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Signals, Storms, and Surveillance: A Case Study in the Militarization of Economy and Society

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> So let us have a systematic network of storm signals all over North America—a sort of telegraphic nervous system with its head center at Washington. . .
>
> —John Grable[1]

The Civil War, as historian Alan Nevins noted, "transformed an inchoate nation, individualistic in temper and wedded to improvisation, into a shaped and disciplined nation, increasingly aware of the importance of plan and control."[2] Although the war was the first major conflict influenced by the industrial revolution, it drew upon existing technology rather than generating much that was new.[3] Nevertheless, as Peter Hall has observed, "the war changed everything"; it transformed and revitalized the elite "culture of organization," introduced new models of organization, and, through national networks: railroads, telegraph lines, and the banking system, infused new technologies into American society.[4] Looking back at the conflict on its fiftieth anniversary, President Woodrow Wilson pointed out what everyone already knew, that the Civil War had "created in this country what had never existed before—a national consciousness."[5]

This paper examines the information network established by the U.S. Army Signal Office during and after the Civil War. It provides an alternative history of meteorological

services by demonstrating that the primary post-war mission of the Signal Corps—maintaining a national storm warning and telegraphic weather service—was intimately linked to national strategies of domestic surveillance and social control. It also documents the role of the federal government in providing scientific services to the public and the growing social impact of national telegraphy. It constitutes a case study of rapid modernization and the search for order in the 1870s and 1880s, decades before the focus of standard accounts.[6] More than a simple case of military patronage for science, it is a story of the interpenetration of values and perspectives among meteorologists and army officers in the decades-long penumbra cast by the Civil War. While the Signal Service gathered meteorological data to provide "telegrams and reports for the benefit of commerce and agriculture," its military commanders were engaged in a much larger project to gather intelligence on all possible threats to domestic tranquility—presiding over an information network that embodied the physical, intellectual, and cultural resources (and fallibilities) of the society that constructed it.[7]

The paper is part of a larger project to situate the history of meteorology within a framework of the larger military history of the United States and Western Europe (see table 1)

Table 1: Meteorology and the Military

War of 1812
U.S. Army Medical Department
Medical climatology
Widespread observations on the frontier

Crimean War (1854)
Founding of French and British weather services
Paris Observatory, British Admiralty

U.S. Civil War
U.S. Army Signal Office national weather service
Signals, storms and surveillance

Spanish American War
Naval operations and Submarine cable to Cuba

World War I
NRC—Signal Corps—U.S. Weather Bureau
Upper air winds, micro-meteorology, polar front
Radio-meteorograph (1930s)

World War II
Crash education program, "baby boom"
Aviation (worldwide), naval operations (worldwide)
Air Weather Service

Cold War
Extensive civilian-military collaboration
Weather and climate modification
Atomic bomb tests and fallout
Radar, satellites, computer modeling

Post-Cold War
Focus on Environmental Protection
"Global Change" and "Earth System Science"
Micrometeorology of the urban environment

Constructing the Network: Meyer and the Signal Corps

The early history of the Signal Corps is intimately intertwined with the biography of its founder, Albert James Myer. Myer was born in Newburgh, New York, in 1828.[8] After graduation from Geneva College in 1847, he worked for telegraph offices in Buffalo and studied medicine, receiving his M.D. from Buffalo Medical College in 1851. He wrote his thesis on "A New Sign Language for Deaf Mutes" that was based on the Bain telegraphic alphabet. For this Geneva College also awarded him an M.A.

Myer passed the army medical board examination in 1854 and was appointed assistant surgeon, assigned to Forts Duncan and Davis in Texas. In addition to his regular medical duties, he served as post treasurer and supervised the diet of the troops. Notably, one of his duties involved filing regular reports on weather observations with the Surgeon General. Myer was seriously ill in 1855, by his own diagnosis with remittent fever and scurvy, but recovered in several months. His marriage in 1857 to Catherine Walden of Buffalo left him financially secure.

In 1859 Myer's proposal for a comprehensive system of military and naval signals was reviewed favorably by a panel of officers headed by Lieutenant Colonel Robert E. Lee and underwent successful field tests. (An earlier proposal had been shelved by Secretary of War Jefferson Davis in 1856). Myer's signaling system, later known as "wig-wag," employed flags by day and torches by night. In 1860, Congress created a Signal Corps in the U.S. Army and Myer was appointed its first officer, with the rank of major. He was assigned to the Navajo Expedition of 1860-61 in New Mexico under Major Edward Canby.

At the onset of the Civil War, Myer was ordered to establish a signal system for the Union Army. He served as an aide to General Irvin McDowell at the First Battle of Bull Run

and then under General George McClellan as Chief Signal Officer (CSO) of the Army of the Potomac. He coordinated training in wigwag and telegraphy for officers and enlisted men detached to him from various departments of the Union Army. He also introduced the "Beardslee magnetoelectric tactical telegraph machine," the army's first electrical communications equipment suitable for field use. Misfortune befell him, however, late in 1863 when Myer, now a Colonel, attempted to recruit skilled telegraphers for commissions in the Signal Corps and came into conflict with the United States Military Telegraph, which used civilian telegraphers. Secretary of War Edwin M. Stanton relieved Myer of his position, denied him access to the electric telegraph, and exiled him to the Memphis-Cairo area. Further misfortune struck in 1864 when the Senate failed to reconfirm his position which had expired. His appointment as the Army's Chief Signal Officer was formally revoked, his rank reverted to Major, Signal Corps, and he was placed on inactive duty.[9] He was befriended, however, by his old comrade General Canby who used him as signal officer for the Military Division of the West Mississippi.

After a long campaign by Myer to restore his reputation, President Andrew Johnson ordered Stanton to reinstate Myer as Chief Signal Officer in 1866 with rank of Colonel. A year later U.S. Grant, now Secretary of War, recommended Myer for promotion to the ranks of Brevet Lieutenant Colonel and Colonel (retroactive to 1862), and Brevet Brigadier General (retroactive to 1865), "for distinguished service." [10]

With his position restored, his promotion in hand, and his reputation intact, Myer now faced the task of rebuilding the Signal Corps and redefining their mission for peacetime service. He convinced the military academies at West Point and Annapolis to teach his system of military signaling and to adopt his Manual of Signals, printed in 1864 during his exile.[11] He also established his own camp of instruction near Washington, D.C., first at Fort Greble and then at Fort Whipple and conducted other training courses for the Corps of

Engineers. Because the U.S. Military Telegraph was no longer in existence, Myer was now solely responsible for electric telegraphy. He argued that in peacetime the Signal Corps should be involved in military intelligence and surveillance of potential enemies. Still, there was no legislative authorization for a separate Signal Corps and his modest budget request for 1869 had been cut in half.

Meteorology, the Military and Modernity

In the more managerial era that dawned after the war the Federal Government established a massive and well-funded national weather service with direct links to the military. Although weather observations had been made in America since colonial times, the first national service providing daily weather reports and forecasts was established in 1870 in the War Department.[12] Before that, meteorological and climatological observations were collected by volunteer observers and a number of federal agencies including the Army Medical Department, the General Land Office, the Navy, and the Smithsonian Institution.[13]

The U.S. Army Signal Service, decorated for its successes in monitoring Confederate troop movements during the Civil War, had been mustered out with the volunteer army of 1865, leaving Chief Signal Officer Myer a bureau chief without a bureau, in charge of one lieutenant and two clerks.[14] Myer, who was known as an innovator and aggressive administrator, now faced the task of rebuilding the Signal Corps and redefining its mission for peacetime service. He was grasping for a mission that would keep the corps alive when, in December 1869 a bill was introduced in Congress establishing a national storm warning service. Because of its prior involvement in meteorological research, the Smithsonian Institution was considered to be a likely candidate to organize the new system. The final version of the bill, however, named the Secretary of War as the responsible party. The Chief

Signal Officer immediately called on Congressman Halbert Paine, the sponsor of the bill, to stake his claim. Defining storms as the "enemy" of commerce, Myer argued that the Signal Corps could use telegraphy to track their movement and provide meteorological intelligence in advance of their arrival: "The telegraph can announce meteorological observations, statistics, and reports giving the presence, the course, and the extent of storms. . . and their probable approach, as it would, in time of war, those of an enemy."[15] As Paine recounted the events two decades later,

> Before I finally obtained the unanimous consent of the House to the passage of the joint resolution, a stranger called upon me and introduced himself as Colonel Myer, of the Signal Corps. He exhibited the most intense anxiety for the success of the measure. It seemed to me that his zeal and enthusiasm marked him as the fit man to launch the new enterprise. As soon as the joint resolution passed, I called upon General [William] Belknap, then Secretary of War, and suggested that he should consider the propriety of assigning Colonel Myer to the duty. He said at one that he had already in his own mind fixed upon Colonel Myer as the officer to commence the work under the joint resolution.[16]

Congress was persuaded by Myer's zeal, signaling expertise, and the promise of military discipline in the system. The first national weather service was established in 1870 under the direction of the Chief Signal Officer. With generous support from Congress, the Signal Office budget soared from $5,000 in 1869 to $400,000 by 1874. During the same period Myer's command expanded from three enlisted men to over five hundred college educated observers. The Signal Office had become a major military and scientific service, providing "telegrams and reports for the benefit of commerce" and weather predictions to the public, which was rapidly becoming accustomed to receiving daily weather forecasts.

Initially, the Signal Service depended on commercial telegraph lines, notably Western Union; observer-sergeants were located only in areas where such service was available. There was a great deal of contention, however, about the public responsibility of the telegraph companies. In 1866 Congress had grated several companies the right to construct lines on public lands using public resources. Each new telegraph station constructed under this act was allotted thirty acres of land. In return the US government and its agents were to have top priority over use of the lines at "rates to be fixed by the Postmaster General." After 1870, according to the telegraph companies, the heavy message traffic of the weather service threatened to overwhelm commercial uses and, because of loss of profits, limit further private expansion of the system. In response Myer suggested shortening government messages (the weather service used an elaborate code), detailing Signal officers to outlying stations to clear government traffic, and building military lines into remote and strategic areas that would connect with the nearest commercial office. When the private companies resisted these proposals Congress reacted, imposing severe penalties, including prison terms, for anyone interfering with the telegraph business of the government.

In the 1870s Myer received authorization to construct military telegraph lines to lighthouses and mountain stations, and into Indian Territory in the southwest and northwest frontiers.[17] Signal Office wires along with those of a score of different telegraph companies all converged on the "Telegraph Room" of the Signal Office placing Myer at the center of an electric intelligence network spanning the nation. After 1870, Myer's correspondence preserved in the National Archives is dominated by telegrams received rather than letters. For example, in fiscal year 1876-77, his office logged 52,342 telegraphic messages sent and 706,812 communications received.[18]

Although telegraphic reports "for the benefit of commerce and agriculture" formed the primary rationale for the weather service, the men of Myer's command served as both

meteorological observers and at times as secret service agents reporting to him on domestic enemies such as striking workers in the rail strikes of 1877, Indian uprisings in the Southwest, and natural hazards to commerce and agriculture. Signal service observers reported on the hatching and migration of locust swarms, on frost and drought in the cotton, corn and tobacco-growing regions, on hazards to shipping along the coast. Mercantile interests were advised of weather conditions affecting the packing and shipment of perishable goods such as oysters, pork, and ice. Sailors received notice of fogs, storms, and fair winds. Insurance companies received data useful to them for setting rates for shipping. River reports warned of floods and low water conditions; railway reports announced heavy snows and track conditions; sanitary reports tracked the course of cholera and yellow fever epidemics in the interest of public health.[19] All of these missions, including daily weather reports, involved potential threats to commerce, agriculture, and the domestic order.

On July 16, 1877 workers on the Baltimore and Ohio Railroad were notified of a ten-percent pay cut and decided to go out on strike. Soon the strike spread to other companies and the Marxist-influenced Workingmen's Party came to the support of the strikers, calling for government ownership of railroads and telegraphs, and an eight-hour day for workers. By July 25th, the strike had reached all major cities, causing most trains to stop running. Concerning the strike, Karl Marx wrote to Friedrich Engels, "What do you think of the workers of the United States? This first explosion against the associated oligarchy of capital which has occurred since the Civil War will naturally again be suppressed, but can very well form the point of origin of an earnest workers' party. . . . A nice sauce is being stirred over there, and the transference of the center of the International to the United States may obtain a very remarkable post festum opportuneness."[20]

During the rail strikes of 1877 the Signal Office provided special reports every three hours from across the nation to the War Department and, by direct telegraph line, to President

Hayes at the White House. After completing their weather reporting duties, Signal Corps "observer sergeants" would dress in street clothes and attend strike rallies, then return to the weather service office to telegraph their findings to Myer. Some of the strike telegrams were actually recorded on the back of weather observation forms. The following four telegrams (for example) document the situation in New York City between 6:00 p.m. and 11:30 p.m. on July 25, 1877, a critical day of the strike:[21]

> Private Pollak, New York to CSO, 6 p.m.—Trouble may follow tonight. Meeting at Thompkins Square though policemen well prepared. Will watch proceedings despite the demand of internationalists not to turn out. Private Jewell will attend meeting and report circumstantially.
>
> Thomas S. James, New York to CSO—At 9:15 p.m. meeting adjourned and square was cleared. The crowd assembled on 9th Street. Inspector Murray ordered them to disperse. They replied with a shower of brickbats and stones. Police immediately charged and after a sharp and decisive struggle they were completely routed. All is reported quiet now.
>
> Private Jewell, NY to CSO—At nine thirty the crowd attempted to form a procession and march up 8th Street, but the policemen would not allow it. The crowd fled rapidly before their charge.
>
> Myer, CSO to President Hayes—It is now half past eleven here. The New York International meeting has ended and is a failure. Albany, Buffalo, Cleveland, Indianapolis, Cincinnati, Pittsburgh, Philadelphia, Baltimore are quiet. Louisville is a little excited but well in hand by special police. Chicago is well controlled. St. Louis is not so well but no serious violence. San Francisco is alert and at 6 o'clock controlled. There seems no reason to fear really serious outbreak anywhere tonight.

According to Robert Bruce, President Hayes used such detailed information in deciding not to escalate the federal response and the strike ended that summer with many of the railroad companies conceding to at least part of the striker's demands (Bruce, 279-80). On August 5, 1877 the Signal Corps issued its final strike report: "Pax Semper Ubique."[22]

Signal Service weather observers also reported from the Indian frontiers in the northwest and southwest territories. A special set of telegraph lines was constructed to military posts on or near reservations where any suspicious activity could be reported instantly. The federal government was determined to shatter the civilization of the Native Americans. The destruction of the bison is a well-known example. Between 1872 and 1874 over 3.5 million bison were slaughtered, a mere 150,000 by Native Americans. General of the Army Philip Sheridan, attending a session of the Texas legislature to discuss this problem, voiced the majority opinion, "Let them kill, skin and sell until the buffalo is exterminated, as it is the only way to bring lasting peace and allow civilization to advance."[23] This was in line with the congressional testimony of Secretary of the Interior Columbus Delano in 1874, "The buffalo are disappearing rapidly, but not faster than I desire. I regard the destruction of such game as Indians subsist upon as facilitating the policy of the Government, of destroying their hunting habits, coercing them on reservations, and compelling them to begin to adopt the habits of civilization."[24] The Signal Office did its part as well to shatter the ecology of natural knowledge. According to May Clemmer Ames, a period of unusually wet and stormy weather followed the establishment of a telegraphic weather station at Fort Gibson in Indian Territory. The natives, thinking the Signal Office observer was responsible, were dissuaded from tearing down the station only after being told by their agent that the observer only recorded the weather, he did not control it.[25] The discovery of gold in the Black Hills in 1874 was accompanied by a furious campaign by the Signal Office to extend its telegraph lines into the northwest. Frontier expansion in the southwest also stimulated a program construction

and operation of telegraph lines into the frontier "against Indian and Mexican depredations." By 1879 there were 5,000 miles of lines and 73 stations from the Dakotas to Washington Territory in the northwest and from Texas to California in the southwest. Signal office telegraphers may have filed regular weather reports, but they also filed more desperate calls for help:

> Telegram from Maricopa Wells, Arizona Territory to Lt. Reade, San Diego, June 1, 1877—A band of 50 Apache Indians committing depredations 3 miles from here, killed one child and mortally wounded one woman. Request protection by troops.

The telegraphic network was vulnerable to Apache raiding parties who pulled down the poles and cut the wires. An even more effective technique was to allow the poles to stand and join the cut wires with a thin strip of leather, making a break in the circuit extremely difficult to locate. Because of this the Army brought in signal officers trained to use the heliograph. Through the wires and communication devices of the Army Signal Office, science, technology and settlement made their incursion into the American west.

By 1877 the Signal Office had constructed a network of telegraphic stations linking coastal lighthouses from Sandy Hook to Cape May; Norfolk to Cape Hatteras; and Wilmington to the mouth of the Cape Fear river, a total of over 500 miles. Observers at these stations had orders to describe all passing vessels and report the signal flags or lights they displayed. Using wig-wag, the observers sent messages to the ships. Although its primary goal was to warn of approaching storms, thus saving lives and property, the seacoast network also provided entertainment for passengers and vacationers who wished to send messages and keep in touch with the national news and weather as reported from Washington.[26] Not all of these messages were important or welcome. Out of devotion to his patron, Myer sent U.S. Grant a cablegram at 3 am when his daughter Nellie and her new husband arrived safely in England. In 1873 he began sending Grant daily weather forecasts for the entire country. He

even sent reports to Long Branch during Grant's summer vacation. One day Myer received a very brief reply, "Stop them—Grant."[27]

As they did with destructive storms, disgruntled workers, renegade Indians, and other domestic disturbances, the Signal Service considered it their mission to help solve the problem of western locusts by cooperating with the U.S. Entomological Commission and other government agencies. They collected specialized data and produced maps, charts and annual reports on how temperature and humidity conditions affected locust hatching, how winds might influence locust migration, and the status of crops and other forage that supported locust swarms. The Signal Service was then able to issue warnings of potential locust outbreaks and supervise the destruction of eggs and young before a swarm developed. [28]

The fact that America now had a well-funded national weather service did not go unnoticed in Europe. In contrast to their usual disdain of "colonial" science, European scientists and administrators now expressed admiration for the huge scale of the American meteorological service, its generous funding, and its utility (if not its theoretical accomplishments). In 1873 Myer, representing the United States at the International Meteorological Congress in Vienna, proposed that the weather services of the nations of the world prepare an international series of simultaneous observations and charts to aid the study of world climatology and weather patterns. The result was the Bulletin of International Simultaneous Observations published by the Signal Office from 1875 to 1889. His office also issued the Monthly Weather Review, begun by Cleveland Abbe, the chief civilian scientist, in 1873 and still published today. As Abbe wrote to his colleague Elias Loomis at Yale, this was the "beginning of what I hope to see grow into something worthy of the human race—for you will see that it is the union of the whole world in an attempt to produce a daily map of the atmosphere. And only thus can we study the atmosphere."[29] In 1879 Myer returned to Europe as a delegate to the second International Meteorological Congress in Rome.

Permanent status for the Signal Corps came late in Myer's life. It became a bureau of the War Department in 1875 and received a permanent enlisted force in 1878. An act of February 24, 1880 established the rank of the Chief Signal Officer as Brigadier General. Albert Myer received that rank on June 16, 1880, just two months before his death; details of his funeral were reported to the nation by telegraph.

The Network Under Siege: The Hazen and Greely Eras

Myer was succeeded as Chief Signal Officer by William Babcock Hazen, a veteran of the Civil War and Indian wars. Hazen was born in Vermont in 1830 and received his military education from 1851 to 1855 at West Point. He was assigned to Fort Davis, Texas in 1858 as a scout was wounded in a skirmish with Comanches the following year. During the Civil War he participated in General William T. Sherman's infamous march to the sea. In 1866 he was appointed Acting Inspector-General of the Department of the Platte and served in the Plains Indian campaigns. In 1870 he was appointed Superintendent of Indian Affairs at Fort Smith, Arkansas. Following several tours of duty in Europe as an attaché and observer of the Prussian military, Hazen was promoted to Brigadier General and Chief Signal Officer in 1880.[30] Hazen's interest in meteorology derived in part from his experiences countering the exaggerated claims of land speculators and railroad companies about the beneficent climate of the west, especially the rainfall of prairies.[31]

Under Hazen's leadership the Signal Office established a scientific study room, appointed a permanent advisory committee of members of the National Academy of Sciences, improved testing and recruitment of new officers, published a new journal Signal Service Notes, issued William Ferrel's text book, Recent Advances in Meteorology, compiled a multi-volume international Bibliography of Meteorology, and responded to its critics in Congress on

the issue of whether the military should be supporting a national weather service.[32] The Signal Office, however, did not fare well in the 1880s. Its funding was reduced and some stations were closed. Its military intelligence missions were largely curtailed.

In 1881 Secretary of War Robert Todd Lincoln ordered a thorough investigation of the Signal Corps and issued a report stating that the weather service had "no natural connection whatever with the military service." He recommended an end to meteorology in the Army. Senator John A. Logan responded by introducing a bill into the 47th Congress to transfer the weather service to the Department of the Interior. Three years later a committee on meteorology of the National Academy of Sciences chaired by Montgomery C. Meigs recommended transfer of the weather service to civilian control. Also in 1884 a joint, bipartisan congressional committee chaired by Senator William B. Allison, began its investigation of the scientific bureaus of the government, including the weather service of the Signal Office.[33] One focus of enquiry was the extent to which government employees were engaged in abstract scientific research rather than in public service. Weather service employees testified that their work was wholly practical. The majority report of the commission, accepted by Congress, upheld the status quo in federal science, although a minority report advocated the transfer of the weather service to a civilian department.

In 1885 another controversy with Secretary of War Lincoln over the handling of the Lady Franklin Bay polar expedition resulted in Hazen's court-martial, temporary removal from office, but subsequent acquittal. That same year, in the final military action of his career, he sent three heliograph signal detachments to Arizona Territory for use in the campaign against the Apaches. Hazen's final trip to Europe was as the U.S. representative to the International Commission of Meteorology in Paris. After completing his memoirs, he died in January, 1887 at the age of 56.[34]

Hazen was succeeded by Adolphus W. Greely, a long-time signal officer and celebrated Arctic explorer. Greely was born in Newburyport, Massachusetts, in 1844 and attended local schools. During the Civil War he enlisted in the 19th Massachusetts Volunteers, seeing action at the battles of Antietam and Fredericksburg, and in the Peninsula Campaign. He was promoted to Corporal in 1862 and Captain of the 81st U.S. Colored Troops in 1865. After the war Greely served in the frontier army in Wyoming, Utah, and as a signal officer in the 1869 campaign against the Cheyenne in Nebraska. A year later he was transferred to Washington, D. C. to assist Albert Myer in the establishment of the weather service. In addition to serving with the River and Flood Service, Greely was placed in charge of completing the Signal Corps telegraph line across Texas in 1875. He also wrote a professional report on the isothermal lines of the United States.

In 1881 Greely volunteered for a scientific expedition to the Arctic to establish circumpolar meteorological stations as part of first International Polar Year (1882-83).. He led a 25-man party to Lady Franklin Bay on the east coast of Ellesmere Island where he established a base camp and collected meteorological and geophysical observations. He and his party mapped a stretch of Greenland's coast, explored Ellesmere Island, and achieved a northern record of 83°24′. When supply and relief ships failed to arrive in 1882 and 1883 Greely and his men broke camp and made their way south by boat to Cape Sabine where they were forced to winter over. By the time a rescue mission arrived in June 1884 only seven men were alive, one of whom soon died. While General Hazen was taking the blame for the failure of the relief efforts, Greely was quickly absolved of any wrong-doing and received a hero's welcome, collecting explorer's medals from the Royal Geographical Society of London and the Société de géographie de Paris.[35] He spent his recovery time preparing popular and official reports of the expedition.[36]

Greely became Chief Signal Officer shortly after the death of Hazen. By Presidential order, he was now a Brigadier General (He had only made Captain a year earlier!). Greely fought to keep the Signal Corps in existence and staffed with qualified scientists. He expanded the service's work concerning agricultural meteorology and focused largely on research. He even wrote a popular book on American Weather (1888). Civilian scientists were employed by the Corps to explore the laws of atmospheric motion, the spatial and temporal distribution of temperature and moisture, cloud photography, atmospheric electricity, the diminution of temperature with altitude, analytical mechanics, and solar physics.

Greely believed that military discipline was necessary to obtain accurate observations, yet, in agreement with earlier critics, advocated the transfer of the weather service to a civilian agency and reorganization of the Signal Corps to increase its efficiency and preserve its military mission. Perhaps too he saw the writing on the wall. As early as 1884 the National Academy of Science recommended a non-military meteorological bureau and, from 1882 to 1890, Congress introduced a number of bills proposing the transfer of the weather service out of the Signal Office.[37] One argument for the separation was that enlisted men were first of all soldiers: "Their first duty is not to prosecute natural inquiries, but to obey the commands of their superior officers." But the observers were also college graduates who overwhelmingly preferred a transfer to a civil bureau. One additional factor should be mentioned—the rise of agricultural colleges, experiment stations, and state weather services provided an alternative model of organization, one that included more scientific control and promised to satisfy the desire of many in agriculture, business, and state government for decentralized (and hopefully more accurate) forecasting.[38] The transfer was enacted by Congress in 1890 and completed on July 1, 1891 when the newly established U.S. Weather Bureau began functioning in the Department of Agriculture.

Conclusion

The U.S Army Signal Service, established as a special military unit during the Civil War, continued its military mission into peacetime as a national weather service and intelligence gathering agency. From 1870 to 1880, under its founder and chief officer Myer, the Corps pursued with a vengeance stormy weather, striking workers, renegade Indians, and other threats to domestic tranquility. Further removed from the shadow of war, Myer's successors Hazen and Greely focussed more on expanding and improving the weather service as they battled their critics and prepared to surrender the weather service to a civilian agency, yet each used signaling technology for both civilian and military purposes. In the case of the Signal Office weather service, meteorology provided the rationale and funding for a wide-ranging set of military activities involving telegraphy and surveillance. According to Napoleon Bonaparte, "Le secret de la guerre est dans le secret de communications"; according to William A. Glassford, a contemporary chronicler of the Signal Service who knew Myer personally, "To the legitimate duties of military signaling he added the utterly foreign concerns of a meteorologist, with a result well known."[39]

Only a year after the transfer of the weather service the Signal Office, now a purely military outfit, advised the National Guard on the use of signaling devices—heliographs, lanterns, and telegraph lines—in the Homestead riots in Pennsylvania. During the Chicago Railroad riots of 1894 the Signal Office installed a "very complete" system of visual, telephone, and telegraph communications between department commanders and subordinates. The lessons learned by Myer during the rail strike of 1877 had not been forgotten.

General Greely served as CSO until 1906. He directed the Corps' activities in the Spanish-American War and was responsible for relief activities after the San Francisco earthquake of 1906. Under his leadership, the Signal Corps introduced new technologies,

including wireless telegraphy, the automobile, and the airplane. Military meteorology reentered the picture in World War I when the Signal Corps and Weather Bureau cooperated in a seamless operation headed by Robert A. Millikan—investigating battlefield climatology, issuing weather forecasts, calculating the effects of upper air winds on the trajectories of artillery shells, and studying the weather conditions affecting gas warfare. But that is another story.

As this example demonstrates, the history of science may be written largely as a political history that examines the role of the military in American society; moreover, it need not focus on great men with great ideas. Increasingly, historians are incorporating the genres of political, social, cultural, and military history into their accounts of scientific and technical change. They are asking hitherto unexamined questions—about privilege and patronage, about elites and non-elites, about mass experience of technological systems, and about civilian and military initiatives. In fields as well cultivated as physics and astronomy, to much newer specialties such as environmental history, historians are weaving accounts of natural knowledge, social relations, technology, and culture into unified explanations of social change.[40] In such accounts, the military's relationship to the geophysical sciences looms large indeed.

Notes

[1] John Grable to William J. Rhees, Jan. 27, 1872, RU 60, Meteorological Project Records, Smithsonian Institution Archives. The elision continues, "to be run by Professor Henry as long as he lives, and improve it from time to time with the assistance of practical meteorologists, as far as can be done."

[2] Alan Nevins, The War for the Union I (New York: Scribner's, 1959-1960), v; quoted in George M. Fredrickson, The Inner Civil War: Northern Intellectuals and the Crisis of the Union (New York: Harper & Row, 1965), 111.

[3] Robert V. Bruce, Lincoln and the Tools of War (Indianapolis: Bobbs-Merrill, 1956).

[4] Peter Dobkin Hall, The Organization of American Culture, 1700-1900: Private Institutions, Elites, and the Origins of American Nationality (New York: NYU Press, 1982), 242 and 227-39.

[5] Woodrow Wilson, Memorial Day Address, May 31, 1915, Arlington National Cemetery, Virginia.

[6] The standard accounts of modernization are Samuel P. Hays, The Response to Industrialism, 1885-1914 (Chicago: University of Chicago Press, 1957), and Robert H. Wiebe, The Search for Order, 1877-1920 (New York: Hill and Wang, 1967).

[7] Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930 (Baltimore: Johns Hopkins University Press, 1983), especially, p. 2.

[8] This sketch of Myer's life is based on James Rodger Fleming, "Albert James Myer," in John A. Garraty and Mark C. Carnes, ed., American National Biography 16: 197-98 (New York: Oxford University Press, 1998); and on Paul J. Scheips, "Albert James Myer, Founder of the Army Signal Corps: A Biographical Study" (Ph.D. dissertation, American University, 1966). Myer's personal papers are located at the U.S. Army Military History Institute, Carlisle

Barracks, Pa. and in the Manuscripts Division, Library of Congress. His military service records and most of his official papers as Chief Signal Officer (RG-111) and head of the national weather service (RG-27) are in the National Archives and Records Administration.

[9] Paul J. Scheips, "Union Signal Communications: Innovation and Conflict," Civil War History 9 (1963): 399-421.

[10] William H. Powell, compl., List of Officers of the Army of the United States from 1770 to 1900 (New York: L. R. Hamersly & Co., 1900; reprinted Detroit: Gale, 1967), s.v. Myer, Albert J., p. 499.

[11] The Manual of Signals was expanded and reissued by Van Nostrand (1866, 1868, 1872 and 1874) and in revised form by the USGPO (1877, 1879).

[12] Donald R. Whitnah, A History of the United States Weather Bureau (Urbana: University of Illinois Press, 1961); and Joseph M. Hawes, "The Signal Corps and Its Weather Service, 1870–1890," Military Affairs 30 (1966): 68–76; and Lewis J. Darter, Jr., comp., List of Climatological Records in the National Archives (Washington, D.C., 1942). See also Paul J. Scheips, "'Old Probabilities': A. J. Myer and the Signal Corps Weather Service," Arlington Historical Magazine 5 (1974): 29–43; and George M. Kober, "General Albert J. Myer and the United States Weather Bureau," Military Surgeon 65 (1929): 65-83.

[13] James Rodger Fleming, Meteorology in America, 1800-1870 (Baltimore: Johns Hopkins University Press, 1990).

[14] More complete documentation of this case study appears in the author's "Historical Introduction: The Signal Office and the Bibliography of Meteorology," in James Rodger Fleming and Roy E. Goodman, eds., International Bibliography of Meteorology: From the Beginning of Printing to 1889, 4 volumes in 1 (Upland, Penna.: Diane, 1994).

[15] Albert J. Myer to Congressman Halbert E. Paine, January 18, 1870, "Letters... Relative to storm telegraphy," U.S. House of Representatives, Ex. Doc. 10, pt. 2, 41st Cong., 2d sess., p. 22.

[16] Halbert E. Paine to H.L. Dawes, U.S. Senate, Sept. 18, 1888, Congressional Record 19, no. 224 (Sept. 19, 1888): 9564-65. See also Halbert Paine to Duane Mowry, Oct. 8, 1903, quoted in Eric R. Miller, "New Light on the Beginnings of the Weather Bureau from the Papers of Increase A. Lapham." Monthly Weather Review 59 (1931): 68.

[17] Report of the Chief Signal Officer in the annual reports of the Secretary of War, 1873, 306; Scheips, "Old Probabilities," 35; Lewis J. Darter, Jr., "The Origin and Development of the Weather Bureau," in List of Climatological Records in The National Archives (Washington, D.C., 1942), 14.

[18] A recent summary of the history of telegraphy likens Samuel F.B. Morse to "an immense spider in the center of a vast web he himself had woven"; Tom Standage, The Victorian Internet (New York: Berkeley Books, 1998), p 182. Standage says nothing, however, about the interrelatedness of telegraphy and weather forecasting, for example as in the careers of Joseph Henry and Albert J. Myer.

[19] [Albert J. Myer], "Some of the Chief Uses and Adaptabilities of the Signal Office Reports and Publications," typeset copy in Albert J. Myer Papers, Library of Congress. For details see Report of the Chief Signal Officer in the annual reports of the Secretary of War, 1871-1891.

[20] Robert V. Bruce, 1877: Year of Violence (Indianapolis: Bobbs Merrill, 1959), 73, 230, 271, 276.

[21] Bruce, 1877; telegrams were edited for clarity.

[22] Bruce, 1877, 279-80, 291.

[23] William H. Leckie, The Military Conquest of the Southern Plains (Norman, OK, 1963), 187, quoting Martin S. Garretson, The American Bison: The story of its extermination as a wild and its restoration under federal protection (New York, 1938), 128.

[24] Secretary of the Interior Columbus Delano, testimony before Congress, Jan. 10, 1874, House Rpt. No. 384, 43rd Cong., 1st sess., 99, quoted in Robert Wooster, The Military and United States Indian Policy 1865-1903 (New Haven: Yale University Press, 1988), 171.

[25] Mary Clemmer Ames, Ten Years in Washington: or, Inside Life and Scenes in Our National Capital as a Woman Sees Them (Hartford,1882), 502.

[26] See for example H.H.C. Dunwoody to W.G. Atkinson, Chairman, Meteorological Committee, Merchant's Exchange, Baltimore, June 27, 1877, OCSO, Miscellaneous Letters Sent, RG-27, Records of the Weather Bureau, National Archives.

[27] D. Marean to Henry E. Williams, April 7, 1922, Other records, reminiscences of employees & miscellaneous historical meteorological information, item 47, RG 27, Records of the Weather Bureau, National Archives.

[28] Report of the Chief Signal Officer, 1877, p. 500; Willis Conner Sorensen, "Brethren of the Net: American Entomology, 1840-1880," Ph.D. dissertation, University of California, Davis, 1984, p. 254. See also letter to C.V. Riley, St. Louis, Mo Feb. 20th, 1877, OCSO, Miscellaneous Letters Sent, RG-27, Records of the Weather Bureau, National Archives.

[29] Cleveland Abbe to Elias Loomis, Mar. 13, 1878, Papers of Elias Loomis, Beinecke Library, Yale University.

[30] George W. Cullum, Biographical Register of the Officers and Graduates of the U.S. Military Academy at West Point, N.Y. from its Establishment, in 1802 to 1890 with the Early History of the United States Military Academy, 3d ed. Vol. II. (Boston, 1891), s.v. Hazen,

William B., no. 1704, pp. 632-35. See also Paul Andrew Hutton, ed. Soldiers West: Biographies from the Military Frontier (Lincoln: University of Nebraska Press, 1987).

[31] William Babcock Hazen, Our Barren Lands: The interior of the United States west of the 100th meridian and east of the Sierra Nevadas (Cincinnati, 1875).

[32] In April 1881 the National Academy of Science appointed a committee on meteorology to confer and cooperate with the Chief Signal Officer. Members included Simon Newcomb (chairman), Elias Loomis, Wolcott Gibbs, H.A. Newton, William Ferrel, Charles A. Schott, Samuel P. Langley, Ogden N. Rood, and Charles A. Young. Fleming and Goodman, eds., International Bibliography of Meteorology.

[33] "Testimony before the [Allison] Commission to consider the present organization of the Signal Service..." U.S. Senate, Misc. Doc. 82, 49th Cong., 1st sess. See also A. Hunter Dupree, Science in the Federal Government: A History of Policies and Activities (Cambridge, Mass.: Harvard University Press, 1957), 190, 215, et seq.

[34] William Babcock Hazen, A Narrative of Military Service (Boston, 1885).

[35] Powell, List of Officers of the Army, s.v. Greely, Adolphus W., p. 339; and Dictionary of American Biography (New York: Scribner's, 1928-36), s.v. Greely, Adolphus W.

[36] Adolphus W. Greely, Three Years of Arctic Service: An account of the Lady Franklin Bay expedition of 1881-84, and the attainment of the farthest north, 2 vols. (New York, 1886); and International Polar Expedition, Report of the proceedings of the United States expedition to Lady Franklin Bay, Grinnell Land, 2 vols. 49th Cong., 1st sess. House Misc. Doc. no. 393 (Washington, 1888).

[37] [H. Helm Clayton] , The Transfer of the United States Weather Service to a Civil Bureau (Boston, 1889). See also Thomas J. Brown, The Necessity for a Civilian Directorship of the New Weather Bureau, as Against a Military Protectorate, n.p. 1891, copy in the American

Philosophical Society Library; and "Records relating to the transfer of meteorological functions from the War Department to the Agriculture Department, 1887," RG 27, Records of the Weather Bureau, National Archives.

[38] N.S. Shaler, "The Weather Service Should Be Non-Military," Boston Herald (March 10, 1889), quoted in Clayton, Transfer, 15.

[39] W.A. Glassford, "Historical Sketch of the Signal Corps, United States Army." Journal of the Military Service Institution (Governor's Island, New York Harbor, n.d.).

[40] Exemplary in these regards are John M Staudenmaier, Technology's Storytellers: Reweaving the Human Fabric (Cambridge, Mass.: Society for the History of Technology and MIT Press, 1985); Michael L. Smith, Pacific Visions: California Scientists and the Environment, 1850-1915 (New Haven: Yale University Press, 1987); and Ann Shelby Blum, Picturing Nature: American Nineteenth-Century Zoological Illustration (Princeton: Princeton University Press, 1993).