Reviews

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How weather became a science

Meteorology was not always a science. In 1846 Francois Arago, director of the Paris Observatory and permanent secretary of France’s prestigious Academie des Sciences, declared “Whatever may be the progress of sciences, never will observers who are trustworthy, and careful of their reputation, venture to foretell the state of the weather.” Arago and his fellow 19th century “gentlemen scientists” considered weather forecasts no different from prophecies delivered by soothsayers—an attitude that damaged the reputation of many who were sincerely trying to understand how the atmosphere worked.

Shortly after the turn of the century, however, meteorology began to modernize. This era, from around 1900 to 1960, is the focus of James Fleming’s book *Inventing Atmospheric Science*. Fleming is a historian of science and technology at Colby College in Maine, US, and also the founder and first president of the International Commission on the History of Meteorology. Following an undergraduate degree in physics and a Master’s in atmospheric science, he has become one of meteorology’s most influential historians. His many well-researched and compelling books include a biography of Guy Stewart Callendar, who first demonstrated the effect of carbon-dioxide emissions on the climate (*The Callendar Effect*, 2007) and a history of “weather engineering” schemes and their false promises (*Fixing the Sky*, 2010). Although modern meteorology had many important forebears, in *Inventing Atmospheric Science* Fleming singles out three and wraps a surprisingly coherent narrative around them.

The first of Fleming’s inventors is Vilhelm Bjerknes (1862–1951), an ambitious Norwegian physicist who began his career by pursuing his father’s research interests in fluid dynamics. During the First World War, while seeking to help his native country survive food shortages, Bjerknes realized that physics had immense practical value for weather forecasting: at its heart, meteorology was simply an initial value problem. But Bjerknes did not just apply his physical insight to develop a weather-forecasting service in Bergen. He was also adept at the practical aspects of running such a service (obtaining data, issuing forecasts); politically astute enough to gain national support and resources; and skilled enough to manage a research group.

This group made several important discoveries, including the “polar front”, a globe-girdling region of enhanced temperature gradient that drives much of the weather of the mid-latitudes. Group members also crafted a conceptual model for the evolution of extratropical cyclones. Both developments, Fleming writes, served as vehicles for Bjerknes’s ambition. While there are other books and articles about Bjerknes (notably Robert Marc Friedman’s *Appropriating the Weather*), Fleming succeeds in shedding new light on his subject, including details on the friction between the Bergen group and a rival Austrian school, and also an account of the American Weather Bureau’s resistance to the Bergen methods.

One of Bjerknes’s most renowned group members was Carl-Gustaf Rossby (1898–1957), the second figure in Fleming’s study. After studying in Bergen, Rossby came to the US on an American–Scandinavian Foundation fellowship. Instructed to bring the Bergen methods to the Weather Bureau (now the National Weather Service), Rossby proved not only an excellent researcher (he developed the Rossby wave equation to calculate the motion of undulations in the jet stream), but also an inspirational leader. After leaving the Weather Bureau, he founded the first graduate school in meteorology at the Massachusetts Institute of Technology; chaired the newly formed Institute of Meteorology at the University of Chicago; and founded two extant scientific journals: the American Meteorological Society’s *Journal of Meteorology* (now *Journal of the Atmospheric Sciences*) and the Stockholm International Meteorological Institute’s *Tellus*. Rossby was also instrumental in working with the teams that produced the first computerized weather forecasts on two continents.

This chapter of the book is the shortest of the three; however, I had the sense that more depth was needed to explain how Rossby accomplished all these things with such apparent ease. A five-minute visit with Rossby was all it took to inspire Fleming’s third protagonist to study meteorology. Harry Wexler (1911–1962) rapidly advanced in his career to become head of research at the Weather Bureau. Despite dying at the young age of 51, Wexler was involved in some of the biggest advances in atmospheric science, including weather radar, computer-
ized weather prediction and satellites. In his short life, he also became the first meteorologist to fly into a hurricane; was appointed chief scientist of the International Geophysical Year in 1957/8; and established the carbon-dioxide measurements at Hawaii’s Mauna Loa volcano, which have been crucial in demonstrating the influence of human activities on the atmosphere. This chapter is probably the one that most meteorologists will appreciate. Wexler is the least known of the three, yet his contributions on such a range of topics were significant. Kudos to Fleming for finally telling Wexler’s story.

Bringing Inventing Atmospheric Science to a close, Fleming argues that 1957 was the turning point when atmospheric science became “big science”, less focused on individuals and more run by committees and national research organizations. Here, the emphasis is on the US with its national investment in science and the creation of the National Center for Atmospheric Research in Boulder, Colorado. This part of the story is especially germane because Bjerknes, Rossby and Wexler were each masters of building structures and leading organizations, and it is these structures that would become critical to the subsequent evolution of atmospheric science as its own discipline, as Fleming adeptly argues.

Although we learn a lot about the accomplishments of these three giants, Fleming delivers few insights into what they were like as people. Personal stories and their non-science lives are rarely described, which makes Inventing Atmospheric Science relatively short (only 226 pages of text in the chapters). Some of the terminology (and many of the more peripheral actors) described in the book might not be recognizable to a non-atmospheric scientist, but that shouldn’t diminish the book’s readability. Almost anyone with a background in science – and especially those interested in the foundations and evolution of a discipline – should be able to understand most of the book. This book also introduces physicists to some of the great scientist–leaders who created the field of atmospheric science. Indeed, few other disciplines can claim to have undergone such a radical change, from soothsaying in the 1800s to the rigorous field of predicting the future that is modern atmospheric science.

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