

Modernization and Innovation in the Weather Bureau: From Origins to the ONWP

The U.S. Weather Bureau has consistently been maligned by historians for its delay in adopting Norwegian methods of weather analysis and forecasting as well as the lack of modernization in general. These claims provide inappropriate representations of American meteorology and the weather bureau. They deny or at least minimize the meteorological improvements and dedication to advanced methods that are evident in the history of the weather bureau and its precursors. This paper argues against this historiographical trend.

In colonial times, statesmen-naturalists such as Benjamin Franklin and Thomas Jefferson advocated weather data collection and interpretation in order to better understand the climate and weather patterns. From these beginnings American meteorological data expanded with army observations and the emergence of meteorologists such as James Pollard Espy, Elias Loomis, William Redfield and Robert Hare. Meteorological information was recorded by a number of federal agencies including notably the Smithsonian Institution, which grew into a network of meteorological stations that collected standardized observations as far as Mexico and Canada (Fleming 1990, 2011). The Civil War interrupted the practice however, and the Smithsonian meteorological project never returned to the same prestige after Appomattox.

After the Civil War, Professor Cleveland Abbe supported the idea of creating a national weather service, and from his insistence arose the Military Signal Service

under the direction of Colonel Albert J. Myer (Weber 1922). Abbe joined the U.S. government's weather service as its first chief meteorologist in 1871 with two goals in mind: the optimization of the weather service and the study of theoretical meteorology (Willis and Hooke 2005). Abbe advocated for scientific forecasting based on equations of thermodynamics and fluid dynamics; he developed equations of atmospheric motion similar to those of Vilhelm Bjerknes. According to Willis and Hooke, "Both cataloged the necessary equations of state, continuity, thermodynamics, and motion. Both recognized the need for upper-atmospheric observations" (Willis and Hooke 2005). Although some of the early members of the weather service were civilians or enlisted men without meteorological training, Abbe stressed the importance of high scientific standards and "required the weather service to stay at the forefront of technology" (Willis and Hooke 2005).

Cleveland Abbe serves as an example of the desire for refined scientific practices in the United States. Although there were times of push back and difficulties to modernization, the foundations of the weather bureau and its devotion to cutting edge meteorological practices ever since Cleveland Abbe highlights the problem with the commonly held opinion that the old weather bureau was archaic and anti-reform. My lecture will examine the early development of government-organized meteorological practices in the United States and the difficulties in adopting the Bergen School techniques in North America. I argue that despite periods of transition, the weather bureau quickly became a leader in global meteorological practices.

From its inception in 1870, the first national weather service under the Signal Office continued to grow and advocate further meteorological study; by 1875 the annual budget reflects its growth with an increase of one hundred-fold, \$400,000 per year (Fleming 2000). In 1890 the U.S. Weather Bureau was established under the Department of Agriculture with Mark Harrington as chief. Many of the individuals who worked for the bureau were not meteorologists, but trained civilians “whose duties included reading the instruments, launching balloons and wiring data to Washington” (Fleming 2011). Although these civilians were not ideal in terms of employee qualifications, they were instructed on gathering data and were not responsible for its interpretation. Harrington was replaced with Willis Moore in 1895, neither having led exceptionally productive administrations. It wasn’t until the leadership of Charles Marvin (1913-1934), Willis Gregg (1934-1938), and Francis Reichelderfer (1938-1963) that the U.S. Weather Bureau was able to continue Abbe’s legacy and advance in world meteorology. World War I provided Marvin the opportunity to institute upper-air sounding balloons and to develop marine and aviation weather services. This daily data collection supported reconnaissance, mail flights, and long-range artillery shelling throughout America’s brief but intense military campaign (Fleming 2011).

In the late 1920s and early 1930s the Bergen School techniques were garnering great attention from the international meteorological community, the United States included. Gregg and Reichelderfer spearheaded the difficult process of establishing Bergen School methods of air mass and frontal analysis in the U.S.

Vilhelm and Jacob Bjerknes traveled through the United States, meeting with Gregg

to promote their ideas. Carl-Gustaf Rossby and Sverre Pettersen also aided in the transition as they were previously trained in Scandinavia. The process of incorporating these new methods necessitated the training and hiring of new meteorologists, Harry Wexler, Jerome Namias, and Horace Byers are three who fulfilled this need. They studied under Rossby and soon brought the Bergen techniques to the weather bureau.

Air mass analysis began in the mid-1930s, however the United States proved to have difficulties that were only alleviated through modification of the Norwegian methods. The Gulf of Mexico, the Rocky Mountains, and the Gulf Stream all distort the Bergen method of weather tracking and highlight the importance of further upper air data, which became available through the use of radiosondes. For these few years the weather bureau was not at the cutting edge of meteorological science as a result of the difficulties in translating the techniques that work for the Scandinavian climate to ones that work in North America. There were individuals in and around the weather bureau who were opposed to change. This was confirmed by Harry Wexler who pointed out that there were criticisms “made in the 1920’s and early 30s by people who were loath to accept the Norwegian methods, and who seized upon any discrepancy between analyses made by different men to discredit the newer methods” (Wexler 1939). Willis Gregg, Francis Reichelderfer, and emerging meteorologists such as Wexler however, were devoted to improved scientific methods and technologies.

This devotion resulted in the steady rise in American meteorological practices. World War II provided another opportunity for American meteorology to

aid the war effort and engage in a period of rapid modernization that utilized such technologies as radar and radio-sondes. After the war the weather bureau propelled itself to the forefront of international meteorological practices through the influence of individuals such as Head of Research Harry Wexler and the leadership of Francis Reichelderfer.

Although there is no denying the weather bureau's obduracy, especially before 1934, it was not as backward as many have claimed. The Bergen School was founded only in 1917, with general acceptance of their air mass analysis techniques and international diffusion coming in 1928 with Tor Bergeron's Ph.D. dissertation. The geographical features of North America differ greatly from Europe, so adoption of air mass techniques was not straightforward and weather forecasting necessitated a significant amount of further study. This work was carried out in the Weather Bureau after 1934 under the leadership of chiefs Willis Gregg and F.W. Reichelderfer, the inspiration of C-G. Rossby, and the practical work of Horace Byers and Harry Wexler in the air mass analysis section.

By 1954, the weather bureau was at the forefront of advancing Vilhelm Bjerknes' 1904 idea (or Cleveland Abbe's of 1901) of weather prediction as a problem in mechanics and physics. Utilizing newly available electronic computers, Wexler helped bridge the gap between the graphical and digital methods, propelling the weather bureau to the forefront of meteorological advancements. He trained under Rossby in air mass analysis while studying at MIT and advocated for the study and implementation of numerical weather prediction.

This lecture will delve into the emergence of the weather bureau, its commitment to innovation, and the eventual incorporation of modified Norwegian techniques into American practice. It will serve as a reminder that the organization, although marred on different occasions by difficulties and obduracy, was overall devoted and consistent in its quest for cutting-edge scientific practices.

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