, nor any sense of global significance of the scale of the data it computes. Like all infrastructures it operates silently and is consciously un-seen, 'transparent' in the sense used by theorists of large technical systems Susan Leigh Star and Karen Ruhleder.[31] What it does make explicit is the fundamentally esoteric episteme of the climate scientist. It emphasises the primacy of the digital simulation as a tool that can be predictive, re-analytic (assimilating incomplete or incongruous data sets), and instrumental.[32] The material site of this production of knowledge is the supercomputer, a machine that has been developed to take on the complex task (although reductively simplified from reality) of simulating the entire climate system as understood through several key strata and geophysical cycles. This conception of climate as a phenomenon that plays out as digital simulacrum instead of a tangible stream of elapsing temperatures, eddies, changing humidity levels, incident solar radiation, etc., is indicated in the strangely referential, hexagonal section of the building, which mimics the circuitry of the computers the building houses.[33]

As an apparatus, the supercomputer is built on the knowledge infrastructure of agreed scientific standards, data collection, and programming from an international cohort of scientists and institutions. However, it cannot physically operate without certain environmental, thermodynamic manipulations. Computing at the scale of the climate model requires not only financial and organisational resources but fundamentally requires a controlled and mediated interior environment.

This mediation is delivered through air-conditioing technologies that were developed in the early twentieth century by engineer Willis H. Carrier as a means of producing 'man-made weather'.[34] This technology for interior climatic control in fact presupposes the productive ability of the supercomputer and the possibility for projected knowledge of future climate scenarios. In Climatic Media: Transpacific Experiments in Atmospheric

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[29] Met Office, 'The Cray XC40 Supercomputing System', *Met Office: About Us*, n.d. <https://www.metoffice.gov.uk/about-us/who-we-are/innovation/supercomputer>.

[30] Liam Young, 'Architecture Without People: Neo-Machine', *Architectural Design*, 89.1 (2019), pp. 6–13.

[31] Susan L. Star and Karen Ruhleder, 'Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces', *Information Systems Research*, 7.1 (1996), pp. 111–134.

[32] *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-based Modelling and Simulation*, ed. by Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (Routledge, 2017).

[33] Ralph James, interview with the author, 20 April 2022.

[34] Kiel Moe, *Thermally Active Surfaces in Architecture* (Princeton Architectural Press, 2010), p. 48.

Control media theorist Yuriko Furuhata proposes that with the advent of numerical weather prediction in American and Japanese laboratories 'adequate systems of air-conditioning had to be constructed in order to provide an infrastructural support for these computers; the machines needed atmospheric pampering for their optimal performance'.[35] In this history of climatic control and predictive computing across transnational climate modelling groups, Furuhata posits that 'without the production of indoor weather, numerical prediction of outdoor weather was impossible'.[36] Conventionally, it is understood that prediction precedes the desire for anthropic control over climates, but for Furuhata 'this reversal of causality — that prediction is dependent on control — indicates the deeper epistemological and political stakes of the thermostatic desire'.[37]

A further architectural and material question emerges from this observation. In serving the thermoregulatory requirements of such an advanced and resource intensive tool as the supercomputing system, how does the building envelope of the space of the supercomputer (with its mechanical, electrical, and plumbed services) exemplify a modern architectural paradigm that relies on an entrenched, carbon intensive model of energy supply, despite superficial labels of sustainability?[38] Given that the foundational motivation of contemporary climate science is to rightly inform and alert the world to potentially catastrophic global heating and anthropogenic climate change, how does the architecture of climate science justify its recourse to 'the closed world' of operationally intensive mechanical cooling?[39]

In developing probabilistic outcomes via computer simulation, compared and averaged through techno-political methods, an understanding of how the climate will change is underwritten by a faith in the veracity of the supercomputer as a tool of omniscient proportion.[40] This results in publications from the IPCC that are couched as warnings but are co-opted towards a strategy of climate mitigation (summed up as 'given carbon emission reduction x we can achieve reduced global temperature increase y'). This logic follows a still dominant argument for 'sustainability' or as Sarah Ichioka and Michael Pawlyn write, the goal of making the climate crisis '100% less bad', failing to conceive of unequivocally better or transformative futures.[41] Climate risk mitigation strategies that are driven by a sustainability agenda emerge from the climate science knowledge infrastructure and its materialisations within the Met Office. This position is fuelled by the neoliberal desire to continue with an, albeit moderated, business as usual approach in which growth is infinite, and the impacts of climate risks are computationally calculated to then be offset and outsourced. This deterministic thinking influences the construction of a climate science knowledge defined by knowing and making climates quantifiable or modellable, and thus something which can be governed.[42]

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35. Yuriko Furuhata, *Climatic Media: Transpacific Experiments in Atmospheric Control* (Duke University Press, 2022), p.53.

36. Furuhata, *Climatic Media*, p. 53

37. Furuhata, *Climatic Media*, p.57.

38. Lizzie Yarina, 'Toward Climate Form', *Log*, 47 (2019), pp. 85–92 (p. 88).

39. Peder Anker, 'The Closed World of Ecological Architecture', *The Journal of Architecture,* 10.5 (2005), pp. 527–552 (p. 539).

40. Lynda Walsh, 'Climate Change and the Technologies of Prophecy', in *Scientists as Prophets: A Rhetorical Genealogy* (Oxford University Press, 2013), pp. 163-185.

41. Sarah Ichioka and Michael Pawlyn, *Flourish: Design Paradigms for Our Planetary Emergency* (Triarchy Press, 2021), p. 9.

42. Martin Mahony and Mike Hulme, 'Epistemic geographies of climate change: Science, space and politics', *Progress in Human Geography*, 42.3 (2018), pp. 395–424.

THE LIMITS OF CLIMATE SCIENCE

Climate supercomputing reproduces planetary systems as models from rarefied centres of calculation, which fulfil the machinic imaginaries developed by the sciences of weather and climate since the nineteenth century.[43] The difficulty of making a complete image of planetary climate has concentrated the power to compose and predict those images at a small number of well-financed, and usually historically well-connected, institutions that can access the most cutting-edge computing technologies. However, these technologies are situated and contingent on environmental conditioning. This means that only by producing controlled indoor climates can the future of planetary climate be predicted.

In regulating and mediating the ostensibly bounded interior space of the computer, the Earth's climate appears to become governable through means of prediction, the intercomparison of models and the deployment of scientific knowledge into political, international processes. The limits of these processes founded in relationships between the technical, scientific, and political spheres are now emerging. Without questioning and historicising the assumptions within the practices and technologies of climate knowledge production, climate becomes a separable object of study, external to the ways of life that change and manipulate it. Dominant Western climate knowledges are constructed. They are brought into being through social, technical, and scientific practices that connect nonhuman agents (the supercomputer and conditioning technologies) and human mathematicians, modellers, and meteorologists. Recognising the beyond-human condition of climate knowledge suggests that different constructions are possible. What would a climate without 'man-made weather', both indoor and outdoor, look like?[44] What happens when climate models retreat from the globalising view and focus on mapping local specificities?[45]

The practices of climate science exist within a world that has sought to know in order to control climate from centres of military, economic, or imperial power. These centres represent a breed of oligoptica, able to create highly resolved but ultimately partial views of planetary climate.[46] In this dominant climate episteme of digital models and cooled computer halls, an architecture that rationalises a fossil fuel-based energetic paradigm has emerged. It cannot escape the conclusions of the knowledge that it helps to realise. However, as climate changes beyond the prior consensus projections of international climate science, the predictive desire for control embodied in the architecture of the supercomputer becomes patently insufficient.[47] How can climate science and its machine imaginaries respond to a world of irrupting climate volatility?

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43. Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Harvard University Press, 1988), p. 254.

44. Moe, *Thermally Active Surfaces in Architecture*, p. 48.

45. Martin Mahony, 'The (re)emergence of Regional Climate', *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-based Modelling and Simulation*, ed. by Matthias Heymann, Gabriele Gramelsberger and Martin Mahony (Routledge, 2017), pp.139-158.

46. Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford University Press, 2005), p. 181; Donna Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', Feminist Studies, 14.3 (1988), pp. 575–599.

47. William J. Ripple and others, 'The 2024 State of the Climate Report: Perilous Times on Planet Earth', *BioScience*, 74.12 (2024), pp. 812–824.

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