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Agricultural capitalism, climatology and the "stabilization" of climate in the United States, 1850–1920

Zeke Baker[1,2]

[1]Department of Sociology, University of California, Davis, Davis, CA, USA

[2]Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, Norman, OK, USA

Correspondence
Zeke Baker, US National Oceanic and Atmospheric Administration National Weather Service, 222 West 7th Avenue, Room 517, Anchorage, AK 99513, USA.
Email: zbaker@ou.edu

Present address
Zeke Baker, US National Oceanic and Atmospheric Administration, National Weather Service, Anchorage, AK, USA

Abstract

Drawing from theory on the "co-production" of science and society, this paper provides an account of trajectories in US climatology, roughly from the 1850s to 1920, the period during which climatology emerged as an organized branch of meteorology and government administration. The historical narrative traces the development of climatology both as a professional/institutional project and as a component of a larger governmental logic. Historical analysis of climatologists' scientific texts, maps, and social organization within government provides a sociological explanation for the emergent "stabilization" of climate as a geographic-statistical category. Climatic *stability*, defined by the view that climate is unchanging, was advanced over this period in a way that linked the interests and practices of climatologists to actors invested in facilitating and administrating commercial agriculture and trade. I position the logic of climatology and the discourse of climatic stability historically, with reference to prior concern with climate change and, in recent decades, efforts to govern global warming through geoengineering climatic stability.

KEYWORDS

climate change, climate science, co-production, rationalization, sociology of science, state formation

1 | INTRODUCTION

With the aim of achieving just social and ecological outcomes in the face of the possibly devastating impacts of climate change, historical analysis can render visible the variable social meanings and actions attached to climatic phenomena. Historicizing climate in sociological terms can open up opportunities to envision social transformation, rather than representing the current situation as the end of the world or an external fact of nature to which society must simply adapt (Hulme, 2017; Swyngedouw, 2010; Watts, 2015).

This article focuses on a historical period in the United States that has received minimal attention among social scientists dealing with the relationship between climate, knowledge, and society—namely, from the 1850s to 1920. My argument regarding the emergence of climatology as a discrete science during this period is two-fold. The first shows how climatology emerged as both a professional project and a component of a governmental logic specific to capitalist society and a bureaucratic state. The second centers on how the science of climatology reshaped the substantive view of climate. I argue that a discourse of *climatic stability*—the basic view that climate is unchanging within a delineated geographic space—emerged in a way that linked the social interests and practices of climatologists with the broader administration of commercial agriculture, trade, and finance.

The historical situation for "stabilized" climates is important to recognize. From the 18th to mid-19th centuries, climatic theory among meteorologists, physicians, natural philosophers, and their publics held that climates were *changing*. Historians have analyzed these ideas with renewed interest, given contemporary climate change (Fleming, 1998; Golinski, 2008; Zilberstein, 2016). Scholars have likewise historicized the authority of climate change science since the mid-20th century (Baker, 2017; Edwards, 2010), an important effort for charting the role of science in what many hold as a need for societal transformation (IPCC et al., 2018). In the problem space of the science-society relationship, conceptualizations of climate as an entity that does *not* change (or can be made to be so) also can be problematized.

To explain the transition, which began in the mid-19th century, toward treating climate as stable I center my analysis on climatologists' texts, maps, and social organization in order to situate climate knowledge in its broader context. Methodologically, the analysis is informed by a "symmetrical" approach (Bloor, 1974) that analyzes the institutional structure and technical content of scientific knowledge without positing in advance the progression of scientific rationality. This approach opens up analysis to how social actors may "co-produce" (cf. Jasanoff, 2004) on the one hand, a new meteorological order within science, and on the other hand, governmental practices. Transformation of concerns about the stability/instability of climate, as a co-production approach suggests, may not be simply keyed to climatic shifts or to the logic of scientific discovery, but also to changes between the domains of science and government.

The article proceeds as follows. I begin by establishing the fact of a major definitional change regarding climatic stability and situate it in the US context. I then draw upon scholarship tracing the rise of industrial capitalism to frame an analysis of how meteorologists and allied actors constructed "stable" climates and put them to work, on the one hand, for the formation of climatology, and on the other hand, as basic categories of modern capitalist society. The article concludes by suggesting that understanding the "stabilization" of climate can yield insights into ongoing debate in climate governance regarding "climate stabilization," including the increasingly common assumption that "solving" climate change can be achieved by technical intervention (i.e., geoengineering).

2 | THE PUZZLE OF CLIMATIC STABILITY

A convenient way to locate changes in knowledge is to uncover novel basic definitions within a field in order to recognize them not as simply given by nature but as effects of definitional struggle among people situated in time and place. Scientists' understandings of "climate" exhibited just such a definitional struggle and transformation in the latter 19th century. By 1903, climatologist Robert DeCourcey Ward translated the Austrian meteorologist

Julius von Hann's influential *Handbook of Climatology* and revised it for an American audience. Ward, who was the first professor of climatology in the United States (at Harvard), defined climate as "the sum total of the meteorological phenomena that characterize the average condition of the atmosphere at any one place on the earth's surface" (in Hann, 1903 [1883], p. 1). As meteorologist Willis Milham likewise made clear in his influential textbook, *Meteorology*, published in 1912: "Weather changes from moment to moment, but climate remains the same" (Milham, 1918 [1912], p. 426). The "constancy of climate," as Milham (p. 437) put it, meant that climate had not changed either in recent or historical times (he cited 7,000 years).

Definitions of climate as "normal" weather, rather unsurprising today, compare sharply with earlier relational conceptions of climate. Just decades prior to the publication of the above-cited definitions, people did not typically treat climate as a geographically stable set of averaged physical parameters, but rather as a set of dynamics relating human populations to their environments. Consider American meteorologist Samuel Forry's (1842, p. 127) definition, borrowed from Prussian geographer Alexander von Humboldt (see Humboldt, 1849 [1845], p. 338): "Climate, in a word, constitutes the aggregate of all the external physical circumstances appertaining to each locality in its *relation* to organic nature." It followed for Forry (1842, p. 128) that "[to] deduce from this knowledge the influence which they exercise on the physical and moral state of man, such is the wide field which climates present to our investigation." Although classical Aristotelean meteorology understood climates to be latitudinally defined climatic "zones," such zones were more heuristic compared to later cartographic representations (Hann, 1903 [1883]; Humboldt, 1817; Köppen, 2011 [1884]; Martin, 2006). Instead, those advancing climatic theory in the first half of the 19th century primarily focused on regional or local variants of neo-Hippocratic environmental medicine (Jankovic, 2010; Rupke & Wonders, 2000). In urban and rural contexts, many meteorologists up to the 1840s were physicians and reformers. To know climate was centrally to understand how and why it may be *changing*, and with what consequences for equally dynamic human and social developments. In 1857, climatologist Lorin Blodget (1857, p. 481) frustratingly characterized the situation when working to establish a new vision of climatology in the US: "Attached ideas of change to the whole subject [of climate] is difficult to remove."

So, a central question concerns how to explain a definitional change in climate and evaluate its consequences? Other scholars have analyzed the 18th to mid-19th centuries to emphasize that, as a category of science and a set of social anxieties, "climate change" is hardly new, but rather "the modern revival of the debate in a new version" (Thompson, 1981, p. 238), for which analysis much find one or another "valuable historical analog" (Stehr & von Storch, 2000, p. 13; see also Fleming, 1998; Hulme, 2008; Zilberstein, 2016). This position has two limitations. First, historical scholarship on climate change risks presuming a false parallel between the contemporary situation of global warming and climatic theory in prior periods. Second, this scholarship hardly problematizes the better part of a century during which climate change was relatively peripheral to science and public consciousness.

It is necessary to consider whether those who enacted a definitional change regarding a stable climate were simply correct. Recent reconstructions of climate history hamper the otherwise plausible claim that climatologists' data speaks for itself and, therefore, straightforward discoveries had closed the "debate" about climate change in the mid-19th century by empirical falsification. In a review of 19th-century climate theory, for example, climatologist Thompson (1981, p. 238) writes, "Ironically, the period of extended debate on the climate-change issue, when opinion was essentially polarized on either climatic amelioration or climatic stability was actually a period of distinct climatic deterioration for the western world." By "deterioration," Thompson meant the cooling period, which climatologists later labeled the "Little Ice Age." Climate historians and climate reconstruction modelers (Bradley & Jonest, 1993; Mann et al., 2009) have consistently identified this cooling trend, which was global in scope up to the late 19th century (although it expressed temporal regional variation).

Recognizing that climatologists' views on climatic stability do not neatly correspond with reconstructed trends suggests that climate data itself provides an insufficient explanation for the transformation, within the logic of climatology, towards a "stabilized" climate. Explanation must in part be sought elsewhere. For that, attention to the social contexts of climate knowledge is necessary for ultimately situating how climatology may have related to the broader rationalization of US society.

3 | THE SOCIAL PRODUCTION OF CAPITALIST CLIMATES

Confluences of government, economic development, and climate knowledge have formed over the historical long term and across national, imperial, and colonial contexts (Mahony & Endfield, 2018). From colonial North Africa (Davis, 2016; Locher & Fressoz, 2012), to India and the West Indies (Harrison, 1996) and Australasia (Beattie, O'Gorman, & Henry, 2014), debates about the "acclimatization" of the colonizer and the racial character of the colonized established, for colonial officials, the "natural" basis of social hierarchy that informed policies regarding hygiene, settlement, assimilation, land development, and military strategy. Within colonial discourse, climate change could result in social degeneration or be amenable to anthropogenic "improvement" (Drayton, 2000). The relationality between dynamic climates and bodies formed an anchor for climate knowledge in "new" territories and uncertain colonial situations.

Scientists advancing climatic theory in the US up to the mid-19th century focused on two major issues that resonated with the Euro-colonial meteorological community: American climate change and the climate-disease relationship. Self-consciously American natural philosophers and physicians brought international debates about American climate into their efforts to establish regional and national meteorological standards of practice (Baker, 2018). Internationally, the co-production of climate knowledge and state- and empire-building in the late-19th century benefited from refined techniques for representing and mapping climates geographically, what Coen (2018) has labeled the process of "scaling." By elaborating the spatiality of climate, climatologists in diverse contexts informed political and economic interests, ranging from land use policy to global imperial ambitions and racially coded geopolitical ideology (Coen, 2018; Mahony, 2016; Ratzel, 1896). The rationalization of society and its environments, which transformed many elements of natural and social reality into discrete units for the purposes of bureaucratic administration and commercial exchange was thus not limited to the US context.

Given the configuration of science, capitalism, and state-making, the US from the 1850s to 1920 provides a case of how those working in or connected to the domain of climatology helped to build what can be labeled *industrial-capitalist climates*. Climates under this conceptualization are "scaled" in a manner that provides a basis upon which markets and capitalist society can be progressively and predictably built by economically exploiting land, water, air, soil, and labor productivity. Analysis of industrial capitalist climates can draw from a Marxian understanding of nature, the state, and knowledge as comprising what Shnaiberg (1980) labels "production science," which facilitates the capitalist "treadmill of production." The natural sciences in the latter 19th century formed one "hand" of capitalist state formation by helping to facilitate the "legibility" and accessibility of territory, land, and natural resources (Morgan & Orloff, 2017; Scott, 1998). Physical scientists during this time oriented toward the innovative, if destructive, extraction of raw materials and labor-power, among what Karl Polanyi later labelled the "fictitious commodities" upon which capitalist production depends (Polanyi, 2001 [1944], pp. 187–200). To use political economist James Dunbar's (1781, p. 308) prescient late-18th-century terms, "economic government" must "recover…our patrimony from Chaos." The production of capitalist nature must confront, and hence exploit or overcome, nature's complexity. A capitalist order called forth the legibility and standardization of nature and society in ways previously unimaginable, a process that became even more rationalized within a 19th-century international market system in which profits were only secured through competitive production, financial innovation, and efficient trade on relatively open markets (Davis, 2004).

The period from the 1850s to 1920 marks the industrialization of the US economy. Moore (1966) has argued that the US Civil War constituted a bourgeois revolution that consolidated a national capitalist class in manufacturing and finance, paralleled by the "freeing" up of Western land to property development and the "freeing" up of labor through the abolishment of chattel slavery in the American South. Historian Clark (2012) has shown that agrarian development complemented the rise of industrial manufacturing through more intensive capitalization of land, property, natural resources, and agriculture, compared to the antebellum period. New state institutions facilitated this process (Skowronek, 1982), and they advanced infrastructural and land development, reclamation, navigation, and public works. Accounts of capitalist state formation thus suggest that the interests and activities

of scientists, those oriented to incorporating natural resources into market society, and bureaucratic state officials could meet one another in the spaces of climate knowledge. An empirical account of this historical process begins with the rise of climatologists concerned with agricultural development.

4 | WORKING LANDS: AGRICULTURAL DEVELOPMENT AND CLIMATIC STABILITY

Climatologists resettled an otherwise fragmented science of climate primarily by leveraging a capacity to speak for the agricultural productivity of geographically delineated areas. Within science, climatology emerged at a time of deep challenges to prevailing concerns among meteorologists. Beginning around the 1850s the logic of "medical geography" as the basis for meteorology was beginning to break down as developments within medicine had begun to displace miasmic-atmospheric theories of disease (Ackerknecht, 1948; Mitman & Numbers, 2003). Although variable across contexts, internationally, the contagionist-bacteriological paradigm for disease generally shattered the prospects of a medically centered climatology (Rupke, 2000). Furthermore, natural-historical accounts of life, earth history, and social organization underwent deep challenges within the emerging social sciences and Darwinian/evolutionary theory. These developments in science provided distinct understandings of long-term developments that were not, as the previous generation largely believed, climatically determined.

4.1 | Seeds of climatic stability within scientific agriculture

In the mid-19th century, meteorologists in the United States advanced their profession by explicitly linking it to the larger movement in science and government toward "scientific agriculture." In 1858, meteorologist and founding Secretary of the Smithsonian Institution Joseph Henry wrote a treatise, titled "Meteorology in its connection with agriculture." Henry sought to bridge the development of experimental science with the recent institutionalization of meteorological data collection at a national scale, at the time organized by a Smithsonian-based network of weather observers. The observation network that facilitated collection of meteorological data was connected via correspondence and telegraphy to other meteorological data infrastructure organized by the Army Medical Department, the Navy, and the American Philosophical Society (Fleming, 1990). Most of these systems were finally integrated into the US Signal Service network in the 1870s.

To outline a national meteorology, Henry (1858, pp. 456–457) provided a political philosophy of climate and agriculture:

> To our political organization, under Providence our prosperity has mainly been promoted by the ample room afforded us for expansion over the most favored regions of this continent. It becomes, therefore, important for us to ascertain the natural limits, if there be any, to the arable portion of our still untenanted possessions.

Henry was beginning to reconsider problems of climate with reference to possible "natural limits" of the nation, a political problem that science could help to address. On this basis, the US Patent Office and Smithsonian Institution began to develop a climatological view of the continent, understanding that "A knowledge of the peculiarities of the climate of a country is an essential requisite for the adoption of a system of scientific [agri-] culture" (Smithsonian Institution, 1864, p. 31).

Around that time, in 1858, the US Agricultural Society (1858, p. 37) reported that the Patent Office also partnered with other organizations to circulate forms to US diplomats and merchants abroad with the aim of formalizing intelligence on "economical plants, growing in the countries you may visit." Reporters were told to

describe, among other features, crops' "periods of sowing and harvesting, the character of the soil and its elevation above the sea, the mean, maximum, and minimum of the thermometer, and the amount of rain, in inches, each month of the year, together with the periods of the latest spring and earliest autumnal frosts." By obtaining this data, agricultural reformers aimed to compare, evaluate, and establish the attributes of climate zones. The effort of comparative agricultural climatology, haphazard at first, envisioned that climate knowledge would ultimately facilitate the proper economy of inputs, agricultural productivity, and trade.

The relationship between the Smithsonian and the federal government propelled Henry's vision of a national agriculture-centered meteorology. On the eve of the Civil War, on January 25, 1860, Joseph Henry wrote to the US Commissioner of Patents, W.D. Bishop, in the preface to the joint Smithsonian-Patent Office *Meteorological Observations*:

> The results are considered as furnishing very interesting and valuable statistics, not only in regard to the science of meteorology, but to that of agriculture, which will be of increasing importance in determining the climatology of different portions of the country. (US Patent Office, 1861, p. iii)

The budding expertise of the "climatologist" was central to developing this vision into a formal program. As one result, many scientists could afford to let go of—and deride as "speculative"—climate change and medical geography as organizing issues for their science.

4.2 | The emergence of "positive climatology"

An important initial effort to formalize the project of climatology can be found in the work of statistician Lorin Blodget. In *Climatology of the United States*, published in 1857 and compiled using Army Medical Department and Smithsonian meteorological records, Blodget demonstrated a novel approach to science that he labeled "positive climatology." The positivist approach would reject climate-change theory and instead advance statistical-geographic representations of the "permanence of special features," meaning spatially demarcated, stable climates. Blodget (1857, pp. vi, ix) organized statistical tables and maps with a goal to provide "a general discussion of the records from all sources in the sense of a CLIMATOLOGY," and to verify the statistical record for "the purpose of using it as a valuable approximation to the various fixed quantities of climate." Blodget contrasted "the illustration of fixed or average conditions" as standing "against the general opinion" and other "historical absurdities and extravagances," alleged to result from "blendings of sagacity and charlatanism which have been always busy in prediction [of] the weather" and provoking anxiety about climate change (p. vii). If the 2000-year time series of climatological records were as available in America as in Europe, Blodget stated, "it would be found to dissipate the apprehensions so frequently entertained that it is becoming more variable or extreme" (pp. 24–25). Climate change had no place in a positive climatology.

Blodget's program denoted the "permanence" of climate with reference to monthly averages of atmospheric measurements, which upon representation could serve as a basis for regional economic development. "Climatology," in its instantiation by the 1860s, signified claims to expertise about the atmosphere as relevant primarily to the emerging concern to establish scientific agriculture. Climate, thus configured, could provide solutions to regional disparities in "rural economy" (Smithsonian Institution, 1859, p. 34), establish the limits to profitable development, and replace meteorologists' work of monitoring climate change with geographic description and comparison.

From the time that Blodget wrote until the mid-20th century, "climatology" continuously positioned inquiry *against* concerns about climate change. Thus in 1889, meteorologist Cleveland Abbe argued in an article, titled "Is our climate changing?" "It will be seen that a *rational climatology* gives no basis for talked-of influence upon the climate of a country." He asserted, "The true problem for the climatologist to settle during the present century is not whether the climate has lately changed, but what our present climate *is*, what its well-defined features are, and how they can be most clearly expressed in numbers" (Abbe, 1889). On the one hand, climatologists rejected

climate change because they could represent large-scale visions of time and space that had not been available to previous generations of meteorologists (see Figure 1).

On the other hand, the vision among climatologists to "fix," in a statistical sense, the parameters of climate across space and time cannot be reduced to a scientific logic. Rather, it articulated with the situation of meteorological science that, if taken hold of, could inform broader political and economic interests.

Establishing climatology across the United States was beset by prior views of climate change but also by material and administrative challenges that affected climatologists' capacity to secure standardized meteorological data. The Civil War destroyed critical elements of the Smithsonian and Army Medical Department networks of stations, instruments, observers and the social, telegraphic, and mail systems that meteorologists relied upon to formulate climate knowledge. Moreover, the Civil War led to profound changes in the regional political economy of the United States, including industrial development in the North, continental expansion (especially via the railroads) in the West, and Reconstruction in the South. It was under the conditions of rapid societal change that meteorologists and their allies successfully institutionalized the vision of "positive climatology" within government.

5 | SECTIONAL DEVELOPMENTS: DEFINING REGIONAL CLIMATES AS COMPETITIVE ECONOMIC ZONES

How to restructure the post-Civil War economy became a central concern for those already aiming to designate climatic areas with reference to agricultural production and trade. To take one example, the oceanographer

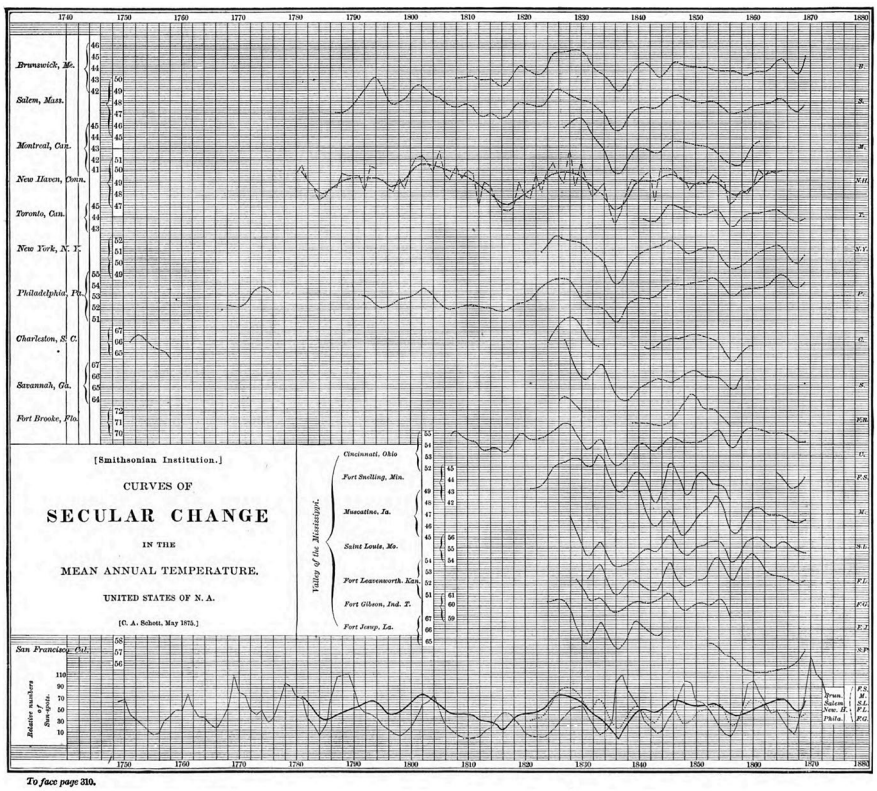

FIGURE 1 Statistician Charles Schott's (1876, p. 311) graph, representing "Curves of Secular Change in the Mean Annual Temperature of the United States," from 1740 to 1870

Matthew Fontaine Maury, famous for identifying Atlantic shipping lanes and a system of maritime meteorology, sought to rebuild his native Virginia after the Civil War. In his antebellum work, Maury had asserted that meteorology provided a way to economically manage the atmosphere as "a grand machine—perfect in all its parts, wonderful in its offices, sublime in its operations" (Maury, 1856, reproduced in Corbin, 1888, p. 76). The atmospheric "economy," he argued, showed that "Supply and demand are in as rigid proportions here as elsewhere" (Maury, 1846). The task of meteorology, in this view, involved harnessing the "economy" of nature to the economy of human affairs. The post-war situation renewed his interest in meteorological economy by emphasizing competitive advantage. Specifically, he sought to reimagine climatically tailored means of economic reconstruction: Thus, "Considering the circumstances under which recent events have placed the people of Virginia," he performed "an economic study of the geographical position of the State," with the goal "to develop the physical resources of the State and to point out the great commercial advantages which naturally arise from its situation…to the end that industry may be stimulated" (Maury, 1869, pp. 3, 6). With a decimated slave-based plantation economy, labor shortage, and a competitive Western agrarian marketization, agricultural market development was especially significant for regional growth.

Maury worried that railroad development would leave Virginia in economic ruin as other areas prospered from increased immigration and export-oriented trade relations established on more favorable terms. He advanced a detailed account of possible canal and rail-building schemes to connect the Mississippi Valley, through Virginia, to the Atlantic Ocean, which he labeled the "great highway of nations." He concluded existing transportation routes constituted "a violation of the laws of political economy" (Maury, 1869, p. 34). He marshalled evidence from weather and insurance records to insist, "Two and a half per cent upon the value of all the commerce that has sought a passage [east] from New Orleans and Mobile since the purchase of Louisiana, surely amounts to more than $100 million, and the use of these Virginia routes would have saved much if not all of it." He continued by arguing that insurance and shipping industries were overly susceptible to weather and climate risk. In a context of economic competition in agricultural markets and the development of trade infrastructure, Maury constructed among the first "climatologies" of Virginia in hopes that it could spur the Reconstruction economy.

The process of performing a "climatology" for a given area of administrative-economic interest was replicated widely by other US states and in the following decades. Maury's climatology highlights two basic ways in which climate intersected industrial capitalist developments in the post-Civil War decades. First, producers had to compete to obtain available sources of production inputs, chiefly natural resources and labor. Second, agriculturalists and manufacturers had to ensure access to markets for their products. Knowing climate became especially relevant to establishing productive and profitable regions and to evaluating the risk of financial investment in infrastructure to produce goods and transport them to distant markets.

Within this commercial context, on February 9, 1870, President Ulysses S. Grant signed the Joint Congressional Resolution that established the Division of Telegrams and Reports for the Benefit of Commerce within the War Department's Army Signal Service. The division required the Secretary of War

> to provide for taking meteorological observations at the military stations in the interior of the continent, and at other points in the States and Territories…and for giving notice on the northern lakes and on [Atlantic] seaboard, by magnetic telegraph and marine signals, of the approach and force of storms. (US Signal Service, 1873, pp. 368–369)

This resolution is widely considered the origin of national weather services in the United States.

State investment in facilitating commercial trade through providing "notice" of the "approach and force of storms" articulated with other ways of governing social and commercial engagement with climate. For commercial specialization, climate knowledge promised a metric of tailored economic development that could be integrated into other statistical analyses of crop yields, labor conditions, and market access (see Figure 2).

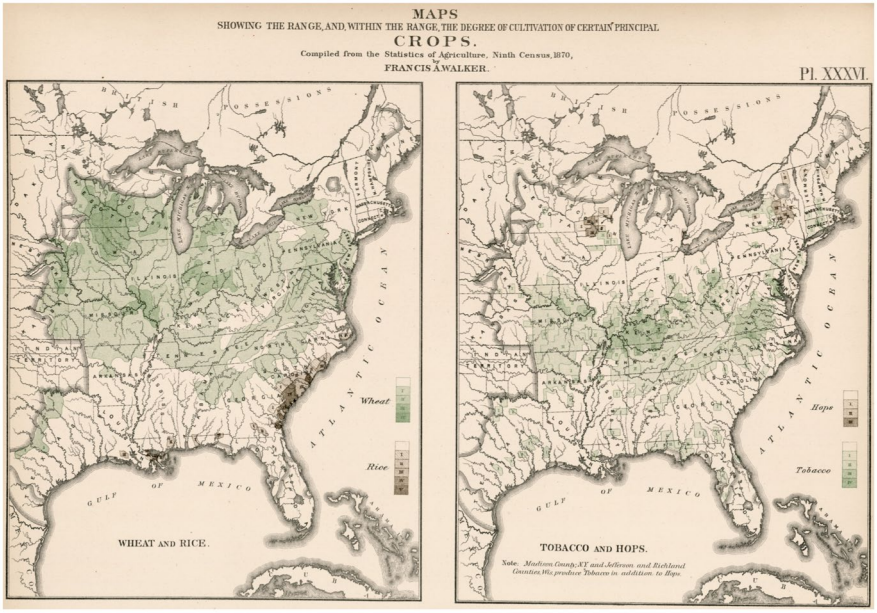

FIGURE 2 Plate 36 of the 1874 US Statistical Atlas, showing color-coded ranges of crop extent and cultivated yields

Efforts to make legible climatic zones for the purpose of economic expansion relied upon simultaneous efforts within scientific and state institutions regarding commercial agriculture. President Lincoln had established the US Department of Agriculture (USDA) in 1862 alongside the Homestead Act. The USDA formed the Office of Experiment Stations in 1888, following a decades-long struggle over whether and how the federal government would provide services for advancing scientific agriculture. The USDA *Farmer's Bulletins*, regularly published by state experiment stations beginning in 1889, routinely included government climate data in pronouncements concerning the climatic zones suitable to growing crops profitably (Dalrymple, 2009; Rosenberg, 1997). Around the same time, US states established their own weather bureaus to supplement national data collection and dissemination. For example, an annual report of the Oregon State Weather Bureau (in US Signal Service, 1889, p. 5) justified its establishment, claiming "the climatology in the State has never been observed and recorded in three-quarters of the State, as is necessary for the best promotion of the various industries." Facilitating climate-specific commerce became a clear governmental priority in order to mitigate economic risk: "Now [the farmer] employs implements and machinery which can be made only with large capital and the highest mechanical skill, and by men who make this manufacturing a business." Therefore, "research—the finding out of nature's secrets," is "costly," meaning "the more useful it is to be, the greater must be the outlay of money, labor, and scientific skill. Here, if anywhere, wise economy calls for the best" (p. 6; see also Harrington, 1895). "Wise economy" within science and government linked the logic of climatology directly to its commercial application.

Following the logic of commercial agriculture, in 1890 President Harrison signed into law the transfer of government weather services from the War Department to the USDA, establishing the US Weather Bureau and linking climatological expertise to the task of commercial development. Climatological expertise, once established in government, helped shore up a central principle that "the crude method of tilling the soil common in these days will certainly give way to an exact economical procedure, based largely upon the result of meteorological research, increasing in precision" (Bigelow, 1900, p. 85).

In reality, expertise within government weather services often held a complex, sometimes outright antagonistic, relationship to alternative formations of climate knowledge. One example comes from optimistic boosters

of settlement on the drought-prone Great Plains. Concerning railroad—as a fixed capital investment—boosters accentuated local climatic niches accessible by rail lines. For example, one Northern Pacific Railroad (1893, pp. 13–14) guide advertised:

> This great Northern Pacific system of railroads has opened to settlement, during the past few years, one of the fairest sections of the country—a region exceeded by no other…in its wealth of natural resources, and not surpassed in any of the conditions of climate or of soil which are best adapted to the well-being of the human race.

Although such pronouncements characterized climates of newly settled areas as well suited for development, railroad companies, settlers, and the US government poorly understood Western arid regions. In the space of uncertainty and boosterism, some considered climate less important to agricultural productivity, for example those adhering to dry-farming techniques (Libecap & Hansen, 2002). Hardy Webster Campbell's "Soil Culture Manual," for example, rendered climate subservient to techniques of managing soil moisture (Campbell, 1902). Such an approach to climate was also evident in his 1916 publication, titled "Progressive Agriculture: Tillage, Not Weather, Controls Yield." Yet simplifying the reality of the arid lands had by that point already been partly responsible for severe crop failures and exodus from the Great Plains during unanticipated drought (Sweezy, 2016).

Whether emanating from the Weather Bureau, commercial enterprises, or those that would challenge official constructions of climates, the meanings of climatic designations were primarily oriented to the economic productivity of specific regions. Climate change mostly did not register as significant. A stable climate did. If climate itself could not be "improved" (meaning, changed), as previous generations held, then stable climate zones could still support auxiliary efforts to improve soil, land, water, and settlement patterns. Improvement, in practice, entailed federal policy that could protect access to land and resources understood to be climatologically useful for given purposes. These processes expropriated indigenous forest and land use patterns (Warren, 2002), and as Whyte (2017) has shown, ruptured native relationships to climate. Climatology thus formed one dimension of the larger governmental project, at once rational and violent, of making legible and fixing in places the social relationship to territorialized climate zones.

6 | MAKING NATIONAL ADMINISTRATIVE CLIMATES

Climatologists, by bringing their science to bear on government-supported commerce, effectively related their accounts of climate "zones" with zones appropriate to administration. Making "administrative" climates could then facilitate government provision of climate information, which users had successfully argued to be of "vital necessity for the protection and advancement of commercial and agricultural interests" (US Signal Service, 1878, p. 36). Willis Moore, Chief of the Weather Bureau thus prefaced Henry's (1906, p. 5) major publication, *Climatology of the United States*, stating that the text provided important "comparative climatic statistics for the different portions of the United States." As Henry explained, the Bureau of Plant Industry (like the Weather Bureau, within the USDA) was introducing newly researched seed and plant varietals, meaning that the Department must map climates so that "the new plant or seed be placed in a climate closely resembling that of its original habitat." Plans to promote agriculture across the Department led Henry to conclude that "The ideal census of climatology, so to speak, is one that shall give the essential features for every county in each political division," to facilitate the USDA task of distributing seeds and managing programs based on administrative and climatological units.

The task of representing climates as "essential" characteristics of administrative units proceeded beyond the issue of seed technology. At the state level, the USDA Experimental Stations, State Weather Services, and Boards of Trade regularly communicated with the federal-level Weather Bureau. State-level installations undertook the

task of linking administrative governance to suitable observations or representations of local conditions, with the explicit aim of defining state-level climate.

How was climate represented in such a context? Ward (1915) discussed how Weather Bureau officials developed 21 "climatic subdivisions" representing "all groupings of districts and stations for convenience of administration, of forecasting, of the collection of data, or of reference." Over the first decades of the 20th century, the division of climatological areas changed because of "practicality rather than on homogenous climate considerations" (Guttman & Quayle, 1996, p. 294; US Weather Bureau, 1912; Ward, 1915).

Nevertheless, representations of climatological zones firmly shaped common understandings of climate beyond administrative convenience. They formed the basis for Weather Bureau studies, reports, and narratives that could structure popular discourse and regional economic strategies. Synopses printed in the Bureau's *Crop Bulletins* and in the Annual Yearbook of the USDA (e.g., US Department of Agriculture, 1906, pp. 473–491), for example, drew upon "normal" statistical averages to narrate "departures from the normal by districts." Seeing climate "like a state" (cf. Scott, 1998) meant that the administrative form supplanted prior understandings of the more open times and spaces that "climate" represented.

The invention of climate zones naturalized categorical differences (e.g., Figure 3; see also US Weather Bureau, 1912). Bourdieu (2014) aptly labels this process "state magic," that is, recording reality while, at the same time, consecrating its existence. Like how climatologists in other contexts had to confront the "real" versus "invented" nature of their purportedly empirical representations of climates (see Coen, 2018), Ward reflected on the arbitrary nature of "official" US climatic designations:

> There is no limit to the number of possible classifications, for these depend on any author's special interest or view-point, which may be climatic, or botanical, or physiographic, or one of administrative convenience. Even from the single view-point of climate alone, an almost infinite number of classifications might be proposed. (Ward, 1915, p. 675)

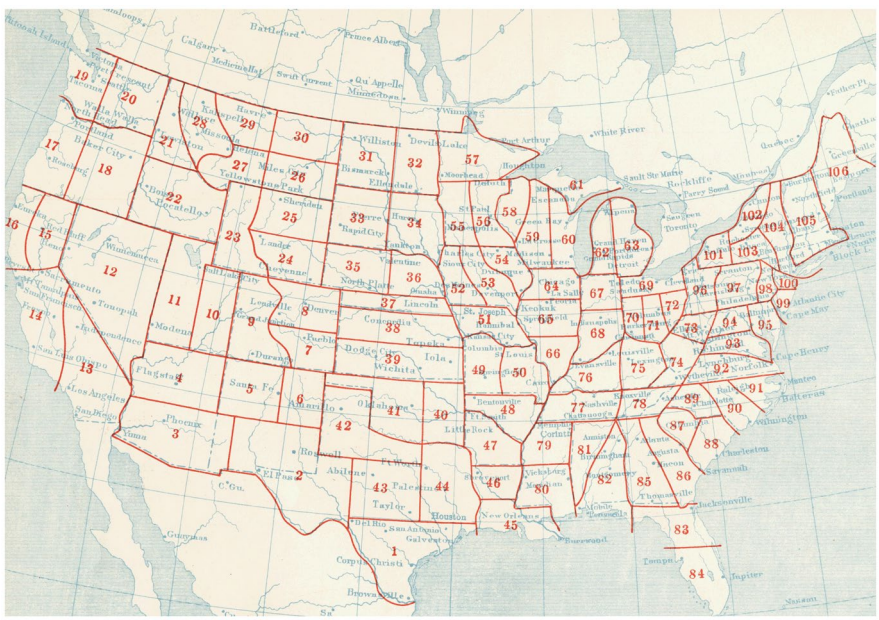

FIGURE 3 "106 Climatological Sections in the United States" (Source: Monthly Weather Review, 1911, Supplemental Charts 2, p. 670)

If such divisions of climate and their relatively stable features appear to make sense, either to Weather Bureau officials or to later generations, it is through the internalization of an administrative logic of territorial government—represented by a superimposed map of the United States—not through the inherent stability or geography of climate alone. The "positive climatology" proposed by Blodget (1857) had come to bear on geographic representations of the climates of the United States. As stable units became linked to administrative units, "climate" became legible to government actors. The state, because of the legibility of climates, could then *act* upon them—improve them, valuate them, and otherwise facilitate their integration into capitalist society.

7 | PLAUSIBLE ALTERNATIVES? MEDICAL CLIMATOLOGY AS A PATH LESS TAKEN

Could actors in this historical context plausibly have defined climate a radically different way? To avoid assuming the historical trajectories of climate knowledge to be self-propelled, let us consider one example of how things could have turned out differently, using the case of medical climatology.

At a time when scientists were only beginning to effectively capture the domain of climatology, some of those who identified with "climatology" were invested in alternative professional possibilities. In 1891, a group of scientists founded the American Climatological Association. The stated focus of their journal, *The Climatologist*, was "All matters relating to Climatology, Mineral Springs, Diet, Preventive Medicine, Race, Occupation, Life Insurance, and Sanitary Science." Their mission was to "become eventually an authority upon all subjects which are included in its title" (meaning *climatology*), especially by attempting to synthesize medical geography with bacteriology (American Climatological Association, 1892, p. 1). The Association's formulation of climatology did not subscribe to a view of stable climates, but rather built upon the previously dominant medical-topographic tradition. While rejecting a narrow view of climate, they also sought to retain an otherwise weakening paradigm of medicine. As one contributor, Dr Isaac Platt, put forth in an article on acclimatization:

> Nearly all the physical influences surrounding a human being…are those which go to make up what we know as climate. The air he breathes …the emanations from the soil; the water he drinks; the food he eats; …the climate to which he is subjected is practically co-extensive with his environment. (Platt, 1886, p. 104)

The holistic "environmental" approach to climatology that would maintain a connection to medical, human, and environmental sciences, failed to define the field.

To be sure, policies regarding "sanitary meteorology" and "climatic physiology" did persist even into the 20th century, if in a subordinate position (Edson, 1921; Meisinger, 1921). Greely (1888, p. 4), a former Weather Bureau Chief, had understood that industrial expansion and urban public health relied upon meteorology to evaluate "the fitness of local climates as a means either of extending the scope and extent of national industries or of alleviating human suffering and saving human life." A Weather Bureau circular in 1895 encouraged submission of vital statistics by Bureau service members and their volunteer networks in order to evaluate how "local climatic peculiarities" impact diseases and to apprehend where invalids and other "health-seekers" might best benefit from "visitation of health resorts and change of climate" (see Michigan Weather Service, 1895, p. 4). As Valencius (2002) shows, although medicine was becoming less central to the work of professional climatology, the business of health-seeking resorts remained popular in the latter decades of the 19th century. Yet, by 1895, one physician, F.R. Campbell (cited in Mitman & Numbers, 2003, p. 398) disparagingly wrote: "etiologists have at present almost given up the investigation of atmospheric causes of disease…They insinuate that the study of medical meteorology is a subject redolent with the ignorance of the Dark Ages." Medical education and physicians' practice from that point forward decentered medical climatology from accounts of most diseases.

The situation of medical climatology exposes a social contradiction in the designation of "stable" climates within capitalist society. Although climatology generally served to make legible "stable" climates, profit-seeking created novel, class-based experiences of climate. Government with respect to "good" and "bad" climates reflected class society. On the one hand, mobility of the rich entailed a newfound capacity to obtain "pure" air at resorts or by residence (Mitman, 2003). Taylorist attention to labor productivity, on the other hand, meant that the novel climates of industrial factories elevated the significance of regulating what science writer Mount (1921) called "indoor meteorology" that "makes all the difference between industrial success and failure." When Mount (1921, p. 188) outlined new air conditioning technologies that reduced the sweltering heat of textile factories, he reported, "it is possible to speed up machines and workers alike and at the same time to lessen the hardships imposed on both, simply by the use of manufactured atmosphere." Governing the deteriorating air quality experienced by workers centered on productivity at the time when the consumption of pristine environments became a prerogative of the leisure class (Cronon, 1996). The changing, socially stratified relationship to atmospheres notwithstanding, climatologists primarily centered on climatic stability, which matched predominant economic and administrative concerns.

8 | THE ENDURING LEGACY OF CLIMATIC "STABILIZATION": A ROLE OF HISTORICAL SOCIOLOGY

In the United States from the 1850s to 1920, the relationship between "positive climatology" and agricultural capitalism dominated the "co-production" of climatology within science and government. This process not only spurred a new scientific specialty, but also established the discourse proclaiming climatic stability, forged even as it was in an era of rapid social and environmental change.

There were consequences. First, the central discourse of climatic stability supplanted concerns with climate change. In his 1924 textbook, *Climatic Laws*, climatologist Steven Visher presumed geographic distribution as the basic boundary around the project to establish "laws of climate." Yet what about climate was law-like? Except for Visher's first stated law, that "climate changes with the nature and effectiveness of solar radiation," the remaining 49 laws dealt with geographic (as opposed to temporal) distributions. For Visher, along with his students and contemporaries, the fruits of Blodget's (1857) declaration of "positive climatology" had achieved paradigmatic status. What Blodget had to make explicit, Visher could by and large take for granted. The major shift that took place within science and government led to a basic shift in the very meaning of "climate" and what it meant to govern society in relation to climate.

As an enduring consequence, the co-production of "climatic stability" in part explains why climate change became so difficult for climatologists in the United States, along with those who came to inhabit industrial-capitalist climates, to consider climate change beginning in the mid-20th century (Baker, 2017; Henderson, 2014). Scientific and government interests had, for decades prior, practically operated on the assumption of an unchanging climate, an assumption that was itself a product of historical developments rather than of a stable climate alone. Climatologist Hubert Lamb (1959, p. 299) therefore argued that by treating climate as "normal" and "static," dominant scientists had come to denigrate climatology as "the dry-as-dust book-keeping branch of meteorology." Once global climate change started to galvanize atmospheric sciences, university-trained researchers invested in "climate science" likewise positioned their work against what some understood to be the "moribund climatology" of the early 20th century, as meteorologist Peter Lamb (2002, p. 4) put it. As one result, Lahsen (2013) shows in the US context, conflicts in climate science in the late-1970s were structured by conservative movement capabilities to exploit "skeptical" positions amongst "traditional" climatologists. However farcical, discourse of stability persistently features in skeptical ideology: "Nature, Not Human Activity, Rules the Climate" was the title that announced the Heartland Institute-funded "Nongovernmental International Panel on Climate Change" 2008 report. Skeptics like these argue not only that humans lack the geophysical agency to change climate, but also that

climate is fundamentally stable. This ideology resonates with findings from American public opinion surveys. For instance, Leiserowitz, Smith, and Marlon (2010) find that a large majority of those who do not think global warming is happening hold a mental model, in which "Earth's climate system is very stable," as opposed to "fragile" or "gradual to change."

If on the one hand skeptics and many of their unwitting followers hold to a myth of a stable natural order (that aligns with capitalism in particular), then on the other hand, climate-change policy holds to a discourse of climate "stabilization." Since the establishment in 1992 of the United Nations Framework Convention on Climate Change, the dominant international policy goal has been to reduce greenhouse gas emissions and thus "stabilize" global warming and avoid "dangerous interference with the climate system" (United Nations, 1992). Boykoff, Frame, and Randalls (2010) show that "climate stabilization" has anchored climate discourse beginning with the preparatory work for that Convention. Although the object of stabilization varies discursively, a core premise is that climate change must be stopped by restoring a prior climate state or creating one that resembles it. Thus, according to Rockstrom et al. (2009) the "relative stability" of the Holocene period (the epoch since the last ice age) represents the "scientific reference point for a desirable planetary state" (see also Berger & Loutre, 2002).

In response to repeated policy failure to ensure meeting "stabilization targets" for global temperature (National Academy of Sciences, 2010), however, an increasingly important component of climate governance is to research and operationalize geoengineering to modify or "optimize" global climate (Crutzen, 2002, p. 23). Thereby climate could remain compatible with expanding fossil-based global capitalism, if only as a "Plan B" to remain within the "climatic boundary" of human society (Gunderson, Stuart, & Peterson, 2018; Rockstrom et al., 2009).

Although 'climate stabilization' is shot through with power relations and assumptions about society, historical sociology has yet to orient analysis towards these challenges. For example, the momentous volume of historical sociology, *Remaking Modernity* (Adams, Clemens, & Orloff, 2005), makes no mention of either historical climate change or the issue of global warming. Historians of science focusing on geoengineering (Fleming, 2010; Harper, 2017) have adeptly analyzed the hubris involved in efforts to technocratically master nature. Climate and social scientists have also argued that presenting climate change governance as a global stabilization effort obscures the social inequalities and political issues that mark climate-change causes, consequences, and impacts (Boykoff et al., 2010; Geden & Beck, 2014; Taylor, 2014). Yet we have little understanding of the historical roots of climatic stability and stabilization as problematics of government and knowledge.

Rather than a logical or inevitably necessary response to global warming, goals to govern global climate via climate stabilization invites further historical assessment of how scientists and others have variously viewed climate in terms of (in)stability. Historicizing global warming and climate change is a necessary but insufficient focus for ongoing research. Here, historical geography and a social science turn in the history of meteorology is instructive for sociologists who might pursue historical sociologies of climate (Mahony & Caglioti, 2017). In her analysis of climatologists of the Habsburg Empire, Coen (2018) showed that climate science is indelibly a matter of "scaling," that is, linking together various spatial scales from the bodily to the planetary. In the process of scaling, climate knowledge ties up with power-laden geographic constructions such as empire. The *spaces* of climate are thus socio-historical achievements rather than given by nature alone. In this article, I advance a similar argument regarding the *temporalities* of climate. The industrializing United States provides one illustrative case of how climate knowledge intersected with capitalism and state formation and in the process recast how social actors practically approached the basic temporality of climate, that is, as stable and unchanging.

Today, science remains a critical link between climate policy and the vision of a once again stable climate. The socio-historical dimensions of science and its relationship to government will thus remain important to how various actors garner intellectual resources to imagine alternatives to climate crisis and create the kinds of climate knowledge that can support those alternatives.

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DATA AVAILABILITY STATEMENT

The historical data that support the findings of this study are available upon request from the corresponding author.

ORCID

Zeke Baker https://orcid.org/0000-0001-7544-8369

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