The earth has been in an interglacial period since the beginning of the Holocene. The interglacial is a period designation that defines a biosphere by its limited ice sheet cover. As opposed to a glacial period (a time of great ice sheet covering, where significant stores of the biosphere's water are locked in ice), interglaciality defines a globe of mostly, but not entirely, unlocked water, where flows of water move and stray across regions. As the people of the Standing Rock Reservation and their allies have made clear, water is life.[1] The possibilities of the period's watery ways are profound. Many worlds have taken form through the offerings of water, and just as many worlds have been broken or taken away by water's harnessing.

For example, where I live in Philadelphia, on the historical and present-day land of the Lenape, there are rivers and creeks that flood city streets and residents' basements when we get a lot of rain.[2] Waters from Cobbs Creek and Darby Creek join in Southwest Philadelphia, and there they merge into zones of former marshland, the marshland itself abutted by the Schuylkill and Delaware Rivers. When it rains, the water pours. The marshland subearth—on top of which whole communities, and even an airport, rest—bubbles, and the city becomes the sink of the land. The shore seems adrift and, along with it, homes and highways, Superfund sites and sewer waters. But some places get more soaked than others: there, the water is more violent and the weather is uncertain.[3] As climate change makes clear—from Southwest Philadelphia to fifty-eight small, low-lying island nations facing rising waters—the weather is a violent uncertainty. Weather affects all living things, and its impacts are unevenly distributed and exacerbated in regions already facing environmental injustices. Some communities are drowning while others are starved for water.[4]

The geological interval of the interglacial is a scientific designation that underscores the importance of water for life. While the interglacial is a geophysical event with material constitution, it also has, as Kathryn

Yusoff suggests, "social effects." Within the interglacial, we must trace "power relations and relations of force."[5] Certain geosocial formations were chosen, built, and furthered through differing forms of colonialism, from settler colonialism to internal and external colonialisms. Where the Anthropocene is the signature of settler violence in the geological record, the interglacial is the geophysical plane—the stage—on which the Anthropocene has been played. As Heather Davis and Zoe Todd have shown, in its original and now popularized framing, the Anthropocene fails to account for power, differential environmental harms, naming the perpetrators of harm, and holding them accountable.[6] It misses how the geophysical formation of the interglacial has been harnessed to particular world-building ends by settlers, and particularly settler colonialists, as they have used unlocked waters to trespass and lay claim to lands, air, waters, and peoples for settler world-making.

I refer to "settlers" and "settler colonialism" many times throughout this book. When I refer to settlers in this work, I am referring to white populations who historically dispossessed, or who participate in the present-day dispossessions of, Indigenous peoples from their homelands across the United States, and who participated—or whose ancestors participated—in systems of enslavement. In this book, settlers are historic populations (and their present-day descendants) who came to Turtle Island of their own free will, and not under the system of chattel slavery, with the intention to homestead, claim sovereignty over Indigenous lands, and build systems that upheld and perpetuated chattel slavery and Native genocide.[7] Though many settlers see the current flooded, extreme-weathered, and heat-laden world as a new, late twentieth-century occurrence tied directly to the scientific designation of the Anthropocene, the drama of the Anthropocene and its attendant injustices has been playing out for centuries and is, in the US context, directly tied to the sovereignty settlers claim to have over all biospheric life.

Centuries of water move between soil, air, and people over and over again. In a grand converging, the weather mixes everything up; it binds the substrate of the earth and, as this book will argue, binds us to the unexamined and harmful settler worldviews that have shaped environmental data collection in the United States. Weather knowledge is a kind of knowledge that can both sustain and shatter life. This book focuses on the weather knowledge that was produced through data gathering, and practices of quantification more generally, in the US settler states from roughly 1820 to the time of Hurricane Sandy in 2012 and reveals that

weather cannot be assumed as a universal experience, set of phenomena, or collection of captured data. *Immeasurable Weather* takes up weather-dependent settler colonialism and rescripts settler environmental data collection as part of the larger project of settler colonialism in the US settler states. I argue that data gathering and quantification gave coherence to a national weather project, and to a notion—grounded on settler and heteropatriarchal values—of "nation" itself. Further, this book elaborates settler complicity in assembling and upholding an instrumentalized view of weather with the goal of settler world-building at all costs. This included dominance and dispossession of Indigenous lands and waters, genocide, and the building and perpetuation of systems of enslavement and white dominance. Much as Traci Brynne Voyles has done in *The Settler Sea* with regard to the Salton Sea, this book "examines the ways that settlers maintain, shape, manage, and mismanage the nonhuman world . . . restructur[ing] physical landscapes in ways that exert and reinforce processes that are part and parcel of colonial power relations in the United States."[8]

Settlers utilized notions of data to disentangle themselves from networks of relationality, responsibility, and accountability. This separation, explored throughout the book, is a loss that can be felt on multiple levels. It can be felt in terms of the effects that petrocapitalism has had on frontline and high-risk communities and more-than-human members of the biotic world. This separation resounds in the ways that settlers themselves are bereft of their own relationality in historical memory, practicing a collectivized forgetting of the violence they perpetrate, and have perpetuated, in the name of settlement, whiteness, and capital accumulation. This book studies the emergence and evolution of weather data from and within the frame of local, settler data making in a US context across the nineteenth and twentieth centuries. In refusing to study settler science from a "universal position" and in seeking to "write from where I know," I uncover the individuals, communities, and ideologies that have built and informed settler weather science in the United States from the early nineteenth century to the present.[9] This is not a history of institutions, although institutions are central characters. It is a history of networked settler volunteer communities and their popularization of data as a fundamental category within the settler environmental imagination.

The following examples—which are in no way exhaustive—reveal how the material condition of a geophysical world of unlocked water was harnessed to enact harm while traveling hand in hand with scientific,

and often meteorological, capture: (1) The British Empire utilized water and weather data for territorial expansion when, throughout the eighteenth century, the East India Company kept logbooks of the weather from 1786 to 1834 on "empire voyages" from southern English ports and the east coast of India, Indonesia, and southeast China.[10] (2) The Dutch utilized weather journals on their colonization crusades to Java and elsewhere.[11] (3) The United States used military forts across the continent as weather data collection stations, which aided in wartime and nation-building terrain advancement, Indigenous dispossession, and settler world-building.[12] (4) The US Air Force, and specifically the Air Force Fourteenth Weather Squadron, collected upper-air radiosonde data from Iraqi Meteorological Department launches across the period of 1958–89, which were used "as reference for flights during Operation Desert Storm in 1990–1993."[13]

The history of science's relation to injustices such as settler colonialism and capitalism in the US settler states has been explored through the work of scholars Tony Perry, Emily Pawley, Paul Lucier, and Conevery Bolton Valenčius. In his article "In Bondage When Cold Was King: The Frigid Terrain of Slavery in Antebellum Maryland," Perry elaborates on "the ways enslaved people leveraged cold weather against slaveholders," revealing how enslaved people and slaveholders "differently mobilized wintry environments against one another in contests over power." In detailing the ways that "slaveholders and the enslaved leveraged elements of the dynamic environment against one another in efforts to assert their respective wills," Perry's research attends to the weathery power relations within the Little Ice Age of antebellum Maryland.[14] In *The Nature of the Future: Agriculture, Science, and Capitalism in the Antebellum North*, Pawley documents the beliefs and practices of "improving agriculturists" in the antebellum North, who approached nature as a "balance sheet." In studying the agriculture of New York, Pawley shows how settlers made nature "legible, measurable, and above all calculable" for the purposes of capital gain.[15] Lucier has documented the ways that scientists have acted not as stewards of the biosphere but as extensions of the capital marketplace. In *Scientists and Swindlers: Consulting on Coal and Oil in America, 1820–1890*, he explores the relation between American earth scientists and the mining industries of the nineteenth century.[16] Valenčius argues that nineteenth-century settlers experienced a "profound connection" with the western agricultural landscapes they sought to inhabit and that settlers' own bodies were sites of environmental and medical connec-

tion with the lands they occupied.[17] Building on this work, *Immeasurable Weather* attends to the interplay of settler colonialism, patriarchal power, and whiteness across a two-century history of settler investment in meteorological data culture.

Additionally, while the relation between Enlightenment science and nation-building has been well attended to in the British, German, and Australian colonial periods, this kind of work has not been done for the post-1800 United States.[18] Jan Golinski has revealed that the origins of weather observation in Enlightenment Britain date back to 1640. Although weather observation was not an official branch of the nation-state, it was part of public culture: weather observation was an important practice for conquest, as knowledge of climate conditions in occupied territories shapes colonial power.[19] In the US settler states—the focus of this book—weather observation functioned similarly as a form of deterritorialization; it also connected settlers to the idea (and the locally situated practices) of a scientific nation-state.

Settler colonialism posits a particular relation to land and is, as Patrick Wolfe argues, a "land-centred project."[20] As Eve Tuck and Marcia McKenzie note, "Settler societies are based on ongoing displacement and dispossession of people in relation to land" and are founded on "deep behaviors of ignorance toward land, water, environment, and sustainability, as evidenced in fuel extractions, agricultural practices, pollution and toxic dumping, hyper-development, and water use."[21] For settlers, weather data enacted settler worldviews that environments—from weather to water to biota—were objects to be measured, with their meaning and value resting in their capacities to be known through quantification. Weather data obfuscated relationality. Relationality—or the lack thereof—is a major theme in this work. By relationality, I mean to analyze the ways that settlers historically related to the more-than-human environments they occupied—from soil to water to air—across the US settler states.[22]

Importantly, settlers did not think of land as *Land*—as Sandra Styres, Celia Haig-Brown, and Melissa Blimkie describe it—an "animate and spiritual being constantly in flux," which "encompasses all water, earth, and air."[23] Following Styres, Haig-Brown, and Blimkie, as well as Max Liboiron, the capitalization of the word *Land* here refers to "a proper name indicating a primary relationship," whereas "small-*l* land" refers to "the concept from a colonial worldview, whereby landscapes are common, universal, and everywhere, even with great variation."[24] Throughout this

book and the history it tells, I use *land* in the nonproper sense to indicate the relationship settlers had with the Lands they occupied. Liboiron continues, "Calling out proper nouns so they are also proper names is part of a tradition where using someone/thing's name is to bring it out of the shadows and engage it—in power, in challenge, in recognition, in kinship."[25] While I recognize the Land that has allowed for my research to take place—that has nourished and sustained me, as well as comforted me in times of uncertainty—I also recognize that the historical actors of this book act toward land and not Land. That is an important distinction that has an impact on how these historical actors were able to conceive of relationality.

While nineteenth-century settlers understood there was a deep connection between the health of their bodies and the lands they occupied, settlers' own understandings of body, land, and health were deeply entrenched in ideals such as "freedom," as well as their belief that the land was theirs to settle and exploit through agriculture.[26] Their way of relating to the land—even when through the "health" of their bodies—was uniquely tied to the logics of settler colonialism, which I argue separated "knowledge from responsibility," in the words of Robin Wall Kimmerer.[27] Part of the journey of this book is to uncover how data culture separated the knowledge of weather and climate from responsibility. Across the book, I refer to the US settler states as a nation-state. When I use this language, I am referring both to material processes (such as the building of settler infrastructures like railroads, forts, and data centers) that allowed for the proliferation of settlement and dispossession and to the ideas (such as domination of environments and property ownership) about the land and the weather that shaped these processes.

Climate change is the logical product of the ways that settlers have related to the environment through data infrastructures.[28] Settler data culture was built by separating knowledge from responsibility, and this relation helped conceive of, project, and further American weather culture. Data culture stabilized a form of relating to environments that isolated the weather—and other parts of the world—as objects to be studied rather than as subjects to be respected and understood through systems of reciprocity and care. This made several ways of life possible for settlers. First, by upholding quantification as the primary means for knowing and making environmental knowledge in scientific spheres, settlers practiced erasure. Their prioritization of Enlightenment measurement schemas marginalized Indigenous environmental knowledges dating

back to time immemorial. Traditional ecological knowledge (TEK) holds various understandings of weather's relation to living systems, human and nonhuman. Raymond Pierotti and Daniel Wildcat write that TEK might be considered "an intellectual foundation for an indigenous theory and practice of politics and ethics, centered on natural places and connection to the natural world."[29] Importantly, as Heather A. Smith and Karyn Sharp point out, TEK is a contested concept, which has "many definitions" and for which "there is no consensus of an operational definition applicable across disciplines."[30] These knowledges existed long before settlers began measuring the weather in this period, and they continue to exist well beyond nineteenth- and twentieth-century settler colonial expansion.[31] Second, as they continued to build data culture, settlers engaged in a collective forgetting that "obscure[d] and eviscerate[d] memory" of colonial violence—genocide, forced removal, and settler colonial "education" systems—that made scientific measurement possible. This "foreclosure of knowledge" produced a sense of history with "all harm, trauma, and associated accountability" for settler colonial violence firmly rooted in the past. This resulted in a settler subjectivity that was and remains occupied with "the settler as innocent and desiring of democracy, fullness, and opportunity."[32] These foreclosures, and the subjectivities they created, are not separate from the history and culture of scientific knowledge making in the US settler states, but rather are origin points for the evolution of meteorological science itself.

This book treats the ubiquity of settler practices, technologies, and their links to a pervasive understanding of white supremacy as the backbone for meteorological data production in the US settler states. From these things grew not only meteorological science but also the notion of a nation grounded in a subjectivity of whiteness. As Audra Mitchell and Aadita Chaudhury elaborate, whiteness can be understood as "a set of cultural, political, economic, normative, and subjective structures derived from Eurocentric societies and propagated through global formations such as colonization and capitalism."[33] Understood in this way, whiteness is created through "multi-scalar structures," is not "reducible to skin pigmentation, genetics or genealogy," and "is remarkable in its ability to render itself invisible to those who possess and benefit from it."[34] Scientific practices, the building of settler subjectivities, and the production of the project of "American" weather were integral to the larger purposes of settler colonialism and whiteness.

While this work focuses on settler colonialism as a structure that is

historically "land-centered," Tiffany Lethabo King has elaborated on the ways that the preoccupation within settler colonial studies "with the settler's relationship to land, or terra nullius . . . displaces how settlers also become conquistadors/(humans) through Native genocide and Black dehumanization."[35] Rather, King argues that "conquest," as opposed to the settler's relationship to land, "is a larger conceptual and material terrain than settler colonialism and far more suited for the regional/hemispheric particularities of coloniality in the Americas."[36] Following King, this book does try to attend to the ways conquest and land theft were interlinked processes that aided the development of meteorological data collection and the development of a national meteorological science. However, this book's dominant focus on white settler scientific production, or "the elucidation of the settler and their concerns," risks "interrupt[ing] [the] examination of the violence of the slave trader and serial murderer of Indigenous people."[37] This underlying tension is part of the book and has not yet been resolved. In marking the nexus points of white settler scientific world-building, my intention is to allow for other ways of conceiving of and relating to the biosphere that exceed settler colonial and conquest-based structures.

As settlers learn to float in a world we have sunk, we must reckon with the ways that, to return to Kathryn Yusoff, "different forms of inequality have result[ed] from the differential harnessing of these geopowers."[38] The environments we inhabit and the measurement systems we have built and continue to build have been used by us, and our communities, in a type of settler world-building, which has structurally disenfranchised Black and Indigenous communities, as well as many others. The Anthropocene does not signify humans' altering of the geological strata, but is rather the material articulation (the living sediment) of what settlers and "petrochemical companies and those invested in and profiting from petrocapitalism and colonialism" have enacted in and across the interglacial.[39] Data capture was, and continues to be, a central logic in this interglacial world, a logic that fuels the writing of the Anthropocene strata. The history of data's emergence and messy evolution in the melting zone of the interglacial period was and is uniquely bound to settlement ideology, an ideology that is literally deadly—an ideology that counts the biosphere, and the life within it, as capital. In the United States specifically, the "language of numbers" was an "enumerative strategy" that buttressed and created a coherent settler colonial space.[40] *Immeasurable Weather* asks what interglacial data making looks like in the settler con-

text and traces the differential knowledges that data making has proliferated in this context.

IN HIS 1856 SECRETARIAL REPORT for the Smithsonian Institution, Joseph Henry pleaded for public patience. He was overworked and overwhelmed, and he needed help processing the stacks of meteorological data sheets that had been accumulating for almost a decade at the Smithsonian's Meteorological Project office in Washington, DC. Henry's team had been steadily reducing incoming data since 1849—all sent from Smithsonian Meteorological Project volunteers across the United States—but by 1856 there was simply too much data for Henry and his team to process, reduce, and send to print. This was a problem not only for the Smithsonian but also for the public it served, which had developed an insatiable appetite for weather data over the last half century. Along with a trusted friend and scientist, James Coffin, a professor of mathematics at Lafayette College, Henry came up with a plan. These two white men decided to hire white women—whom, they agreed, they could pay significantly less than men—to solve the problem of data overload. By 1857, "twelve to fifteen persons, many of them females," were employed as human computers to reduce meteorological observations by converting numerical weather observations from across the country into data sets.[41]

This nineteenth-century intersection of settler science, an overwhelmed institution, and gendered labor sits at the origin point of contemporary US understandings of weather, data, and climate. This book charts the two-century history of weather data by investigating the labors associated with bringing data to life, the diverse media forms that data took, and the social embeddedness of environmental science in settler colonial communities. Roughly two hundred years before "big data," mid-nineteenth-century human computers and meteorological volunteers interfaced with locally situated weather reports, which would gradually become significant and impactful climate data.

In the mid-nineteenth century, data collection shifted from an East Coast practice to one that attempted to encompass new settler territory as far as the ancestral lands of the Ramaytush Ohlone, or what settlers call San Francisco.[42] The first settler weather observations from this territory were taken by Lieutenant John C. Frémont of the US Army in 1845, five years before California's recognition a state. First as invading armies, and then as "volunteers" and "experimenters," different formations of

settlers from across the nineteenth and twentieth centuries aided the US government in creating a vast, relational weather database in which all historic and contemporary data points could be put into conversation. Over two centuries, settler experimenters, government employees, volunteers, and institutions used the language of data to produce and share "knowledge of our climate in all its relations," as Joseph Henry described in 1852.[43] They used data to create a coherent national space that foretold settler futures and settler pasts through data archives.

This book centers around key moments of environmental data configuration, rupture, and crisis across two centuries. I tell an intergenerational story of data labor, with specific attention to how these labors nurtured ways of understanding one of the most important forces shaping everyday life: the weather. My research locates the rise of data as a concept and practice and then documents its monumental shifts across the technological landscape of the last two centuries. Tables and graphs were tools of settler colonial territorial advancement and world-building. Throughout the book, I study how correspondence, scientific journals, instruction manuals, reports, manuscripts, and newspapers from the Smithsonian Institution, the National Archives, the National Aeronautics and Space Administration, and National Oceanic and Atmospheric Association (NOAA) research centers articulated a national concept of data that allowed for the imagination, sustenance, and proliferation of settler worlds. My broad analysis of these archival documents provides the backdrop for detailed portraits of five different communities of weather data laborers.

As a settler scholar living and working on the Lenape lands, I struggle with the stories of weather science and environmental data capture that have been told by settler scholars. These stories that settlers tell themselves about weather science are rooted in notions of discovery, experimentation, and seemingly democratic or grassroots science.[44] But they pay no mind to the ways that "grassroots," or "citizen," science was enacted in the early to mid-nineteenth-century period by non-Indigenous peoples in order to claim "settler sovereignty over all things"—specifically, land, air, water, and the "subterranean earth."[45] These stories of Enlightenment objectivity and scientific progress have been incredibly mobile within the history of science, within environmental history, as well as in science and technology studies. If we tell ourselves stories in order to live, as Joan Didion once said, then we need to interrogate the kinds of living that these stories in particular make possible. My work investigates how, in

the United States, quantifying the weather was tied up in existing injustices such as settler colonialism, patriarchal power, and white supremacy.

Weather science and data collection emerged as a practice and flourished in the nineteenth century while several communities faced injustice and violence, some through forced removal from their ancestral lands and others through forced enslavement. "Citizen science" traveled hand in hand with settler territorial aims and claims, patriarchal power, and white supremacy.[46] Whiteness was a powerful category across the nineteenth century, as Gregory Smithers argues,[47] and well before then, as Cheryl Harris has shown. Harris points to the ways that the social construction of race was active as early as the seventeenth century, where "laws parceled out differential treatment based on racial categories." Smithers argues that the category of whiteness was contested across the nineteenth century.[48] Yet, I argue, despite this categorical contestation, whiteness shaped power structures in this period and much earlier; as an orientation, Sara Ahmed writes, whiteness "puts certain things within reach . . . not just physical objects, but also styles, capacities, aspirations, techniques, habits."[49] My research takes seriously the phenomenological and ideological power of whiteness across this period, noting that while some settlers articulated themselves through discourses of "whiteness," documents from settlers more often make "implicit race and gender dimensions."[50] Understanding oneself as white was not, in fact, the primary way in which whiteness acted historically. Ahmed further suggests the operation and coherence of whiteness as an "unnoticing." Unnoticed whiteness by white people is part of its power—the fact that white bodies do not have to face their whiteness is the operation of its privilege.[51]

Reporting weather data to institutions throughout the nineteenth century required an address. This means that performing science was tied up in land occupation and the rights of property ownership, which was afforded exclusively to white settlers at the time.[52] The National Centers for Environmental Information, part of NOAA, categorizes nineteenth-century weather data from the unceded lands of the Dakota and Lakota peoples as "climate data records" without any acknowledgment that these data were gathered by generals who were occupying such lands.[53] Settlers utilized these occupations not only to overharvest habitats and animals, which were crucial to Indigenous—here, Dakota and Lakota—life but also to gather meteorological data to send back to the federal government, data that furthered settler knowledge of local climate and ter-

rain, and thus advanced settler movement and the creation of settler infrastructure in the region. The violence of settler appetites—and especially settler institution appetites—for environmental data has not faded over time but rather has intensified, as the recent Mauna Kea Hui resistance to the Hawai'i State Land Board and the University of Hawai'i's plan for an astronomical telescope on the sacred lands of the Mauna Kea shows.[54] While scholars of science, technology, and society have been studying the sociocultural dimensions of data big and small by attending to the history of cybernetics and nineteenth- and twentieth-century human computing, such studies rarely explore the environmental dimensions of data, or data as a form of settler colonial world-building. Additionally, though historians of technology have begun to ask questions about twentieth- and twenty-first-century labor, from YouTube content moderation to "gendered technocracy" in British computing, these inquiries into data labor have yet to tackle environmental data in particular.[55] At the same time, critical inquiries into the history of information have not played a major role in the scholarship of settlement within the field of environmental history to date, nor has the relationship between settler colonial world-building and Indigenous persistence and erasure been fully addressed.[56] Historians of climate change have begun to historicize information graphics, but their lack of attention to the cultural production of data itself has left us with a dim understanding of cultures of environmental data as well as that culture's emergence among a gradually professionalizing scientific community that included underpaid women in the nineteenth century.[57] *Immeasurable Weather* bridges the gaps between these fields by centering an environmental humanities lens that attends to the hinge space between these fields.

Immeasurable Weather is a necessary book for today's world not only because it bridges these disciplinary gaps but also because it illuminates why all the data in the world will not be an elixir for extreme weather, environmental collapse, and climate change. Though settler scientists and environmentalists imagined that more environmental data would increase environmental action and change, quite the opposite has happened. *Immeasurable Weather* explains this phenomenon through a sociocultural history of environmental data, situating the close reading of primary source materials—from letters enclosing live specimens like locusts to hand-filled data forms—alongside cornerstone questions belonging to environmental and information studies. I track how weather has become a numerical experience, a form of data itself, and I

ask how US communities in the nineteenth and twentieth centuries perceived the weather as a distinctly numerical phenomenon, why it was so important to do so, and the inheritances of that thinking. In asking these questions, I assert the link between settler colonialism and top-down as well as bottom-up scientific practice. I frame settler environmental data as resonant for media and information studies, history of science, and especially environmental media studies.

In the US settler states, data emerges and gains popularity in the specific context and evolution of American weather. In exploring the rich environmental origins of data, each chapter illuminates the power that everyday communities have in shaping data. First, I argue that between 1820 and 1890, data was conceptualized by a public sphere whose efforts would lay the groundwork for the National Weather Bureau and, later, the National Weather Service. Settler farmers and teachers were building conceptual frameworks for American data in this period—frameworks that were centered on tactility—but they were also the original advocates for and compilers of American climate archives. Next, I argue that, from 1890 to 1940, data was reconceptualized once again when Weather Bureau workers and Dust Bowl weather volunteers are tasked with data stewardship in a landscape of automated instrumentation and weather crisis. Finally, with the rise of meteorological satellites in the 1960s, data is more formally enmeshed in military-meteorological nation-state structures. As such, data moves away from locally situated systems of caretaking and toward instrument-oriented and semigalactic perspectives that further obscure settlers' bonds to the environments they inhabit. This obscuration is often crystallized during crisis events, such as Hurricane Sandy, the final focus of the book's concluding chapter. In exploring these formative periods, I highlight the ways that humans have been producers, computers, compilers, and caretakers of data. I explore what these relationships with data have meant historically, how they can be used to contextualize data today, and how they might be employed to transition to a more just environmental future.

The history of data, the pervasiveness of data, and data's relation to injustice have been attended to by numerous scholars, including Catherine D'Ignazio and Lauren Klein, Lisa Gitelman, Rob Kitchin, Kathleen Pine and Max Liboiron, David Ribes and Steven Jackson, and Daniel Rosenberg.[58] D'Ignazio's and Klein's *Data Feminism* positions data as "a double-edged sword," where "data is power" and "the power of data is wielded unjustly."[59] Gitelman understands data as a cultural form, made

and remade through communities of practice.[60] Kitchin treats data as a recent historical manifestation, offering definitions of big data as well as advice for harnessing data in contemporary research landscapes.[61] Pine and Liboiron attend to the "measurements, the artifacts and practices that form some of the smallest units of quantification underlying data, algorithms, and other vectors of representation" that "power dynamics, knowledge systems, and culturally-based assumptions."[62] Taken together, Gitelman, Kitchen, and Pine and Liboiron help question notions of raw data, positioning data as a product of social and cultural factors. Rosenberg adds the understanding that "data" itself was shifting in meaning across the nineteenth century, operating at the beginning of the century as the "premise" of investigation but as the "result of investigation" at the end.[63]

Meanwhile, in histories of science, scholars have rightfully addressed data gathering and environmental display as sociocultural processes. Lorraine Daston and James R. Fleming show how scientific observation—a form of data gathering—emerges across institutional networks.[64] Much like Gitelman and Kitchen, and Pine and Liboiron, historians of science also illuminate the situated practices that render data a product of culture. While environmental history scholars have been less concerned with data proper, Kristine Harper and Joshua Howe have contributed to our understandings of environmental data display.[65] Harper considers the art of meteorology within the history of meteorological computation, arguing that computational display was both a science and an art in the postwar period. Similarly, Howe explores theories of the natural lurking behind environmental displays like the Keeling curve (a graphical representation of atmospheric CO_2). Taken together, these works develop a rich, transdisciplinary approach to the study of data concepts and observational and display practices. My book enriches this approach by offering a deep history of weather data culture, asking how data itself grew roots across the US settler state and how these roots have spread over the last two centuries.

As this book demonstrates, weather data recording and measurement have deeply shaped settler environmental consciousnesses, access to land and Land, and the capacity for settlers to narrate their past and imagine a future.[66] In this book, I isolate the ways that settlers in the United States have come to understand the weather through systems of numerical capture (today is seventy-eight degrees with fifteen-mile-per-hour winds

from the west), and specifically the ways that these numerical systems mobilized settler perspectives and worldviews. Settlers crafted a national concept of data, and this concept organized settler worlds around the quantification of environments, leaving little room for relations of reciprocity and responsibility with the worlds they inhabited.

CHAPTER 1 BEGINS with the story of two volunteer observers in Ithaca, New York, and their daily routine of observing the weather in the mid-1820s. The chapter then expands out to consider a regional network of newly titled "weather observers" across the northeastern United States and the ways in which this network utilized weather measurement to uphold settler claims to territory and build archives of settler environmental knowledge. Data collection in this period grew out of land surveying, which furthered Indigenous land theft: collecting "national" data meant extending and occupying unceded territories. The network of observers who furthered settler surveying and data collection included members of institutions such the New York State Regents, the Franklin Institute, Girard College, and the Maryland Academy of Science and Literature. I show that as settler volunteers around the eastern United States collected daily weather observations, they created an origin story for settler environmental knowledge. Over the course of the early nineteenth century, these observations would become a collection of regional meteorological data points. In doing this, they depended on the graphic form of the table for storing and processing data. By studying this work, I chart the rise of data practices and data language within settler meteorological communities of the early century.

With these practices and discourses in place, the stage was set for a meteorological observation project that would seek to encompass the transitional national boundaries. As plans for a national project brewed through the efforts of two seminal figures—Joseph Henry and James Espy—observers and institution officials positioned and solidified data as a public good: observers and institutions managed the practice of weather observation, assigned the language of data to collections of observations, and, finally, joined data discourses with calls for public data and climate archives. I argue that this process illustrates how data was conceptualized through the social life of settler science. These practices worked to inform settler environmental imaginations, positioning

weather and environments as knowable through the processes of quantification. Much like landownership, data traveled with notions of settler patriarchal dominance and whiteness.

Whereas the work of male weather enthusiasts—and the tables they created—helped to discipline data in the early part of the century, chapter 2 tells an allied story of data's move from regional importance to national importance in the midcentury period through the labors of white women. This chapter uncovers the work of several groups of white women who acted as weather data collectors and meteorological calculators for the Smithsonian Meteorological Project, the first settler-operated national weather data collection project in the United States. Working with correspondence and institutional publications, I show how women volunteers understood themselves as weather data laborers, how they utilized patriarchal power to navigate male meteorological data culture, and the ways they were met with resistance and erasure under that same patriarchal system.

This chapter travels from Washington, DC, to Easton, Pennsylvania, to Nebraska Territory and back again. The historical characters include famous women, like Clara Barton, as well as women computers whose work shaped scientific practice in the mid-nineteenth century but whose names could not be recovered. The named and nameless women volunteers, computers, and copyists who were part of this project helped to build the foundations of a settler colonial meteorological data collection and computation system in the United States. I argue that though the Smithsonian Meteorological Project was a unique opening for women to enter scientific roles, weather data collection and calculation practices in the mid-nineteenth century were tied up in cultural power structures that made it impossible for women to practice weather data collection and calculation as men could and would at the time. These power structures positioned masculine skill at the center of meteorological data labor and women's data labor at its edge. The chapter shows that white women were able to enter meteorological science only by furthering the intertwined projects of settler colonial expansion and white male supremacy, a supremacy that sought simultaneously to utilize and erase their efforts.

Chapter 3 considers how the utilization of meteorological kite technology facilitated the search for upper-air data from 1890 on. In this chapter, I explore the ways that data was reconfigured through emerging automatic and remote technologies that combined with meteorological kite experimentation. Beginning with weather experimenter W. A. Eddy

launching a kite, with a camera mounted to its frame, into the air on the shores of Bayonne, New Jersey, the chapter captures the experimenter-based nature of upper-air exploration at the turn of the century. Weather kites not only allowed for the collection of upper-air data but also acted as a popular toy-turned-tool that propelled white male communities into professional science. This chapter follows data collection as it moves from the ground to the air through amateur weather-kite tinkering along the Eastern Seaboard from 1880 to 1900, examining how aerial data exploration depended on the cultures of masculine science and settler masculinities. I outline the ways that white masculinity extended US military dominance through formal and informal partnerships with male weather experimenters.

The popularity of weather kites mounted with cameras, thermometers, and barometers literally shifted perspectives, physically reorienting where experimenters—and later institutions—gathered meteorological data as well as the ways that consumers of data understood the weather around and above them. By the late century, remote sensing technologies combined with pictorial imaging, as exemplified by emerging aerial photography, drawings and lithographs published in newly popular scientific journals. Photographs were understood as scientific and quantitative material that visualized the urban landscape with great clarity. Print culture supported the formation of a settler-defined meteorological knowledge that was not only popular but also textual and graphics-based, white, and male. These new media produced a national weather consciousness (more on that later in this introduction) rooted in aerial technology and the promise of endless quantification of aerial space through the dominance of pictorial data. This period begins to lay the groundwork for satellite meteorology in the 1960s.

Chapter 4 opens with a description of Weather Bureau employee George Franklin and his office at 102½ Spring Street in Los Angeles, California, on the morning of June 6, 1900. As a Weather Bureau employee, Franklin was responsible for an ensemble of self-recording weather instruments. His work represents an important shift in data labor as weather data collection becomes systematized and automated throughout the early part of the twentieth century. Franklin and others acted as caretakers of data rather than its primary producers, and across the nation, publics became consumers of weather data products that relied on pictorial interpretations of weather data rather than its numerical presentation. This chapter shows how self-registering instruments altered

data relationships by restructuring notions of data as anonymous, autonomous, and pictorial for producing and consuming publics. Through a study of instruction manuals and Weather Bureau reports, I explore how the bureau and its personnel created data qualification schemes that positioned data between two poles—"clean" and "good"; "dirty" and "bad."

As the Weather Bureau continued to craft data collection practices, professional meteorology was also on the rise. Chapter 4 focuses on the Weather Bureau within the context of the rise of professional meteorology and pinpoints how discourses of clean/good and dirty/bad shaped data classification systems and environmental consciousness in general. The chapter also explores how, between 1900 and 1930, data landscapes grew more complex as self-registering instruments produced twenty-four-hour data streams, and bureau employees, volunteers, and publics grew estranged from the data they were once charged with creating a century earlier. This estrangement is highlighted in the chapter's consideration of the Dust Bowl. An examination of this event shows how data measurement and management regimes failed to render the escalating catastrophe of airborne dust and soil erosion, how dust data fell out of existing data-capturing systems. The onset of dust challenged existing modes of data collection and expression. Importantly, it challenged the efficacy of settler data measurement systems and the promise of endless quantification. In the wake of the Dust Bowl, World War I, and World War II, endless and constant data streams were realized through satellite meteorology. Twenty-four-hour data streams—from ground-based sensors to satellite feeds—could narrate environmental pasts for the nation and foretold a quantifiable future. There was more to know—and leverage—about American weather, and meteorological satellites were essential to that knowledge.

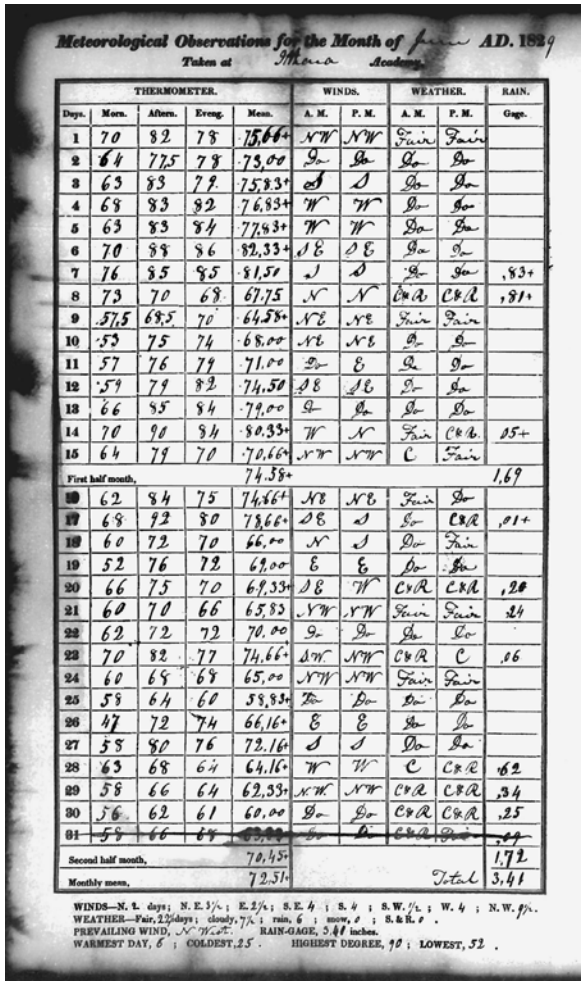
The role of satellite meteorology, and the constant access to land (as resource) and life (as data point) such technology assumes, is the focus of *Immeasurable Weather's* final chapter.[67] In the two-century drama of weather data's emergence and utilization in the US settler states, satellite data becomes a restructuring force in the final act. I begin chapter 5 by documenting the emergence of satellite meteorology through cooperative efforts by the War Department, the Weather Bureau, the Central Intelligence Agency, and the RAND Corporation. From TIROS to NIMBUS, and Landsat to GOES, satellite meteorology was a product of collaboration between these sectors and the various desires (military reconnaissance, resource extraction, and national science) they held. Satellite meteorol-

ogy consolidated the nation-state's power across the middle to late twentieth century, yet it has also left inhabitants of that same nation-state bereft. Surrounded by data, they could not see themselves amid it.

The second section of chapter 5 opens on October 26, 2012, three days before Hurricane Sandy's East Coast landfall, when NASA released its first aerial, time-lapse video of the storm. Roughly twenty-two thousand miles above earth, NOAA's GOES 14 satellite scanned the hurricane's movement across the southern United States. The NASA video, produced through rapid-scanning technology, captured the enormity of the storm, its dynamic cloud structure, and the sharpening of the storm's eye as the continent dimmed under the setting sun. But despite the complicated process of data gathering and transmission that is involved in meteorological satellite sensing and imaging, this satellite media passed as uninterpreted weather reality for popular audiences, offering visual and textual narratives of weather crises that abstracted viewing publics from environmental disaster. Contemporary consumers of weather data cannot see the back-end processes that form popular weather and climate representations. By analyzing the meteorological satellite movement of the 1960s, contemporary GOES 14 experimental satellite technology, and visual satellite data and media during storm crises, I argue that weather data visualizations appear as uninterpreted environmental realities and that this has magnified an already existing tear between weather systems and species that live and die by weather's logics.

Immeasurable Weather argues that data is made and unmade in the local and the everyday; it is a tool that is as dynamic as it is contested. Data is steeped in traditions and structures that have profoundly impacted the stories settlers tell about the environments they occupy. "Stories are compasses and architecture," writes Rebecca Solnit. "We navigate by them, we build."[68] It is time, and has long been, to reckon with landscapes built from stories of environmental measurement—to reckon with the architecture, and to ask what a turn to transformative environmental justice could allow considering this history.

This book charts how, across two centuries, weather data was an outgrowth of settler colonial ideologies of domination and atomism. These ideologies not only informed environmental measurement but also built a settler sense of place that understood biospheric systems as categorically distinct rather than as nodes within a larger interconnected and variable earth network.[69] These systems of data capture informed how settler data collectors understood the crisis itself. A brief visual his-



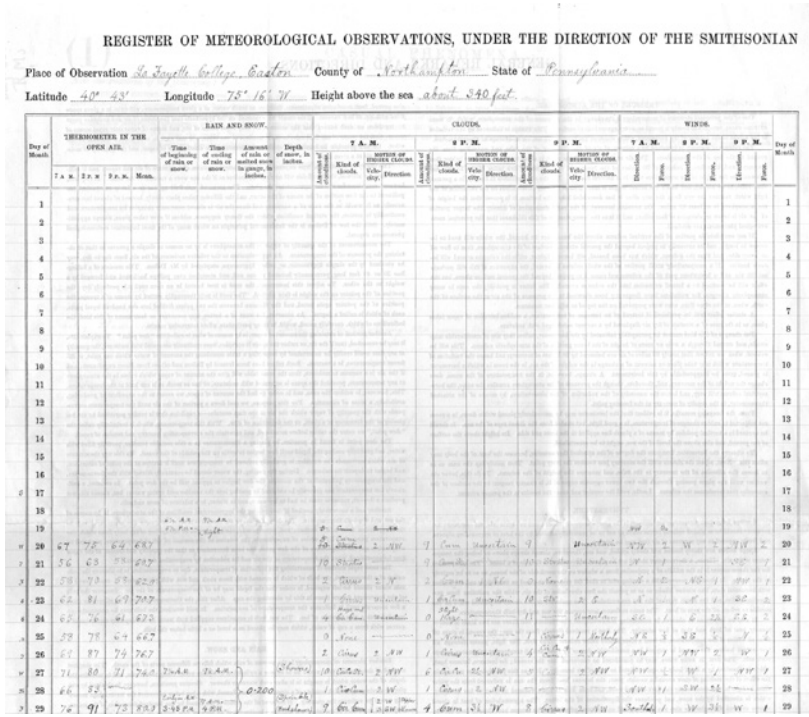
Meteorological Observations for the Month of June AD. 1829
Taken at Albany Academy.

Days.	THERMOMETER. Morn.	Aftern.	Evenng.	Mean.	WINDS. A. M.	P. M.	WEATHER. A. M.	P. M.	RAIN. Gage.
1	70	82	78	75,66+	NW	NW	Fair	Fair	
2	64	77,5	78	73,00	Do	Do	Do	Do	
3	63	83	79	75,83+	S	S	Do	Do	
4	68	83	82	76,83+	W	W	Do	Do	
5	63	83	84	77,83+	W	W	Do	Do	
6	70	88	86	82,33+	SE	SE	Do	Do	
7	76	85	85	81,50	S	S	Do	Do	,83+
8	73	70	68	67,75	N	N	C&R	C&R	,81+
9	57,5	68,5	70	64,58+	NE	NE	Fair	Fair	
10	53	75	74	68,00	NE	NE	Do	Do	
11	57	76	79	71,00	Do	E	Do	Do	
12	59	79	82	74,50	SE	SE	Do	Do	
13	66	85	84	79,00	S	Do	Do	Do	
14	70	90	84	80,33+	W	N	Fair	C&R	,25+
15	64	79	70	70,66+	NW	NW	C	Fair	
First half month,				74,38+					1,69
16	62	84	75	74,66+	NE	NE	Fair	Do	
17	68	92	80	78,66+	SE	S	Do	C&R	,01+
18	60	72	70	66,00	N	S	Do	Fair	
19	52	76	72	69,00	E	E	Do	Do	
20	66	75	70	69,33+	SE	W	C&R	C&R	,28
21	60	70	66	65,83	NW	NW	Fair	Fair	,24
22	62	72	72	70,00	Do	Do	Do	Do	
23	70	82	77	74,66+	SW	NW	C&R	C	,06
24	60	65	69	65,00	NW	NW	Fair	Fair	
25	58	64	60	58,83+	Do	Do	Do	Do	
26	47	72	74	66,16+	E	E	Do	Do	
27	58	80	76	72,16+	S	S	Do	Do	
28	63	68	64	64,16+	W	W	C	C&R	,62
29	58	66	64	62,33+	NW	NW	C&R	C&R	,34
30	56	62	61	60,00	Do	Do	C&R	C&R	,25
31	~~58~~	~~66~~	~~84~~	~~69,33+~~	~~Do~~	~~Do~~	~~C&R~~	~~Do~~	~~,09~~
Second half month,				70,45+					1,72
Monthly mean,				72,51+				Total	3,41

WINDS—N. 1 days; N. E. 3/4; E. 2/4; S. E. 4; S. 4; S. W. 1/2; W. 4; N. W. 9/4.
WEATHER—Fair, 22 days; cloudy, 7/4; rain, 6; snow, 0; S. & H. 0.
PREVAILING WIND, NW. RAIN-GAGE, 5,41 inches.
WARMEST DAY, 6; COLDEST, 25. HIGHEST DEGREE, 90; LOWEST, 52.

FIGURE I.1. Meteorological data form, Albany Academy, 1829. From *Reports of Meteorological Observations Made at Academies, 1826–1859*. Courtesy of New York State Archives, series no. A0346-78.

tory of the "weather blank," a meteorological form, conceptualized over this century-long period, shows the persistence and evolution of formal numerical schema as well as distinct categorical arrangements for weather across time. As this book reveals, streamlining and codifying meteorological data collection passed between many institutions, from the Albany Academy (figure I.1) in upstate New York, to the Smithsonian Institution (figure I.2), the Commerce Department, the Department of Agriculture, the Department of War (figure I.3), and the Weather Bureau itself (figure I.4). Data collection began with volunteer communities in the nineteenth century and grew into a formalized, employee-based sys-


REGISTER OF METEOROLOGICAL OBSERVATIONS, UNDER THE DIRECTION OF THE SMITHSONIAN

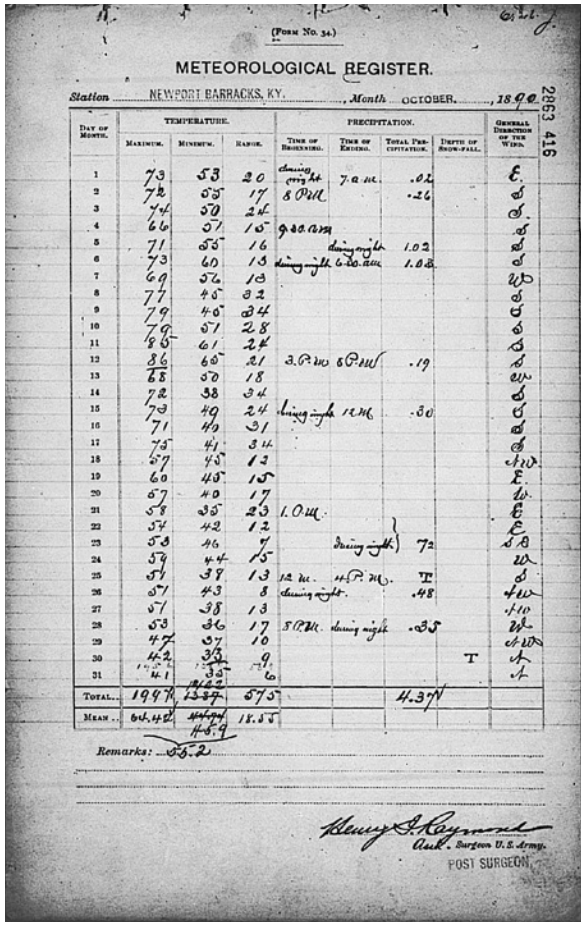
Place of Observation La Fayette College, Easton County of Northampton State of Pennsylvania

Latitude 40° 43' Longitude 75° 16' W Height above the sea about 340 feet

FIGURE I.2. Meteorological data form, n.d., likely 1850s or 1860s. Courtesy of Lafayette College Meteorological Records. Special Collections and College Archives, Skillman Library, Lafayette College.

tem in the twentieth century, which complemented but did not replace volunteer efforts.

Throughout this book, I use *data* as a singular and a plural. When I use *data* in the singular form, I am referring to the concept. When I use *data* in the plural form, I am referring to masses of observations collected by weather observers and remote sensing technologies. I refer to settler weather data cultures and settler environmental consciousness through this work. Both concepts have particular meanings. Settler weather data cultures are composed of material textual, graphic, or infographic practices associated with data collection, collation, reduction, and dissemination. When I refer to environmental consciousness, I am referring to the ways of thinking, relating, and feeling that grow out of that culture. Throughout the book, I call attention to the different technical regimes that made data collection possible, but this book is about data predom-



(Form No. 34.)

METEOROLOGICAL REGISTER.

Station NEWPORT BARRACKS, KY. Month OCTOBER. 1890

2863 416

Day of Month.	Temperature. Maximum.	Minimum.	Range.	Precipitation. Time of Beginning.	Time of Ending.	Total Precipitation.	Depth of Snow-fall.	General Direction of the Wind.
1	73	53	20	during night	7 a m.	.02		E.
2	72	55	17	8 PM		.26		S
3	74	50	24					S
4	66	51	15	9 a.m.				S
5	71	55	16		during night	1.02		S
6	73	60	13	during night	6 30 am	1.02		S
7	69	56	13					W
8	77	45	32					S
9	79	46	33					S
10	79	51	28					S
11	85	61	24					S
12	86	65	21	3 P m	6 P M	.19		S
13	68	50	18					W
14	72	38	34					S
15	73	49	24	during night	12 M	.30		S
16	71	40	31					S
17	75	41	34					S
18	57	45	13					NW
19	60	45	15					E.
20	57	40	17					W.
21	58	35	23	1 0 M.				E
22	54	42	12					E
23	53	46	7		during night	72		S S
24	59	44	15					W
25	51	38	13	12 m.	4 P M.	T		S
26	57	43	8	during night.		.48		NW
27	57	38	13					NW
28	53	36	17	5 P.M.	during night	.35		W
29	47	37	10					NW
30	42	33	9				T	N
31	41	30	6					N
Total...	1997	1387	575			4.37		
Mean ..	64.42	44.74	18.55					

Remarks: 55.2

Henry S. Raymond
Asst. Surgeon U.S. Army.
POST SURGEON.

FIGURE 1.3. US Army surgeon/sergeant observer, form no. 34, Newport Barracks, Kentucky, October 1890. Courtesy of Midwestern Regional Climate Center, accessed June 15, 2022, https://mrcc.purdue.edu/FORTS/forts_forms/AE04490/00899.JPG.

inantly and technology secondarily. In the later part of the book, I pay increased attention to these technical regimes, primarily because they deeply influence notions of data in popular consciousness. I also treat data, at times, as a form of "ecomedia," to borrow from Hester Blum.[70] Blum's attention to polar ecomedia, and its capacity to "register complex systems of ecological and environmental change," resonates with *Immeasurable Weather*'s study of data as media, especially in chapters 3 and 5.

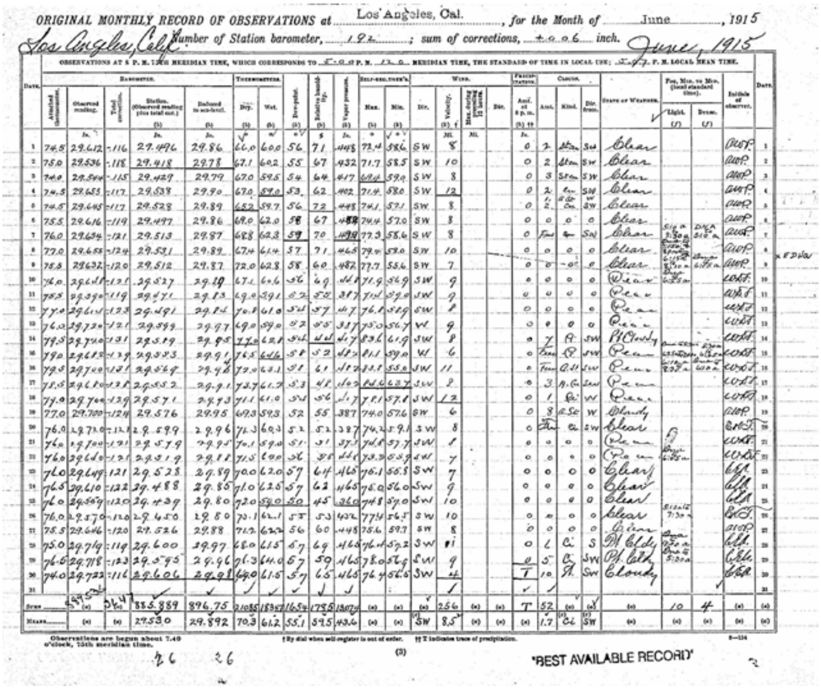


FIGURE I.4. Weather Bureau meteorological data form, Los Angeles, California, 1915. Courtesy of NOAA's National Centers for Environmental Information (NCEI), accessed June 2022, https://www.ncdc.noaa.gov/IPS/coop/coop.html.

Settlers upheld data as a tool for coming to know a world that did not belong to them, and yet one that they claimed. The more data settlers had, the more they thought they knew. But as this book will show, the systems they set up for knowing the very environments they inhabited had inherent faults: relationships of impact and reciprocity across biospheric communities were not part of the systemization. As data became more popular, it seemed to be the only way settlers could engage the world they had made. This book is about the worlds weather data creates and the legacies it leaves behind.