"The Ozone of Patriotism": Meteorology, Electricity, and the Body in the Nineteenth-Century Yellowstone Region

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This paper speaks to the theme of this special issue of *History of Meteorology* by "relocating meteorology" in three ways. First, it geographically re-centers meteorology in the Rocky Mountain West of the late nineteenth century, placing particular attention on the Yellowstone region. Yellowstone has long been connected with advances in the biological sciences, but little scholarship examines the role of either meteorological or electrical science in the region.[1] Second, it repositions meteorology thematically by contextualizing it within the development of popular and scientific discourses on the physics of electricity and electrochemistry. Finally, it relocates meteorology within the emplaced and material human body by examining qualitative accounts of bodily encounters with atmospheric electricity published in scientific and technical journals.[2]

The primary thesis is twofold. First, rather than being rejected in favor of more objective meteorological instruments, the human body and its subjective sensory experiences were crucial components of the scientist-explorer's toolkit. Especially in the study of meteorology and atmospheric electricity, the body served as a remarkably sensitive and useful tool. Furthermore, these subjective bodily experiences were published in respected scientific journals and were largely accepted by the scientific community as valid technical data. Theories of electricity, as it

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[1] For a history of science in the park, see Richard West Sellars, *Preserving Nature in the National Parks* (New Haven: Yale, 1997): 3.

[2] This article uses the term "atmospheric electricity" in roughly the sense in which it appeared in Victorian-era parlance, to refer to an atmosphere charged with static electricity as to be detected by the senses or by mechanical instrumentation. Although the definition has not changed significantly, this term is uncommon today.

existed in both the lab and the sky, were in flux and highly contested at this time, and where mechanical apparatuses failed, the senses could sometimes succeed.

Secondly, this article suggests that these visceral and phenomenal experiences with atmospheric electricity, as interpreted through the lens of science, helped to solidify in Americans' minds a deep and intrinsic connection between the human body and the electrical Yellowstone landscape with ozone acting as the physiological mechanism of action. This cutting-edge science bolstered and lent scientific credence to the discourse of Yellowstone as a healthful climate. Examined through this narrative, Yellowstone's early history is as much a part of the histories of meteorology and medical climatology as it is tourism and conservation.

This work is indebted to the rich and comprehensive literature on the history of meteorological observation in the nineteenth century. Perhaps most salient to this study is Katherine Anderson's *Predicting the Weather: Victorians and the Science of Meteorology*. Anderson explores the tension between the institutionalized and formalized science of meteorology in the late-Victorian era, and the informal and highly local "weather wisdom" of everyday Victorians: "Because it was perceived as a form of automatic operation, weather wisdom was akin to the tools of modern science." This study differs from Anderson's, however, by attributing a kind of embodied weather wisdom not only to the uneducated and the "roughest sorts," but to highly-trained experts as well.[3] Jeremy Vetter tells a similar story in *Field Life: Science in the American West during the Railroad Era*. Vetter shows how the peculiar contexts of Western geography, infrastructure, and social networks shaped scientific knowledge, and how that knowledge in turn shaped western landscapes.[4] Electricity, in both the lab and in nature also bears a significant historical literature. Daniel French's recent book, *When they Hid the Fire: A History of Electricity and Invisible Energy in America* explores the efforts of late-nineteenth century Americans to grapple culturally and intellectually with electricity's intangibility. Michael Brian Schiffer brings together electricity, environment, science, and the body in *Draw the Lightning Down: Benjamin Franklin and Electrical Technology in the Age of Enlightenment*.[5]

In its theoretical and methodological approach, this article is in dialogue with several emerging and interrelated bodies of literature. Most notably, this article is influenced by continuing trans-disciplinary conversations surrounding the dual theoretical approaches of phenomenology and materiality studies. In recent years, historians of science have increasingly looked to the psychological dimensions and constructed nature of objectivity as an epistemological goal.[6] Relatedly, the role of sensory perception in the making of knowledge has also come to the

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[3] Katherine Anderson, *Predicting the Weather: Victorians and the Science of Meteorology* (Chicago: University of Chicago Press, 2005), 177.

[4] Jeremy Vetter, *Field Life: Science in the American West during the Railroad Era* (Pittsburgh: University of Pittsburgh Press, 2016).

[5] Michael Brian Schiffer, *Draw the Lightning Down: Benjamin Franklin and Electrical Technology in the Age of Enlightenment* (Berkeley: University of California Press, 2006).

[6] For example: Lorraine Daston, "On Scientific Observation," *Isis* 99, No. 1 (March 2008): 97-110; Lorraine Daston and Peter Galison, *Objectivity* (Boston: Zone Books, 2010).

fore in the history of science, dovetailing with a broader turn towards critical histories of the senses.[7] Although less frequently used in studies of history, the philosophical and methodological tools of phenomenology and spatial-cultural theory, long used in the adjacent fields of geography and anthropology, have informed this article's interpretation of the embodied and environmentally contextual nature of lived experiences. A branch of epistemology, phenomenology suggests that an understanding of the external world of environment and landscape cannot be separated from the experiential reality of inhabiting a living, material body.[8]

Similarly, innovative approaches in critical theory, materiality studies, and network theory have further problematized the construct of subject/object dualism. Like sensory and phenomenological approaches, a material interpretation of knowledge creation is inherently transdisciplinary. Scholars from across fields have approached the questions of the non-human and the material from diverse angles.[9] In the 1980s and 1990s, Latour and Law's Actor Network Theory was instrumental in illustrating how human and non-humans actants shaped history collectively.[10] Subsequent theorists reframed and reassembled its general principles in various ways. The work of Ian Bogost and Jane Bennett, particularly her work on assemblage theory and electricity, influenced this study.[11]

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7 For a general overview of sensory history see Mark M. Smith, *Sensory History* (Berkeley: University of California Press, 2008). Smith is also the series editor of the "Studies in Sensory History" series from the University of Illinois Press. Though not strictly a sensory history, Daniel Lord Smail, *On Deep History and the Brain* (Berkeley: University of California Press, 2007) looks to the neurochemical processes that shape history. Regarding subjectivity and the senses in scientific inquiry, see Dorindra Outram, "On Being Perseus: New Knowledge, Dislocation, and Enlightenment Exploration" in *Geography and Enlightenment*, David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999); Simon Schaffer, "Astronomers Mark Time: Discipline and the Personal Equation," *Science in Context* 2, no. 1 (April 1988): 115-45; Christopher J. Phillips, "The Taste Machine: Sense, Subjectivity, and Statistics in the California Wine World," *Social Studies of Science* 46, no. 3 (June 1, 2016): 461-81; Steven Shapin "A Taste of Science: Making the Subjective Objective in the California Wine World," *Social Studies of Science* 46, no. 3 (June 1, 2016): 436-60; and Steven Shapin, *Historical Studies of Science as if It Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority* (Baltimore: Johns Hopkins University Press, 2010).

8 As a philosophy, phenomenology has its roots in the work of Martin Heidegger, Edmund Husserl, and Maurice Merleau-Ponty. In the 1970s, geographer Yi-Fu Tuan was instrumental in bringing it to contemporary scholarship in a practical and accessible way. See Yi-Fu Tuan, *Space and Place: The Perspective of Experience* (Minneapolis: University of Minnesota Press, 1977). More recent examples include: John Wylie, "A single day's walking: narrating self and landscape on the South West Coast Path," *Transactions of the Institute of British Geographers* 30, no. 2 (June 2005): 234-247; Hayden Lorimer, "Telling small stories: spaces of knowledge and the practice of geography" *Transactions of the Institute of British Geographers* 28, no 2 (June 2003): 197-218; and Tyra A. Olstad, *Zen of the Plains: Experiencing Wild Western Places* (Denton, TX: University of North Texas Press, 2014).

9 For example, Sophia Roosth explores the subjectivity of yeast cells in "Screaming Yeast: Sonocytology, Cytoplasmic Milieus, and Cellular Subjectivities," *Critical Inquiry* 35, no. 3 (2009): 332-50.

10 Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987); Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005).

11 Ian Bogost. *Alien Phenomenology, or What It's Like to Be a Thing*. Minneapolis: University of Minnesota Press, 2012; Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010); Jane Bennett, "The Agency of Assemblages and the North American Blackout," *Public Culture* 17(3): 445–65.

This paper begins with a brief assessment of the conceptual roots of environmental electricity. Then, it will turn to a core case study emerging from the Yellowstone region of Wyoming Territory in 1871. Next, it will move to a comparative analysis of several other descriptions of bodily encounters with electrical storms in the Rocky Mountains. Finally, it will explore two ideas: the linking of electricity and the chemical ozone, and the shift in popular perception of the Rockies' electrical climate from fearsome to healthful. Ultimately, this article seeks to show some of the ways that the wild landscape of the Rocky Mountains and its uniquely electrical climate moved—both bodily and psychologically—those who sought to understand it in the late ninetieth and early twentieth centuries.

Electrical America

Across cultures, humans have long been aware of the physiological effects of lightning and other atmospheric phenomena on organic bodies.[12] Lightning has played a major role in nearly every ancient culture and religion, and modern society continues to engender stories, myths, and other philosophies regarding its origins, behavior, and meaning. The Nez Perce of the northern Rocky Mountains, as well as other indigenous groups, described tremendous and powerful mythological Thunderbirds, whose eyes flashed lighting and wings created thunder. Antagonizing a Thunderbird could easily result in the untimely demise of a foolish individual.[13] Modern science did not stray far from this idea. Lightning and other forms of electricity had significant power over organic bodies in a variety of ways. Ideas about the sources, operational mechanisms, and effects of that electricity became increasingly complex and contested over time. Paradoxically, electricity appeared to be both innate to the body and necessary for life, yet too much of it could prove fatal.

Nineteenth-century scientists recognized that electricity existed atmospherically and played an important role in the expression of climatological and meteorological phenomena. Benjamin Franklin's famed 1752 kite experiment had cemented the unity of lighting with laboratory-produced sparks, and the work of subsequent meteorologists further reinforced these notions.[14] To what extent and in what ways atmospheric electricity influenced weather and climate was a subject of significant debate throughout the eighteenth and nineteenth centuries, however. Scientists proposed electricity's involvement in everything from wind currents, cloud formation,

[12] Mary Ann Cooper, et al., "Lightning Injuries," in *Wilderness Medicine*, Ed. Paul S. Auerbach (Maryland Heights, MO: Mosby, 2001),

[13] Roy G. Willis, ed., *World Mythology,* (New York: Henry Holt & Co., 1993), 225.

[14] J. Alan Chalmers, *Atmospheric Electricity* (London: Pergamon Press Ltd., 1967), 2. See also, Schiffer, *Draw the Lightning Down*.

tornadoes, floods, and rainfall,[15] to vegetation growth,[16] the formation of mineral deposits,[17] ball lightning, cloudbursts,[18] and the aurora borealis.[19] Hypotheses regarding the origins of atmospheric charge were nearly as numerous. Friction generated by moving air currents, the evaporative component of the water cycle, solar energy and flares,[20] the metabolic processes of plants,[21] and the "latent caloric" that was believed to fill the spaces between atoms of water were all considered to be scientifically plausible causal factors.[22]

Science of the nineteenth century reached few sure consensuses regarding the mysterious role of "electric fluid" in shaping climate and weather patterns. It was known that its influence was substantial, but scientists also generally conceded that "electrical conditions of the air do not seem to have any simple relation to one another."[23] Despite atmospheric electricity's propensity to defy scientific explanation, one further generalization tended to be agreed upon: certain geographic regions were more prone to higher atmospheric potential energy, as well as its accompanying spectacular phenomena. M. J. Fournot, a French specialist in the meteorology of thunderstorms, termed these places "electric countries," determining that many such electric countries existed in the Americas, most notably the United States and its territorial possessions.[24] Throughout its expansive geography, the United States seemed to demonstrate what Fournot and other Europeans interpreted as an excess of atmospheric electricity.

In a 1795 tour of the United States, French philosophe Constantin François de Chassebœuf, comte de Volney, remarked that he perceived the country to possess a greater intensity and abundance of robust static electricity in the atmosphere, even in the absence of storms, as compared to the European continent. "This difference may be made perceptible to the senses at any time, without any complicated apparatus," he noted, awestruck, in his 1804 publication, *Tableau du climat et du sol des États-Unis.* Superior vividness of lightning and loudness of thunder further evidenced this difference, as "the electric fluid appeared to me so copious, that all the air was on fire. Its arrowy and zigzag lines were broader and longer than any I had ever before seen, and so strong were the pulsations of this fluid, that they seemed to my ear and my face like the wind produced by the wings of some passing bird."[25] Yale professor of natural philosophy Elias Loomis further described related phenomena, noting the frustrating

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15 Charles L. Hogeboom, "What is a Cloud-Burst?" *The Outlook* (July 7, 1894): 13-14.
16 Constantin-François Volney, *A View of the Soil and climate of the United States of America*, trans. Charles Brockden Brown (Philadelphia: J. Conrad & Co., 1804), 199.
17 Rossiter W. Raymond, *Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains* (Washington D.C.: Government Printing Office, 1873), 502.
18 Hogeboom, 13-14.
19 Reuben Phillips, "On the Aurora" *Proceedings of the Royal Society of London* 8 (1856-1857): 214-15.
20 Amédée Guillemin, *Electricity and Magnetism*, ed. Silvanus P. Thompson (New York: MacMillan and Co., 1891), 534-35.
21 George M. Beard, "Atmospheric Electricity and Ozone: Their Relation to Health and Disease" *The Popular Science Monthly* 4, no. 25 (Feb. 1874): 463.
22 "Atmospheric Electricity," *The Knickerbocker* 4 (1834): 464.
23 Thomas Russell, *Meteorology: Weather, and Methods of Forecasting* (New York: MacMillan Company, 1906), 81.
24 Guillemin, 537.
25 Volney, 198.

tendency for free-floating bits of dust and lint to affix themselves to the body via electrical cling. Carpeting similarly elicited "little crackling noises" and sparks, the charge from which could be transferred back and forth between the body and surrounding objects: "You can sometimes even light a gas jet with your finger after having shuffled along on the insulating carpet."[26] Professionalizing Humboldtian scientists increasingly fetishized scientific instruments and their uncanny ability to render Nature's hidden processes detectible. Instrumentation, and its delicate calibrations, was at the heart of Humboldtian scientific identity.[27] The rugged nature of the American environment itself rendered these technologies notably difficult to handle in the field.

Volney and Loomis easily sensed a preponderance of electrical charge in the New England atmosphere, but those who explored the continent's high and dry interior found the phenomenon amplified by an order of magnitude. Nowhere was it more pronounced than along the north-south wrinkle formed by the geological dividing line of the Rocky Mountains. Despite the many mysteries surrounding atmospheric electricity and the lack of any mathematical law governing its expression, atmospheric scientists unquestionably agreed that the voltage potential of the air increased with height.[28] The Rocky Mountains, with their quintuple-digit elevations, seemed to be Nature's dramatic organic "laboratories" in which one might test this phenomenon.[29]

Of the Rockies' numerous geological and environmental curiosities, the most "unnatural"[30] and "freakish"[31] was nearly always agreed to be the Yellowstone region of northwest Wyoming Territory. Although popular and scientific interest regarding the Yellowstone area has historically tended to gravitate towards its remarkable geological and geothermal features, the region is replete with a wide variety of exceptional organic and environmental processes. Not only its peculiar geothermal activity, but also its driving rivers, blistering wildfires, scorching summer sunshine, and torrential thunderstorms all served as testament to the dynamic, energetic, and ephemeral nature of the Yellowstone environment.

Voyagers to the area, scientists and amateurs alike, did not overlook the latter of these features. Numerous traveler narratives recount tales of the region's dramatic summer thunderstorms with a combination of sublime awe and anxiety. In an 1859 meteorological survey of the territory, Army Corps of Engineers Brigadier General W. F. Raynolds recorded a strange mixed weather event in which "a storm of mingled rain, snow and hail, accompanied with vivid lightning and heavy peals of thunder" emerged from behind the nearby mountains, "which were

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26 Guillemin, 537-8.

27 D. Graham Burnett, *Masters of All They Surveyed: Exploration, Geography, and a British El Dorado* (Chicago: University of Chicago Press, 2000), 93. See also: William H. Goetzmann, *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West* (Austin: Texas State Historical Association, 1993), 303-4 and Susan Faye Cannon, *Science in Culture: The Early Victorian Period* (New York: Science History Publications, 1978), 103.

28 Russell, 123.

29 Frank B. King, "In Nature's Laboratory: Driving and Fishing in Yellowstone Park," *Overland Monthly* 29, no. 2 (June 1897): 594.

30 Ferdinand V. Hayden, *Bulletin of the United States Geological and Geographical Survey of the Territories* (Washington D.C.: Government Printing Office, 1873), 54.

31 Edwin J. Stanley, *Rambles in Wonderland or Up the Yellowstone* (New York: D. Appleton and Co., 1883), 62.

shrouded in the densest clouds, while ahead the sun continued to shine brightly and its rays were brilliantly reflected from the snow-clad peaks before us, unveiled by any apparent vapors."[32] Nathanial Pitt Langford of the famed 1870 Washburn expedition remembered "terrific tempests, with all the incidental accompaniments of thunder [and] lightning…afford the most awe-inspiring exhibition in nature."[33] Six years later, Captain Daniel C. Pearson of the Second Cavalry recounted somewhat less enthusiastically the "terrible violence" of frequent, drenching nighttime thunderstorms.[34] Visitors to Yellowstone often readily identified lightning storms and other electrical phenomena as defining features of its landscape, often noting their brutality and unusual characteristics.

But the magnificent and sublime effects of atmospheric electricity extended beyond the landscape, permeating the human body itself. Visceral encounters with electricity were, according to Amédée Guillemin in 1891, "not rare in high mountains, without however being frequent."[35] Descriptions of the bodily effects of high-altitude climatological electricity abound in contemporary scientific literature, but nowhere was the anomaly more extensively recorded, nor the descriptions more dramatic than in the Rocky Mountains, where explorers and surveyors believed that circumstances combined to make the area "singularly favorable to the study of condensation of [vapors] and concentration of electric currents."[36] Although the specific language describing the experiences varied, the general experience remained remarkably consistent. As meteorologists and geographers attempted to objectively survey mountaintops throughout the Rocky Mountains, the sensory reality that the body manifested became at times even more salient and meaningful than mechanical instrumentation. Mountaintop scientists could not ignore the reality that atmospheric electricity enthralled the entire corporeal body, stimulating all five senses, plus the uncanny sixth sense of the sublime.

The 1871 Hayden Geological Survey, led by University of Pennsylvania geology professor Ferdinand Hayden, saw one such event. Hayden handpicked his team members, 32 in all, from his friends and colleagues. Many were college-educated, bringing expertise in numerous scientific and technical disciplines, including geography, geology, cartography, mineralogy, botany, zoology, ornithology, and photography, among others.[37] Geographer Henry Gannett worked

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[32] W. F. Raynolds, *Report on the Exploration of the Yellowstone River* (Washington D.C.: Government Printing Office, 1868), 91.

[33] Nathaniel Pitt Langford, *Diary of the Washburn Expedition to the Yellowstone and Firehole Rivers in the Year 1870* (St. Paul: Nathaniel Pitt Langford, 1905), 9.

[34] Daniel C. Pearson, "Military Notes" *Journal of the United States Cavalry Association* 12, no. 41 (March 1899), 305.

[35] Guillemin, 542.

[36] Frederic M. Endlich, "Electric Phenomena in the Rocky Mountains," *The Penn Monthly* 6 (June, 1875): 405.

[37] Aubrey L. Haines, *Yellowstone National Park: Its Exploration and Establishment* (Washington D.C.: Government Printing Office, 1974), 98. Historians of science have contextualized the institution of exploratory expeditions within the contexts of experimental observation and the mechanisms of state power. For example: Kohler, *Landscapes and Labscapes*, and *Expeditions as Experiments: Practicing Observation and Documentation*, ed. Marianne Klemun and Ulrike Spring (London: Palgrave, 2016) examine the intellectual and geographic spaces of knowledge creation. Marlene Deahl Merrill, ed., *Yellowstone and the Great West-Journals, Letters and Images from the 1871 Hayden Expedition* (Lincoln: University of Nebraska Press, 1999), 31–3.

directly under Hayden, his responsibilities including gathering meteorological, astronomical, and hypsometric data on the Yellowstone. Although only 25 at the time of the Yellowstone excursion, his colleagues already lauded Gannett for his pioneering cartographic style and talent for disseminating geographic knowledge and nurturing a popular appreciation of it.[38] Assisting Gannett were various other technical specialists, each of whom was handpicked by Hayden. Although he held a medical degree, 21-year-old Dr. Albert Peale never practiced medicine, but rather served as the expedition's chief mineralogist.[39] Also accompanying the party was mechanical engineer Alexander E. Brown.[40] The Hayden Expedition was an opportunity not only to put their newly-earned professional credentials to use, but also to test themselves physically, pushing their bodies to the limit on the six-week backcountry excursion.

Rocky Mountain Science and the Electrical Body

On July 15th in the sultry summer of 1872, the team set out for the Yellowstone from Fort Ellis in southwest Montana Territory. Gannett was responsible for an array of scientific instruments, including an assortment of various types and sensitivities of barometers, thermometers, and other accoutrements. Astronomical observations required an additional set of entirely different devices, including telescopes, chronometers, and sextants. Gannett complained of the fallibility of these instruments, some of which "got out of order" to the extent that they were "of no use on the trip."[41] Despite these setbacks, he and his team did their duty, collecting such an abundance of meteorological statistics—including hourly measurements of barometric pressure; dry bulb, wet bulb, and dew point temperature; relative humidity; wind velocity and direction; and cloud character—that they had to be published in an additional volume printed separately from the survey's primary report.[42]

In the expedition's comprehensive technical report, Gannett recounted "a rather singular experience" that he faced in common with Brown and Peale.[43] In the afternoon of July 26th, 1872, the group clambered up a mountain near the Gardiner's River Springs, hauling with them a cumbersome and unwieldy variety of gear.

[38] N.H. Darton, "Memoir of Henry Gannett," *Annals of the Association of American Geographers* 7 (Jan. 1917): 68.
[39] Henry Brown Floyd Macfarland, *District of Columbia: concise biographies of its prominent and representative contemporary citizens, and valuable statistical data* (Washington D.C.: The Potomac Press, 1908): 364.
[40] Paul Latzke, "The Unknown Captains of Industry," *The Saturday Evening Post* 174, no. 51 (June 21, 1902): 6.
[41] Ferdinand V. Hayden, *Sixth Annual Report of the United States Geological Survey of the Territories*, (Washington D.C.: Government Printing Office, 1872), 795-7.
[42] Ibid, 806.
[43] Albert Peale. "Friday, July 26th." Diary. Page 18, YELL 2466, Museum Collection, Heritage and Research Center, Yellowstone National Park.

> A thunder-shower was approaching as we neared the summit of the mountain. I was above the others of the party, and when about 50 feet below the summit the electric current began to pass through my body. At first I felt nothing, but heard a crackling noise, similar to a rapid discharge of sparks from a friction machine. Immediately after, I began to feel a tingling or prickling sensation in my head and the ends of my fingers, which, as well as the noise, increased rapidly, until, when I reached the top, the noise, which had not changed its character, was deafening, and my hair stood completely on end, while the tingling, pricking sensation was absolutely painful. Taking off my hat partially relieved it. I started down again, and met the others 25 or 30 feet below the summit. They were affected similarly, but in a less degree. One of them attempted to go to the top, but had proceeded but a few feet when he received quite a severe shock, which felled his as if he had stumbled. We then returned down the mountain about 300 feet, and to this point we still heard and felt the electricity.[44]

That evening, Peale recounted the experience in his diary:

> We reached the summit of the peak about 4 o'clock. There was a strong cloud all about us. Gannett was a little ahead and we saw him hurrying back to us with his hair standing on end. As he neared us we could hear a crackling noise as though there were a lot of frictional electrical machines all about him. We soon began to feel it ourselves. Gannett said [that when] he got to the summit the electricity was so strong that he was obliged to put down the gradienter & hurry down. Brown tried to go up and get it but got a shock on the top of his head and came back in a hurry also. We then descended about 100 feet having the noise all about us as though there were a lot of electrical machines about us.[45]

The eerie and awesome experience on the mountain that day so inspired Gannett that he subsequently christened the mountain Electric Peak, a toponym it retains to this day.[46] If the Earth in its entirety was "an immense Galvanic pile, forever in action, under the guidance of unchangeable laws,"[47] then Electric Peak was a "giant storage battery," or a "huge Leyden jar."[48] That Gannett chose to document this experience alongside the rest of his technical and quantitative data is revealing. He interpreted the qualitative experience of his electrified and instrumentalized

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44 Hayden, *Sixth Annual Report*, 807.
45 Peale.
46 Ibid.
47 "Atmospheric Electricity," 466.
48 Burton Holmes, "The Yellowstone National Park," *Travelogues* 12 (Chicago: The Travelogue Bureau, 1914), 29-30.

body to be as scientifically meaningful as the reams of numerical data that his mechanical implements provided.

Peculiar and unsettling as encounters with high-altitude atmospheric electricity were, they were not uncommon, and scientists and other technical specialists who chanced upon them sometimes went on to document the experience in professional journals and other publications, often describing it with significant literary flourish. Such encounters with atmospheric electricity were profoundly corporeal experiences that gripped and enthralled all five senses in a variety of unexpected ways. In its most dramatic manifestation, electricity literally possessed the body, sending sparks flying from fingertips and stealing away the voluntary control of muscle movement. Dangerous and frightening as they were, such experiences were dramatic and visceral demonstrations of the physical power of wild western landscapes, as well as the occult power of Nature's electricity. The weather and landscapes of Yellowstone and the Rocky Mountains were clearly and demonstrably linked with the human body, and electricity was the bridge that merged them.

Furthermore, the men of science who encountered high-altitude atmospheric electricity perceived their bodies as legitimate instruments for logical inquiry, should opportunity arise. They presented their findings professionally, sometimes publishing on the experience in government reports and scientific journals. Rife with metaphor and rhetorical flourish, however, this data was worlds away from that of Gannett with his reams of charts and statistics. Where mechanical technologies of data-collecting failed, like Gannett's faulty chronometers and barometers-cum-lightning rods, the human body, replete with all of its subjective sensory idiosyncrasies, could be a valid substitute.

In at least some circumstances, the body was perhaps even better than any mechanical apparatus for studying atmospheric electricity. Mechanical instruments for the detection and measurement of atmospheric electricity existed at this time, including an array of various electroscopes and electrometers, and the meteorological and scientific literature of the day typically described such mechanisms at length. These devices were fragile, cumbersome, and often required priming with an electrical charge transferred from an electrophorus or other outside source. If this priming charge dissipated, the apparatus lost efficacy, so many such instruments also relied on drying agents such as calcium chloride to counteract ambient humidity. Some also incorporated clockwork or photographic elements for recording purposes.[49] Such contraptions made field research difficult, if not impossible, and thus quantitative studies of mountain electricity were quite rare in the nineteenth century. Ironically, the imponderable fluid that orthodox science struggled to capture or describe could perhaps be best understood through the bodies and senses of Rocky Mountain explorers.

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[49] Negretti and Zambra, *A treatise on meteorological instruments: explanatory of their scientific principles, method of construction, and practical utility* (London: Williams and Strahan, 1864), 129-135.

In addition to those from Gannett and Peale, the following discussion focuses on seven such case studies of encounters with atmospheric electricity in the Rocky Mountain West, each published in a scientific or technical publication. Six of the seven date from the years 1873 to 1884; one temporal outlier dates from 1911 quoting a source from 1909. Each describes one or more such events in the Rocky Mountain territories of Colorado or Wyoming.[50]

One account refers specifically to Wyoming's Yellowstone region. While making topographical observations on Electric Peak in 1878, a thunder cloud enveloped cartographer A. D. Wilson as one had done to Gannett and company several years prior. The electricity made his scalp prickle, his pencil click with a sharp sound, and produced a "strange burst of mountain music."[51] Though Wilson was not a meteorologist, his encounter was so memorable and noteworthy, that he included in his report. Although not explicitly stated in the proceedings, it is very likely that Wilson was familiar with the events of the earlier Hayden expedition, and may have anticipated the possibility of such an encounter himself.

Most recorded descriptions of encounters with atmospheric electricity in the Rockies occurred just south, however, in neighboring Colorado. In an 1873 U.S. Geological Survey report on mining statistics, mining engineer Rossiter Raymond recounted the experience of colleague and fellow engineer George S. Dwight, on Colorado's Gray's Peak, which he compared to studies conducted in Europe by M. J. Fournot and M. Henri de Sassure in 1867 and 1868 respectively.[52] Two years later, geologist Fredric M. Endlich vividly described his corporeal experiments with atmospheric electricity in Colorado's San Juan Mountains: "this is an opportunity for studying the progress of storms." Contrary to Raymond's and Guillemin's assertions that such phenomena were of modest frequency, Endlich found them to be so frequent and consistent that such experiments could be consistently replicated, ultimately finding these results consistent enough to account for the direction and velocity of wind, time of day, and season.[53] Within months of the publication of Endlich's article, meteorologist and naturalist J. H. Tice presented the findings of a comparative study of atmospheric electrical phenomena to the Illinois State Horticultural Society, declaring

> I only state what I have seen heard and felt, on more than on occasion…It was not possible to be mistaken, either as to the phenomena or as to the cause of them….cloud formation and digestion of a thunder storm were taking place before my eyes and I could observe the process in all its minutae and details…my nerves were thrilling with an electric current, flowing out at the ends of my erect hair, or from my fingers when I raised my hands…the thunder-cloud was digesting and rapidly increasing in dimensions and density. There could be no mistake. The

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[50] Colorado gained statehood in 1876. Wyoming in 1890.
[51] A. D. Wilson, "A Trip through Northwestern Wyoming," *Proceedings of the Newport Natural History Society* 2 (July 1884): 27.
[52] Raymond, 504.
[53] Endlich, 403-409.

> electric charge on the mountain initiated and sustained all these phenomena. *It* was the *cause*; *they* were the *sequences* [italics in the original].[54]

For Tice, an embodied and phenomenal experience informed his knowledge of the meteorological process of cloud and storm formation. Paradoxically, only through a fundamentally qualitative and personal experience, could Tice come not only to a place of understanding, but one of certainty.

Mirroring Gannett and Peale's experience on Hayden's 1871 Yellowstone expedition, A. D. Wilson and F. Rhoda, members of the 1877 Hayden topographical expedition through Colorado, encountered an electrical storm that produced, upon the raising of a hand, the curiously synesthetic effect of a "tickling sound." Noting the eerie clicking of a telescope perched on a tripod, Rhoda analogized his own curious sensory phenomenon to its comparable effects on his party's technical instrumentation. He further noted the failures of these instruments under the influence of the electrical storm: "an attempt was made to take a barometric observation. But no sooner was the barometer held up than it began to hum most alarmingly, and the telescope and tripod was so much affected that the two observers retired a little way down the mountain." In this instance, the party's barometer failed to function in its intended capacity, but did convey important information about the lightning storm to the surveyors through the physical phenomenon of sound.[55]

In 1911, physicist Oliver Lester prepared a comparative analysis of Colorado-based encounters with atmospheric electricity, concluding that "these experiences usually consist of unpleasant buzzing around the head, pulling of the hair, sparks jumping from fingers, etc., all indicating a highly charged state of the body."[56] Notably, Lester's most prominent case study came from naturalist Enos A. Mills, best known as the "Father of Rocky Mountain National Park." Singularly amongst these various accounts, Mills described pronounced effects of electricity upon the action of his muscles: "I made a clumsy climb of about five hundred feet, my muscles being 'muscle-bound' all the time with rigidity from electricity." Mills may or may not have exaggerated the truth in his account, but physicist Lester took him seriously at his word, concluding that "the phenomena of static electricity can have very little to do with modern engineering practice…. they have little to do with the constructive side of engineering, but a great deal to do with the destructive side."[57] For Lester, environmental electricity was something that could potentially be understood, but never controlled.

Although most of these documented cases were prepared by naturalists or physical scientists—geographers, geologists, or engineers—some biological scientists, particularly

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[54] J. H. Tice, "Meteorology," *Transactions of the Illinois State Horticultural Society* (Chicago: Illinois State Horticultural Society, 1875): 77-8.
[55] "Singular Electrical Phenomena," *Locomotive Engineers Journal* 11, no. 11 (Nov. 1877): 491.
[56] Oliver C. Lester, "Atmospheric Electricity." *The University of Colorado Journal of Engineering* 7 (1911): 92.
[57] Lester, 93-4.

physiologists, also took a keen interest in the area. Dr. Charles Denison, a specialist in the medical climatology of the Rocky Mountain West looked to the region's restorative climatic and geographic properties.[58] In his 1880 analysis of the role of environment and weather in the establishment of long-term convalescent care facilities, Denison dedicated a full chapter to the subject of atmospheric electricity and ozone. By his assessment, its electrically charged, ozone-rich atmosphere contributed to making the Rocky Mountains an ideal location to recover from pulmonary disease. Though contextualized with research based in the United States and Europe, he drew heavily on his own embodied experiences based on high-altitude fieldwork in the Colorado Rockies:

> "It would seem that, with the increase of tension due to elevation, the positive electricity of the air, so abundant in dry elevated regions, would be constantly nearing the negative electricity of the earth. With no other evidence to prove this than the experience of our nervous systems as we ascend into electrified strata, and the frequency of electrical phenomena there witnessed, I shall incline to the opinion that this is the true state of electric tension of high altitudes, till evidence is produced to the contrary."[59]

Based on evidence gathered with his own nervous system, Denison concluded that the specific environmental mechanism that made mountain environments so notably restorative was "the continued mediumship of the human body between the negative ground and the positive air…[it] is a constant renewal of his vitality."[60]

Via these seven case studies, a portrait emerges of how scientists, engineers, and doctors interpreted the relationship between climate, electricity, and human body in the Rocky Mountain West of the 1870s and early 1880s. Some, such as Endlich and Denison, took repeated scientific "readings" with their bodies over an extended period. Those who could not do so tended to turn to comparative analyses as an alternative. In fact, each of these examples, save for that of Gannett and Peale, took a comparative approach to a greater or lesser extent, some looking abroad to the widely-reported studies by Fournnet and de Sassure, while others compared more regionally. In each instance, atmospheric electricity was depicted as frightening and uncanny, but entirely

[58] Charles Denison, "Atmospheric Electricity: Ozone and Winds," in *Rocky Mountain Health Resorts* (Boston: Houghton Mifflin, 1880): 74-80. Many historians have examined the relationship between science, medicine, and environments. On the topic of medical climatology in tropical climates, see Gregg Mitman, "In Search of Health: Landscape and Disease in American Environmental History," *Environmental History* 10, no. 2 (2005): 184-201, and Mark Carey, "Inventing Caribbean Climates: How Science, Medicine, and Tourism Changed Tropical Weather from Deadly to Healthy" *Osiris* 26, no. 1 (2011): 129-41. Regarding Rocky Mountain Health Resorts, see: Tom Sherlock, *Colorado's Healthcare Heritage: A Chronology of the Nineteenth and Twentieth Centuries Volume One - 1800-1899*; Nancy Owen Lewis, *Chasing the Cure in New Mexico: Tuberculosis and the Quest for Health*.

[59] Denison, 74-5.

[60] Ibid, 75.

fathomable through the tool of a body controlled by a scientific mind. Through corporeal experimentation, natural electricity could be understood and, they hoped, bent to serve human needs and desires through technology, medicine, and tourism.

The "Child of Lightning"

The smell of acid accompanied by a peculiar taste of lobster that many mountain surveyors experienced was conjured by a gas that, though known since the time of Homer, had only recently been described by science.[61] First isolated in 1839 by Christian Friedrich Schönbein, who named it for the Greek word *ozein* meaning "to smell," in reference to its strong and peculiar "electric odor," the chemical formula of ozone (O_3) was not determined until 1865. Laboratory experimentation had established a close relationship between ozone and electricity as the chemical could be derived from common air by passing an electric spark through it, while field research corroborated that the chemical was produced during thundershowers.[62] It was this latter source, lightning, that appeared to be essential to organic processes, leading one specialist to conclude that "ozone is a child of the lightning."[63] Termed "active oxygen"[64] for its intense oxidizing properties that were believed to "stimulate," "purify," and "disinfect" the blood and the flesh, ozone was thought to be congenial to life, its presence integral to human health.[65]

Like the electricity that created it, ozone could be produced synthetically in a laboratory and put to use industrially as, for example, a disinfectant or bleaching agent. Contemporary scholars interpreted it as first and foremost a product of Nature, however, and, by extension, a healthful and necessary addition to the human body.[66] Ozone was suspected to affect the pulse, respiration, and circulation in various ways, and "in this respect, it behaves like electricity." Medical science further suggested that the passage of a mild electrical current directly through the body could electrochemically produce these benefits from the inside out, but such a technique was not medically practicable at this time; bodies remained dependent on atmospheric sources of ozone.[67]

Like Fournot's electric countries, certain places seemed to be blessed with an abundance of ozone. Chief among these were elevated, thunderstorm-prone regions (oceanic and shoreline

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[61] Homer, *The Iliad*, trans. Walter Leaf (Cambridge: Cambridge University Press, 1902), 172.
[62] "American Contributions to Science," *United States Magazine*, 4 (1857), 47.
[63] Brigham, "Ozone," 260.
[64] "American Contributions to Science," 47.
[65] Brigham, "Ozone" 260-1.
[66] E. Andreoll, "Ozone: Its Commercial Production and Application," *Journal of the Society of Chemical Industry* 16 (Feb 27, 1897), 95. For more on Schönbein's isolation of the chemical, see Mordecai B. Rubin, "The History of Ozone: The Schonbein Period, 1839-1868" Bulletin of the History of Chemistry 26, no. 1 (2001): 40-56. Robert Kohler discusses the development of medical biochemistry as a field in *From Medical Chemistry to Biochemistry: The Making of a Biomedical Discipline* (New York: Cambridge University Press, 1982).
[67] Beard, 464.

environments were also believed to be healthful and ozone-rich, although later science demonstrated the pungent smell of sea air to be not ozone, but rotting seaweed). Grimy urban areas were believed to be ozone deficient because as the chemical disinfected and purified putrid matter, it became depleted, losing its power of oxidation: "it dies, that others may live."[68] Both medical and popular literature suggested that living in an ozone-deficient environment, such as a busy urban cityscape, would deprive one of exposure to this seemingly essential, life-giving ambient chemical. Thus divested, a person would sicken and die. As one sensationalist popular magazine put it:

> Thus is man often where he least expects it, the creature of physical influences, which, unseen, but no less actual, brood on the passing wing of a vivific or a pestiferous air; that slumber in the shadows of the clouds, or crawl like invisible reptiles upon the earth; that drop upon him in the noiseless exaltations of shrubs and trees, and even haunt him, as ministers of life and death, in the very aroma and in the nameless qualities that distinguish dwellings, localities, and countries from one another. We are penetrated through and through with natural laws; and if Nature fail for a brief period to furnish around us a due supply of disturbed electric action, of new-wrought and avid oxygen, or of we know not how many other essential elements of vigorous life, we droop, sicken and die; and the "mourners go about the streets" for those who fell ostensibly of rheums, and typhus, and cholera, but really of vast and uncontrollable revulsions in the operations of Nature herself.[69]

Neither professional nor popular literature left any doubt that the body's health was enormously dependent upon the health of its surrounding climate and environment, and electricity was absolutely essential for a vigorous life.

Scientists and others believed ozone influenced not only the fitness of the corporeal body, but also an individual's personality and his or her mental and moral hygiene. "Who shall say that even ozone does not modify the play of ambition or avarice, of love, of patriotism, or of crime?" speculated one contemporary social critic.[70] Even a city as a collective whole was vulnerable to the dangers of insufficient levels of sterilizing atmospheric ozone, which was hypothesized to affect everything from activity and enterprise, to the moral, social and aesthetic life of a metropolis's citizenry. Beginning in the latter two decades of the nineteenth century, a discourse emerged that specifically analogized ozone with a variety of desirable, masculine, and energetic qualities, leading to rhetoric of "the ozone of town spirit,"[71] "ozone of the national ambition,"[72]

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68 Ibid, 464.
69 "American Contributions to Science," 48.
70 Brigham, 49.
71 George Blackstone Irving, *My Town; Or Community Patriotism* (Chicago: The Rogerson Press, 1912), 94.
72 Mortimer Thomson, *The Divine Comedy of Patriotism* (New York: Press of Duane Printing Company, 1900), 153.

and "the ozone of patriotism."[73] Atmospheric ozone was nothing short of a vital necessity for a modern, sanitary, civic society, and meteorological science was the means to quantify it.

Thus, electricity and ozone had become so deeply correlated in the late nineteenth-century mind as to be functionally inseparable in both popular and scientific discourses. In covering the science of medical geography, many scientific publications, including *The New York Medical Journal*[74] and *The Popular Science Monthly*,[75] correlated and conflated the two concepts, referring generally to "atmospheric electricity and ozone."[76] To be electric was to be ozonated, and vice versa. Moreover, these qualities—electrification and ozonation—were interpreted as fundamentally natural climatic processes innate to both the organic environment and the human body. Although they could be replicated in the laboratory, they were first and foremost processes and products of Nature.

Viewed through this lens, venturing to Yellowstone was not only recreation, personal enrichment, or the nationalistic appropriation of a distant land. It was the application of meteorological science to human health and well-being, touted to have profound benefits in nearly every aspect of life, from physical health and wellness to patriotism and work ethic. In the eyes of a typical middle or upper-class tourist of the time, the re-creative effects of a Yellowstone tour would make him a more efficient cog in the capitalist political economy once he returned home. Experiencing Yellowstone came to be interpreted as a type of modern, scientific medical procedure. Nor was it seen as a sham treatment; it was based on cutting-edge medical science that identified specific physiological mechanisms, including ozonation, for the transmission of atmospheric electricity's healthful effects.

Modern meteorological and electrical science and the cultural development of Yellowstone occurred contemporaneously, from the 1870s through about 1910, with the American sanitarium movement joining them in 1885. The case study of Yellowstone was thus an important antecedent and related cultural development to that of "health stations," "health resorts," and "sanitariums." Such facilities were intended for the treatment of tuberculosis and other ailments throughout the Rocky Mountains, and have been the subject of much historical scholarship. Many such histories neglect the importance of atmospheric electricity and ozone to the therapeutic process, however, instead focusing on the climatic features of warmth, sunlight, and dryness.[77] Electricity's importance must not be overlooked, however, as references to electricity and ozone abound in contemporary medical literature like Denison's.[78]

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[73] *Journal of the Twenty-Eighth Encampment of the Grand Army of the Republic* (Boston: E. B. Stillings & Co., 1894), 262.
[74] Charles Denison, "The Annual and Seasonal Climatic Maps of the United States," *The New York Medical Journal* 42 (Dec. 5, 1885): 629.
[75] Beard, 456.
[76] Ibid.
[77] Daniel Freund, *American Sunshine: Diseases of Darkness and the Quest for Natural Light* (Chicago: University of Chicago Press, 2012), 70. Jeremy Agnew, *Medicine in the Old West: A History, 1850-1900* (Jefferson: McFarland, 2010), 75.
[78] Denison, 74-80.

Yellowstone Park thus offered access to an energetic, invigorating, and healthful climate for those middle-class Americans not looking for the directed attention provided at dedicated sanitariums or convalescent facilities. In *Our National Parks*, John Muir suggested that those weak of constitution ought to "try to climb Electric Peak when a big, bossy, well-charged thunder-cloud is on it, to try to breathe the ozone set free, and kindly get yourself shaken and shocked," apparently providing this advice with genuine sincerity.[79] In describing the region "as a health resort," physicians suggested "unimpeachable evidence in favor of Montana climate" for the geographic treatment of consumption, malaria, asthma, and rheumatism.[80] For these reasons, the American Institute of Homeopathy held its 1898 national convention in Yellowstone, noting that "the season will be delightful for such excursions, and our visiting doctors and their friends will get so full of mountain ozone and patriotic enthusiasm that they will be carried many years beyond the three-score and ten allotted to man."[81]

Especially in urban areas, mountain imagery dominated popular discussions of ozone's relationship to the body. Once exposed to popular books and articles on the importance of adequate ozone intake, city dwellers now had yet another reason to believe their urban environments dangerous and unhealthful. Fortunately for concerned urbanites, electrical appliance manufacturers leaped at the opportunity to fill the gap. Because it was "not always convenient for Mohammad to go to the Mountain," they developed and marketed a cornucopia of devices and contrivances intended to mimic the effects of ozonated mountain air.[82] For those who could not make the pilgrimage to Yellowstone or the Rocky Mountains, home ozonators provided "pure mountain air in your own home."[83] Mohammad no longer needed to go to the mountain to maintain his vigor, and the mountain would have to acquire a new meaning if it was to remain relevant in the twentieth century.

Conclusion

One of the great ironies of this story is that ozone was not the health-promoting wonder-chemical that Gilded Age Americans believed it to be. It retained its healthful mystique well into the twentieth century, but as new evidence came to light and cultural principles shuffled, ideas regarding the relationship between body and ozone changed. Beginning in the mid-nineteen-teens, perhaps as a result of accelerating industrialization or the development of chemical weapons, the American Medical Association and other such professional bodies reevaluated their positions on

79 John Muir, *Our National Parks* (Boston: Houghton Mifflin, 1901), 59.
80 Robert E. Strathorn, *Montana and Yellowstone National Park* (Kansas City: Ramsey, Millet, and Hudson, 1881), 40-1.
81 D.A. Foote, "A Plea for Western Pilgrimage," *Medical Century* 6, no. 3 (March 1, 1898): 87.
82 Brigham, 261.
83 "Ozone Pure Airifier," *The Literary Digest* 40, no. 2 (April 16, 1910): 770.

ozone's effects.[84] Today, all relevant regulatory or advisory entities, including the Environmental Protection Agency, World Health Organization, and European Union categorize ozone as an atmospheric pollutant, respiratory irritant, and menace to public health.[85]

Americans understood electricity less as part of a morally and physically toxic modern social regime than as an integral component of the climate's optimal and balanced functioning. American surveyors and explorers further corroborated these theories via their intense and visceral encounters with ambient atmospheric electricity in their Rocky Mountain fieldwork. These travelers, typically formally trained in the sciences, approached the phenomena as experimenters. Although such climatic events occurred somewhat unpredictably, once met, they could be appraised systematically. The rub was that conventional mechanical instruments for studying electricity in the atmosphere were not conducive to the harsh conditions of wildland travel. In practice, however, this "problem" could sometimes be sidestepped through creative use of the human body. Subjective and phenomenal sensory information turned out to be a more sensitive and manageable instrument than any manmade apparatus. Scientist-explorers disseminated the data gathered with their bodies in scientific publications and professional arenas, and medical experts ultimately reached the conclusion that backcountry travel was a healthful practice specifically because it provided for exposure to invigorating and purifying electricity and ozone.

Hayden and Gannett were not searching for a link between atmospheric electricity and the body when they explored Yellowstone. Such science was too new and too unconnected to the conventional goals of surveying for it to be an issue relevant to their purposes. In the latter decades of the nineteenth century, however, the cultural and scientific meanings of Yellowstone National Park, as well as those of atmospheric electricity and ozone, developed concurrently and in tandem, ultimately forming a cultural tautology. Yellowstone came to function as a symbol of national and individual strength and power because its climate was electric and ozonated. Conversely, ozone signified vitality and purity because it was part and parcel with the ostensibly pristine Yellowstone wilderness.

The case study presented in this article repositions the geographic context, methods, and conceptual framework of late nineteenth century meteorological science. Relocating meteorology within material human bodies in the Rocky Mountain West reveals that scientific and popular discourses acknowledged and embraced the fundamental and fluid reciprocity between bodies and their environs. Positioning the history of meteorology adjacent to and in dialogue with the history of the physical science of electricity further complicates conventional historical narratives. The lens of electrical science suggests that late-nineteenth century scientists and surveyors saw electricity (and, by extension, ozone) as a primary mechanism of action by which climate and landscape influenced and shaped the body. Via the mechanisms of atmospheric electricity and

[84] Edwin O. Jordan and A. J. Carlson, "Ozone: It's Bactericidal, Physiologic, and Deodorizing Action," *Journal of the American Medical Association* 61, no. 13 (Sept. 27, 1913): 1012.
[85] Environmental Protection Agency, "Ground Level Ozone," March 25, 2015, http://www.epa.gov/air/ozonepollution/ (May 1, 2015).

ozone, the Rocky Mountain West's electrical landscapes asserted themselves viscerally upon material bodies in the late nineteenth century, thereby reaffirming the salience of the electrical human organism in defining and interpreting the region's place based meteorology and medical climatology. Ultimately, the concept of the electrical body would persist in both scientific and popular discourses, while its former companion, the "ozone of patriotism," fell out of usage.