HISTORICAL REVIEW

Monthly Weather Review at 150 Years: Its History, Impact, and Legacy

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ABSTRACT: Monthly Weather Review, one of the oldest continuously published meteorological journals in the world, publishes its 150th volume this year. In January 1873, the U.S. War Department’s Army Signal Service began producing this monthly report summarizing weather across the United States. Its first issue consisted of a one-page narrative of weather conditions and storms and one chart depicting tracks of low pressure centers during that month. In 1891, Monthly Weather Review continued as a government publication with the transfer of the nation’s weather service from the military to the newly established U.S. Weather Bureau. Over time and sometimes erratically, it grew into a scientific journal. In 1974, Monthly Weather Review was transferred to the American Meteorological Society, who continues to publish it to this day (although a 2003 proposal might have ended it). This Historical Review discusses some of the journal’s history and impact, as well as its legacy. This review also compiles for the first time a complete list of Monthly Weather Review editors. The research published within Monthly Weather Review has included highly cited, ground-breaking articles on weather and climate phenomena (e.g., extratropical and tropical cyclones, El Niño–Southern Oscillation, Madden–Julian oscillation), general circulation modeling, and numerical weather prediction. The data published in the early issues have been used—and continue to be used to this day—for a variety of applied research and historical analysis purposes. The composition and content of Monthly Weather Review have changed over the past century and a half, continuing to evolve with the modern publishing landscape, with color figures at no additional cost, open-access articles, open data, and, in the near future, embedded figure animations.

KEYWORDS: Atmosphere; History; Editorial; Numerical weather prediction/forecasting; Climate records

1. Introduction

Starting in 1873, the U.S. War Department began producing a monthly report on the weather across the United States called Monthly Weather Review. Produced by the Division of Telegrams and Reports for the Benefit of Commerce and Agriculture within the Office of the Chief Signal Officer, the January 1873 issue amounted to a one-page written weather summary and one chart (produced later) of the tracks of low pressure centers across the United States during that month (Fig. 1). This monthly report grew to three pages and three maps by the December 1873 issue. Although initially consisting of brief summaries of climatological data, this publication continued to grow to include news items and research notes, eventually culminating in the present-day scientific journal, consisting of around 5000 pages a year of peer-reviewed research articles related to theoretical, observational, and practical meteorology. Its list of contributing authors and editors includes many notable names from the pantheon of meteorology: Abbe, Beck, Bigelow, Bjerknes, Brooks, Fujita, Humphreys, Köppen, Manabe, Newton, Rossby, Shaw, Simpson, Smagorinsky, and Wexler, among others. It has had three different publishers—with 48 different individuals leading the editorial process over the years (Table 1)—and has evolved into an online format with its archive freely available to researchers and others across the globe. This modest little report—the Monthly Weather Review—has become one of the world’s longest running and most influential journals for weather research.

As Monthly Weather Review enters its 150th year of publication, we look back at its origins and development, recall some of the more noteworthy articles that have filled its pages, and reflect on the impact it has had on the world of meteorology, as well as its legacy, which continues to evolve. Specifically, topics to be covered include its history under the Signal Service in section 2, the Weather Bureau and its successors in section 3, and the American Meteorological Society (AMS) in section 4. Section 5 explores further the content of the journal, from data and charts to the research articles, special issues, and most-cited articles. Section 5 also shows the value that content in Monthly Weather Review has brought to health, aviation, and modern climate studies. Section 6

\textsuperscript{c} Denotes content that is immediately available upon publication as open access.

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FIG. 1. The first issue of *Monthly Weather Review* from January 1873. The sizes of the full pages (including margins cropped for display here) are (top) 8 in. × 10 in. for the text page and (bottom) 11.5 in. × 9.25 in. for the chart. Scans courtesy of Deirdre Clarkin, NOAA Central and Regional Libraries.
Table 1. Editors and chief editors of *Monthly Weather Review*. Sources of information derive from mastheads and covers or content pages of individual issues available from printed journals (referred to simply as “mastheads”), the AMS website (https://journals.ametsoc.org/view/journals/mwre/mwre-overview.xml), NOAA Central Library (https://library.oarcloud.noaa.gov/#docs.lib/htdocs/rescue/mwr/), Hathi Trust (https://catalog.hathitrust.org/Record/000524019, https://catalog.hathitrust.org/Record/009025178), the Annual Reports of the Chief Signal Officer (which cover fiscal years ending 30 June; https://www.library.noaa.gov/Collections/Digital-Docs/Signa-Corps-WB-Annual), Humphreys (1919), Henry (1929), and a list compiled by AMS Archivist Sophie Mankins. Where discrepancies between what the mastheads said and what Humphreys (1919) and Henry (1929) wrote arose, we have given priority to the mastheads. The editor for 1881–82 was determined to be not listed, a result extrapolated from the January 1882 and January–July 1884 issues for which we were able to obtain complete issues and there was no editor listed. This period also is after the last mention of those who alternated in preparation of the Review, given in Drum (1880), and precedes the first issue in which the editor appears to have been regularly indicated on the issue’s cover or masthead (August 1884).

<table>
<thead>
<tr>
<th>Period</th>
<th>Editors, unless title is otherwise specified</th>
<th>Source</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Jul–Dec 1872</td>
<td>Henry Calver and Thompson B. Maury</td>
<td>Abbe (1895), MWR (1901), Henry (1929)</td>
<td>Published retrospectively (MWR 1901)</td>
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<tr>
<td>1873–75</td>
<td>Cleveland Abbe, Robert Craig, H. H. C. Dunwoody, Thompson B. Maury (“in rotation”/“alternated”)</td>
<td>Myer (1873, p. 303), Myer (1874, p. 95), Myer (1875, p. 101)</td>
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<td>1876</td>
<td>Cleveland Abbe, H. H. C. Dunwoody, Robert Craig (“alternated”)</td>
<td>Myer (1876, p. 114)</td>
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<td>1877–78</td>
<td>J. P. Story, H. H. C. Dunwoody, Robert Craig, and Cleveland Abbe (“alternated”)</td>
<td>Myer (1877, p. 7), Myer (1878, p. 8)</td>
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<tr>
<td>1879</td>
<td>J. P. Story, H. H. C. Dunwoody, Robert Craig, C. E. Kilbourne, and Cleveland Abbe (“alternated”), A. W. Greely (“assisted”)</td>
<td>Myer (1880, p. 7)</td>
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<td>1880</td>
<td>J. P. Story, H. H. C. Dunwoody, Robert Craig, C. E. Kilbourne, A. W. Greely, and Cleveland Abbe (“alternated”)</td>
<td>Drum (1880, p. 7)</td>
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<td>1881</td>
<td>No editor listed</td>
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<td>1882</td>
<td>No editor listed</td>
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<td>1883</td>
<td>No editor listed</td>
<td>Mastheads</td>
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<td>1884</td>
<td>No editor listed (Jan–Jul), W. A. Glassford (Aug, Oct), Thomas M. Woodruff (Sep), H. H. C. Dunwoody (Nov, Dec)</td>
<td>Mastheads</td>
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<tr>
<td>1885</td>
<td>James Allen (Jan, Feb), J. S. Powell (Mar, Nov), H. H. C. Dunwoody (Apr, May, Oct, Dec), J. C. Walsh (Jun), W. A. Glassford (Jul), Thomas M. Woodruff (Aug, Sep)</td>
<td>Mastheads</td>
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<td>1886</td>
<td>H. H. C. Dunwoody</td>
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<td>1887</td>
<td>H. H. C. Dunwoody (Jan, Feb, Apr, May, Jun, Aug, Nov, Dec), F. M. M. Beall (Mar, Jul), J. Mitchell (Sep, Oct)</td>
<td>Mastheads</td>
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<tr>
<td>1888</td>
<td>Frank W. Ellis (Jan), H. H. C. Dunwoody (Feb, Mar, Apr, May, Jun, Jul, Sep, Nov, Dec), Thomas Russell (Aug), H. A. Hazen (Oct)</td>
<td>Mastheads</td>
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<tr>
<td>1890</td>
<td>H. H. C. Dunwoody (Jan, Feb, Mar, Apr, May, Jun, Sep, Oct, Nov), H. A. Hazen (Jul, Aug), James Allen (Dec)</td>
<td>Mastheads</td>
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<tr>
<td>Jan–Jun 1891</td>
<td>H. A. Hazen (Jan, Mar, May), H. H. C. Dunwoody (Feb), James Allen (Apr), E. B. Garriott (Jun)</td>
<td>Mastheads</td>
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<td>May–Jul 1893</td>
<td><strong>E. B. Garriott</strong></td>
<td>Mastheads</td>
<td>Henry (1929) grouped this period with the previous one</td>
</tr>
<tr>
<td>Aug 1893–Jun 1909</td>
<td><strong>Cleveland Abbe; Assistant Editors:</strong> <strong>H. H. Kimball</strong> (Jan 1902–Aug 1903), <strong>Frank Owen Stetson</strong> (May 1904–Apr 1907), <strong>Herbert C. Hunter</strong> (May 1907–Jun 1908), and <strong>Cleveland Abbe Jr.</strong> (Jul 1908–Jun 1909); <strong>Alfred J. Henry</strong>, Acting Editor (Mar 1896, Sep 1897)</td>
<td>Henry (1929), mastheads</td>
<td>Humphreys (1919, p. 485) said Abbe was editor from 1892 to Jul 1909</td>
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<tr>
<td>Aug 1910–Dec 1913</td>
<td><strong>P. C. Day,</strong> plus 12 District Editors</td>
<td>Henry (1929)</td>
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<tr>
<td>Jan 1914–Jun 1915</td>
<td><strong>Cleveland Abbe</strong></td>
<td>Henry (1929), mastheads</td>
<td>Humphreys (1919, p. 486) said Abbe was editor Jan 1914–4 Aug 1916</td>
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<tr>
<td>Jul 1915–Jul 1916</td>
<td><strong>Cleveland Abbe, Jr.,</strong> Acting Editor</td>
<td>Henry (1929), mastheads</td>
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<tr>
<td>Aug 1916–Apr 1918</td>
<td><strong>Cleveland Abbe, Jr., Herbert Lyman,</strong> Acting Editor (Mar 1918)</td>
<td>Mastheads</td>
<td>Henry (1929) said term ended Jun 1918</td>
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<tr>
<td>May–Sep 1918</td>
<td><strong>Herbert H. Kimball,</strong> Acting Editor</td>
<td>Mastheads</td>
<td>Henry (1929) said Jul 1918–May 1919</td>
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<td>Oct 1918–May 1919</td>
<td><strong>Herbert H. Kimball,</strong> Acting Editor; <strong>Charles F. Brooks,</strong> Associate Editor</td>
<td>Henry (1929)</td>
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<tr>
<td>Jun 1919–Apr 1921</td>
<td><strong>Charles F. Brooks</strong></td>
<td>Henry (1929)</td>
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<td>May 1921–Dec 1924</td>
<td><strong>Alfred J. Henry</strong></td>
<td>Henry (1929), mastheads</td>
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<tr>
<td>Jan 1925–Mar 1927</td>
<td><strong>Alfred J. Henry,</strong> Burton M. Varney, Assistant Editor</td>
<td>Mastheads</td>
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<td>Apr 1927–Sep 1931</td>
<td><strong>Alfred J. Henry</strong></td>
<td>Mastheads</td>
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<td>Oct 1931–Dec 1935</td>
<td><strong>W. J. Humphreys</strong></td>
<td>Mastheads</td>
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<td>Jan 1936–Feb 1945</td>
<td><strong>Edgar W. Woolard</strong></td>
<td>Mastheads</td>
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<td>Mar–May 1945</td>
<td>Temporarily Vacant</td>
<td>Mastheads</td>
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<tr>
<td>Jun 1945–Mar 1948</td>
<td><strong>Robert N. Culman,</strong> Acting Editor</td>
<td>Mastheads</td>
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<td>Apr 1948–Dec 1968</td>
<td><strong>James E. Caskey, Jr.</strong></td>
<td>Mastheads</td>
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<td>Jan 1969–Jul 1970</td>
<td><strong>Miles F. Harris</strong></td>
<td>Mastheads</td>
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<tr>
<td>Aug 1970–Mar 1971</td>
<td><strong>John O. Ellis,</strong> Acting Editor</td>
<td>Mastheads</td>
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<tr>
<td>1974–77</td>
<td><strong>Chester W. Newton;</strong> Harriet R. Newton, Assistant Editor</td>
<td>Mastheads</td>
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<tr>
<td>1978–80</td>
<td><strong>Donald R. Johnson,</strong> Chief Editor; Editors: John J. Cahir, James C. Fankhauser, John B. Hovermale</td>
<td>Mastheads, Johnson (1978)</td>
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examines the factors that facilitated the 150-yr history of *Monthly Weather Review* through a comparison with other long-lived meteorological journals. *Section 7* concludes this Historical Review.

2. History: Signal Service (1873–91)

*Monthly Weather Review*’s history is nearly as old as that of the United States federal weather service that first published it. The nation’s weather service effectively came into existence with the passage of a joint resolution of Congress, signed into law by President Ulysses S. Grant on 9 February 1870, authorizing the secretary of war to take meteorological observations at military posts across the country and give notice of approaching storms via telegraph (e.g., *Fleming 2000*). The service initially fell under the auspices of the U.S. Army Signal Service, with General Albert J. Myer serving as chief signal officer. On 1 July 1891, an act of Congress transferred control of the meteorological service from the Army to a civilian agency, the U.S. Department of Agriculture, where it remained until 30 June 1940, when it was transferred to the U.S. Department of Commerce. Under civilian control, the service officially became known as the U.S. Weather Bureau. Its name changed to the present-day National Weather Service (NWS) on 9 October 1970.

In its first two years of existence, the burgeoning weather service dealt primarily with activities related to its organization, the establishment of signal stations and training of personnel in taking and transmitting observations, as well as the development of a system of storm warnings and, eventually, tridiaily forecasts (originally called “probabilities”). The compilation of regular reports chronicling the country’s weather would come later. Writing in the Annual Report of the Chief Signal Officer for 1891, First Lieutenant William A. Glassford of the Signal Service noted that, in 1872 and again in 1873, the scope of the service “was considerably increased by acts of Congress, and in the latter year was instituted the publication of the Monthly Weather Review which was the first attempt in this country to present meteorological data to the general attention of students with the least interval of occurrence of the phenomena discussed” (Glassford 1892, p. 338). In his annual report to the secretary of war, Myer (1873) described the journal’s origin:

The *Monthly Weather Review*, the publication of which was commenced in January last, reviews the facts for each month concerning storms, winds, rain-fall, air, river, and ocean temperatures, and the rise and fall of rivers. It is accompanied with charts showing the tracks of low barometric pressure, the isobars, isotherms, and prevailing winds for the month. The number of copies of this publication issued during the year has been six thousand seven hundred and ninety-six.

Copies of *Monthly Weather Review* were sent to volunteer observers, scientific institutions, libraries, and newspapers, among others. Some received copies free of charge; others who requested it were charged one cent per issue to cover the cost of postage (Myer 1873).

*Monthly Weather Review*, however, was not the first government weather publication. Following numerous attempts to initiate regular publication of weather data involving the U.S. Navy, Smithsonian Institution, and Agricultural Bureau of the Patent Office (*Fleming 1990*), the Signal Service began issuing the *Weekly Weather Chronicle* in late 1872. The *Chronicle* “contained a weekly summary of the weather, drought, rain, frosts, and other meteorological phenomena of special interest to agriculture” (*National Archives 1942*, p. xxx) and eventually evolved into the *Weekly Weather and Crop Bulletin* (*Heddinghaus and Le Comte 1992*). In contrast, *Monthly Weather Review* was intended to be a “permanent record of the month’s weather” and subsequently has been described as the “most important” of the early series of government weather publications (*National Archives 1942*, p. xxx).

One of the first editors of *Monthly Weather Review* was Cleveland Abbe, who served as a civilian assistant to Myer and his successors and whose career in the Signal Service and Weather Bureau spanned 45 years. He wrote of the journal’s origin in a paper titled, “The Meteorological Work of the U.S. Signal Service, 1870 to 1891,” part of a report of the International Meteorological Congress held in Chicago in August 1893. In it, Abbe (1895) said, “The need for preserving in some permanent form a brief history of the successive storms and other prominent features of the weather led me early to propose some form of weather review. The same idea was simultaneously suggested by another, who, however, left it for me to execute, and my first review was published at the close of January, 1873...” Abbe (1904) noted that the first brief summary of storms carried “the somewhat ambitious title of the *Monthly Weather Review*,” adding, “Its publication was ordered, and has continued without interruption ever since.”

Over the years, there has been some confusion over *Monthly Weather Review*’s origin. Careful review of historical sources, however, shows that the journal began publication in January 1873 and that issues for July–December 1872 were produced later (as detailed in the appendix to this Historical Review). It was not until February 1883 that volume and issue numbers began to appear on the masthead, with that issue designated Vol. XI, No. 2, further indicating that 1873 should be regarded as the start of *Monthly Weather Review*.

Almost from the beginning, the new publication caught the attention of the scientific community, as well as the popular media at the time. The *Chicago Daily Tribune* reprinted the February 1873 issue in its entirety in its 19 March 1873 edition. That same day, the *Knoxville Daily Press and Herald* ran a notice that began, “We have received from Prof. J. K. Payne, Signal Officer at this station, a copy of the *Monthly Weather Review* for February, issued by the Chief Signal Officer.” The notice highlighted “the advantages of the weather reports and the interest manifested by the public in reference to them.” A summary of the June 1873 issue was included in the Editor’s Scientific Record section of the September 1873 issue of *Harper’s New Monthly Magazine* (*Harper’s 1873*).

An article about the Signal Service published in the June 1874 issue of *The Republic*, which billed itself as “a monthly magazine
devoted to the dissemination of political information,” included *Monthly Weather Review* among the important works of the service (*The Republic* 1874):

Besides the work of the prognostications, that of the publications of the bureau are most important. Not only are the reprints of the weather maps, bulletins, and probabilities thrice a day scattered over every section of the country, through the ubiquitous agency of the telegraph, but there is a weekly weather chronicle [sic.] printed every day for the preceding week, and circulated by mail to the public press; also, a permanent record, called the Monthly Weather Review, is issued about the 12th of each month, giving all the great meteorological data necessary for a scientific study of American climatology and the development of agricultural and sanitary meteorology.

Also in 1874, the scope and length of *Monthly Weather Review* had expanded, due, in part, to an increase in the number of regular and volunteer observations received at the Signal Office (Myer 1874). Further improvements came in November 1877, when a section on “International Meteorology” was added, with accompanying charts, though this was later replaced in 1883 by a separate monthly publication, *Summary and Review of International Meteorological Observations*. As its longevity and importance grew, the numbering convention of the journal’s pages changed to be sequential from month to month (instead of being reset to page 1 for each month), with formal volume numbers added beginning with the February 1883 issue.

In February 1883, the journal *Science* took notice of changes in the look and feel of *Monthly Weather Review* that began with the November 1882 issue, calling it “an improvement over any of its predecessors, in being stitched and furnished with a neat cover, which contains the name of cooperating observers and of vessels whose officers furnish marine reports, and also a list of meteorological instruments, with the prices at which they may be obtained through the signal-office” (*Science* 1883). “The Monthly Weather Review has grown to an exceedingly valuable meteorological magazine,” hailed the Annual Report of the Chief Signal Officer for 1883 (Hazen 1884).

Perhaps one of the most interesting notes involving *Monthly Weather Review* itself is that of a French edition the Signal Service experimented with publishing in 1878. A note published in the July 1900 issue (MWR 1900b) described this endeavor and, in doing so, included some of the journal’s early history:

The publication of the *MONTHLY WEATHER REVIEW*, which began with the number for January 1873, compiled by the present Editor [Abbe], was soon recognized as an important means of bringing before the world a general summary of the work done by the Weather Bureau, at that time a part of the Signal Service. The enlargement of the *REVIEW*, in 1875, enabled it to include the results of observations by voluntary observers, and also notes and extracts from current meteorological observations, and it became widely recognized as a model for other nations to copy and improve upon. In 1878, Gen. A. J. Myer, the Chief Signal Officer, and head of the Weather Bureau, thought it important to try the experiment of translating the *REVIEW* into French and publishing an international edition. The labor and expense attending this experiment was subsequently found to be prohibitive, but the few copies of this edition that are still to be found in the libraries mark one of the many interesting episodes in the history of the Weather Bureau. Unfortunately, the copy of the French edition that formerly belonged to the library of the Weather Bureau has mysteriously disappeared, and the Librarian joins with the Editor in the hope that several of our numerous correspondents have, or know of, copies for sale or exchange. We would esteem it a favor to be apprised of the fact, so that we may be enabled to complete our files.

Despite a wide search among colleagues, institutions, and online resources, we have been unable to locate any surviving copies of this French edition of *Monthly Weather Review*.

3. History: Weather Bureau (1891–1973)

*Monthly Weather Review* had been in existence for nearly two decades when Congress transferred the meteorological duties of the Signal Service to the U.S. Department of Agriculture in 1891 and created a wholly civilian agency known as the U.S. Weather Bureau (the direct predecessor of the NWS). However, *Monthly Weather Review* had begun to vie around this time with another publication for recognition as the preeminent meteorological journal in the United States—the *American Meteorological Journal*, founded in 1884 by Professor Mark W. Harrington of the University of Michigan (who became the first chief of the Weather Bureau in July 1891). Ultimately, *Monthly Weather Review* would lay claim to this title in 1896, when, after 12 volumes, the *American Meteorological Journal* ceased publication due to financial troubles (Abbe 1906; Potter 2020, p. 226).

3.1 Preparation of issues

Throughout much of its period under the Signal Service and into that under the Weather Bureau, *Monthly Weather Review* was prepared by a group of individuals alternating or working in rotation (Table 1). “The general rule was that the forecast official for the month prepared the *REVIEW* for that month, but, of course, as a variety of duties multiplied and the scope of the *REVIEW* increased, the work of the editor was often limited to a very general supervision of the work done by the clerks of the *REVIEW* room [more formally known as the Review Division],” according to a note published in the April 1901 issue (MWR 1901), which added that “the personality of the editor did not enter into the *REVIEW* quite as clearly as it has done during the past few years.” Henry (1929) gives a similar account for the preparation of the journal during its early years, although suggesting (likely incorrectly) that forecast officials served as editor of *Monthly Weather Review* for the month following that during which they prepared forecasts. As outlined in General Orders No. 28: Regulations and Rules of the Office of the Chief Signal-Officer of the Army (reprinted in Myer 1873), the preparation of *Monthly Weather Review*, along with other
reports and publications, fell to the officials in charge of the daily forecasts:

The preparation of the current “Synopsis and Probabilities,” and of the official publications in relation to practical meteorology, including the “Weekly Weather Chronicle,” “Monthly Weather Review,” “Daily Bulletin, Synopsis, Probabilities, and Facts,” and such other duties as are related thereto, will be divided between several assistants to the Chief Signal-Officer and civilian assistants, in accordance with a roster to be published from time to time providing in advance for the specified period. In the absence of other orders, the assistant, who at any time may be relieved from the preparation of the current Synopsis and Probabilities, will take charge of the preparation of the publications above referred to.

Compiling each issue of *Monthly Weather Review* during this period required a considerable and combined effort involving multiple staff members. First Lieutenant Henry Harrison Chase Dunwoody described the intricate work involved in collecting, compiling, analyzing, tabulating, and charting the vast amount of data that went into *Monthly Weather Review* at the time, as part of an overall discussion of the Signal Service’s Review Division in an appendix to the Annual Report of the Chief Signal Officer for 1888 (Dunwoody 1889):

In this division have been prepared during the year twelve numbers of the Monthly Weather Review, for each month from June 1887, to May 1888, inclusive. In the compilation of each issue were used from eight hundred to one thousand reports of meteorological observations taken at the various stations, viz: the regular Signal Service stations, those of voluntary and State weather observers, and of United States Army post surgeons. In addition to the above-mentioned reports, meteorological data obtained from special reports and clippings of newspapers forwarded to this office by observers at the various stations have been used, together with such reports from tornado observers as have contained information of value. The tabulated data published in the Monthly Weather Review, which in former years was arranged for publication in this division, is now prepared in the Records Division and furnished this room, where the data is charted and discussed. The meteorological journals from the regular Signal Service and voluntary observers (about 175 from the former and 300 from the latter each month), however, are examined and extracts made therefrom in the Review Division, as in former years. Prior to January 1888, the work of checking the receipt of all reports from voluntary observers and those of the international system was done in this division, but in that month this work was transferred to the Records Division, where it has since been done. From 1 July 1887, until the transfer of this work to the Records Division, there were received in the Review Division about 2,700 reports of international simultaneous observations and about 2,000 reports from voluntary observers in the United States. The receipt of these reports was checked and acknowledged by this division. During the year ended June 30, 1888, about 1,600 letters were referred to this division for note, recommendation, or complete action.

Dunwoody (1889) noted that, from 1 July to 6 December 1888, “there were four clerks assigned to this division, but since the latter date there have been but three.”

From 1891 to 1893, a board of editors prepared *Monthly Weather Review* (Table 1), with Edward Garriott (who was in charge of the Review Division, and who would later become professor of meteorology before his untimely death in 1910 at the age of 57) serving as “the actual editor during the life of the board” (Henry 1929).

Until now (Table 1), no reliable and complete documentation of the editors of *Monthly Weather Review* of this period existed. The challenge in piecing together the history of these early years is that some of the published evidence is contradictory, even for seemingly straightforward facts, such as who served as editor for any given month. Henry (1929) stated in his time, “It is not now possible to give a categorical list of the early editors more than to say that the work was divided among the civilian professors... and the... Army officers who had been detailed for service in the Signal Service...” In admitting his uncertainty in compiling such a list, he grouped those who were assigned the duty of preparing *Monthly Weather Review* during the period from January 1873 (the first issue produced) to July 1891 (the introduction of an editorial board, under the newly formed Weather Bureau) as simply “C. Abbe and others.” More detailed info on who was responsible for the preparation of *Monthly Weather Review*, as well as other publications of this period, was found in the Annual Reports of the Chief Signal Officer for 1873–80 (Table 1), as well as the mastheads of the individual issues.1

b. Cleveland Abbe as editor (1893–1909)

Beginning with the August 1893 issue, Abbe took the reins as editor, a change that marked a turning point in the journal’s evolution and heralded a new era in the dissemination of meteorological and climatological information. It was “to him more than any other person that the publication reached its high standing as a meteorological journal,” Henry (1929) declared. By the time of his death in 1916, Abbe was credited with having “prepared 22 of the first 60

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1 Further confusion can be found elsewhere. Henry (1929) listed Abbe as editor from August 1893 to July 1909, and again from January 1914 to June 1915, which matches what appears on the mastheads during this period, with the exception of July 1909, when the editorial changes discussed in section 3b took effect. It is possible that Henry simply got this wrong or, perhaps, he meant “until July 1909,” since the next line in his table (listing “H. S. Bigelow and 12 district editors”) begins with July 1909. Meanwhile, Humphreys (1919) attributed Abbe as editor from 1892 to July 1909 and from January 1914 to 4 August 1916. The source for this information appears to be Abbe’s typewritten curriculum vitae among his papers in the Manuscript Division of the Library of Congress (Abbe 1917), which was prepared by Cleveland Abbe Jr. in 1917, the year following the death of the senior Abbe. The inclusion of 1892 contradicts the listing of the editorial board throughout that year and the July 1909 reference could be explained by the same reason suggested above for Henry (1929) or could simply be in error. Although Abbe Jr. is listed as acting editor from July 1915 to July 1916, it possible that Abbe Sr. continued to serve in an editorial role of some capacity (albeit not listed on the masthead) during this period, which also coincides with Abbe Sr.’s leave of absence, due to poor health, shortly before his death (MWR 1916; Potter 2020, p. 263).
numbers” (MWR 1916), with more than 220 issues bearing his name as editor during his formal tenure as editor.

1) INCLUSION OF SCIENTIFIC ARTICLES

The changes that took place under Abbe’s editorship were remarkable, if not at times radical. From its inception until the start of Abbe’s formal tenure, Monthly Weather Review served primarily as a record of meteorological and climatological data, with tables, summaries, and charts filling its pages (Fig. 2). This was the first of what Corzine (1972) referred to as several “data periods” that existed throughout the journal’s history: “Only occasionally were articles on some special weather occurrence or a local forecast study published during these periods,” he said.

Although changes were at first subtle, by May 1895, they became more substantial, as indicated by the tables of contents for the monthly issues of April–July 1895. Although April’s contents were similar to those in the past, May’s issue included three articles: “Tropical storms of the Gulf of Mexico and the Atlantic Ocean in September,” under the department Studies by Forecast Officials, and two in the department Special Contributions titled, “Cloud Photography” (Henry 1895) and “Meteorology and Public Health” (Phillips 1895). By July, 10 articles had appeared, 6 of which were written by Abbe himself under the department Notes by the Editor. These articles comprised 9 of the 44 pages (20%) of text of that issue, indicating the magnitude of the changes Abbe was implementing.

One of the more important articles published during this time, Abbe (1901), detailed the physical and mathematical means by which weather could be predicted, predating both Vilhelm Bjerknes’s (1904) famous essay on the matter by several years (Willis and Hooke 2006; Potter 2020, 239–240) and Sir Napier Shaw’s (1914) Monthly Weather Review article “Principia Atmospherica.” Abbe’s marked-up page proofs from a reprint of this seminal paper are in the Cleveland Abbe Papers collection of the Library of Congress, and the first page of these proofs is reproduced in Fig. 3. Abbe (1901, pp. 552, 554) wrote:

Of course a full knowledge of the actual physical condition of the atmosphere at any initial moment is not now practically attainable.... Assuming that the time will come when we shall have the necessary observational data, it is now our duty to prepare the way for the complete utilization of the information that will eventually be at hand. We must therefore attack the physical, mechanical, and mathematical problems relating to the general and the special circulations of the atmosphere upon the real globe as it now exists, including in our consideration the fields of snow and ice, the mountain ranges, the continents and the oceans, and not forgetting the distribution of clouds.

Our problems can not be resolved by merely examining the charts of the globe, charts of the diurnal insolation, or charts of the prevailing upper and lower temperatures, moisture, and pressures, or charts of the orographic resistances to the motion of the atmosphere. The methods most appropriate for attacking the problems are not those of types and averages, but those of analytical mechanics, and it is only after the problems have been fully stated analytically and algebraically that we are likely to succeed in devising auxiliary geometrical and graphical methods of solving them that may eventually be made the basis of a system easily handled by practical experts... it will not seem trite if I call attention to the formulæ that present the mechanical conditions that must be fulfilled by every particle of the earth’s atmosphere. These need not seem abstruse or profound because they are clothed in the simple algebraic language that is used in order to give precision; the fundamental principles expressed by these formulæ are easily comprehended by all.

Abbe then presented and described the physical laws needed for prediction that are familiar to all students of introductory dynamic meteorology: the ideal gas law, hydrostatic equation, thermodynamic equation, mass continuity equation, conservation of energy, and momentum equation. Abbe (1901, p. 561) concluded:

We shall arrive at the desired result [long-range seasonal forecasts] sooner and better by the study of the mechanics of the atmosphere than by the search for elusive empiric periodicities, and it is in the hopes of inducing some to turn their attention toward this study that I have submitted these views.

Although Abbe (1901) preceded Bjerknes (1904), the complete extent to which Bjerknes was influenced by Abbe’s writings on weather prediction is not known at this time. Abbe was eager for Bjerknes to contribute to Monthly Weather Review, and the two started a correspondence that led to a valuable interaction and data exchange (Friedman 1989, 38–39). Monthly Weather Review would also later publish an English translation of Bjerknes’s January 1913 inaugural lecture at the University of Leipzig titled, “Meteorology as an Exact Science” (Bjerknes 1914). We are unaware, however, to what degree they discussed the approach that would later be used by Richardson (1922) to perform his calculations of a weather forecast and that ultimately led to numerical weather prediction (e.g., Charney et al. 1950).

In addition to the usual data that served as the foundation of Monthly Weather Review and his own articles, Abbe actively solicited content from contributors both within the Weather Bureau and outside of it. These articles and other contributions often intersected meteorology with other fields, such as physics, biology, optics, geology, astronomy, planetary science, history, pedagogy, linguistics, and even poetry. An early example is an article titled, “Thomas Jefferson as Meteorologist” (Randolph and Francis 1895), which was illustrated with a photograph of Jefferson’s home, Monticello, and included a table of temperature observations the Founding Father took in Philadelphia during the early days of July 1776, as the Continental Congress debated and planned the guiding principles of a new nation. Another interesting article, which appeared in the August 1898 issue, explored “The Effect of Approaching Storms Upon Song Birds” (Linney 1898).

While the two examples above constitute complete articles attributed to a single author, many of the more interesting items Abbe included were short summaries of research, news, or other information he solicited or otherwise obtained from a vast network of colleagues and others with whom he corresponded. These items were published under the section heading Notes by the Editor and, later, Notes and Extracts, and
they included such titles as “The Noise Made by a Meteor” (February 1895), “Ancient Tornado Tracks” (August 1899), “A Rain of Small Fish” (June 1901), “Science in Poetry” (May 1902), and “Meteorology of the Planet Mars” (October 1905).

The popular media of the time sometimes took note of these Notes by the Editor. One example is an item published under that department in the April 1900 issue titled, “The effects of diminished pressure on cooking,” which discussed a report by Robert M. Hardinge, the Weather Bureau’s New
The physical basis of long-range weather forecasts.

By Prof. Cleveland Abbe.

The expression "long range" must not be misunderstood. It refers only to the length of time involving between the date of making a weather prediction and the date when we expect it to be fulfilled. At the present time, by the help of the daily weather map, the official weather forecasters of this country, and indeed of every civilized nation on the globe, publish forecasts, in detail, of approaching weather changes, and especially storms, for one and two, or possibly occasionally three days in advance. These predictions all relate to comparatively minute details for regions that have been charted and studied daily for many years. They merely represent the direct teachings of experience; they are generalizations based upon observations but into which physical theories have as yet entered in only a superficial manner if at all. They are, therefore, quite elementary in character, as compared with the predictions published by astronomers, based on the laws of gravitation and inertia, or the predictions sometimes offered by chemists, based on the laws that are being worked out by these investigators. Even the electrician, familiar with mathematical physics and its predictions based on far more complex theories than we are wittingly competent of constructing, must be noted. But he is slowly building a grand structure, mathematical, graphical, and numeric, in which deductive reasoning will take the place of empirical rules. The whole will eventually form a complex intellectual machinery, by means of which the general, and possibly the detailed phenomena of the atmosphere, will be followed up day by day. Then we shall be justified in calling our work rational science, as distinguished from empirical science, and use the word science in its fundamental meaning, as referring to that of which we have accurate knowledge, and not that which is merely speculative.

While I thus indulge hopes in the prospective future high perfection of the science of the weather, I recognize the fact that we must not expect to realize these hopes in this generation. The progress of all science is necessarily slow. Proofs Comparable to Kepler, from Kepler to Newton, from Newton to Laplace, and from Laplace to the living giants in the theoretical astronomy of to-day, we proceed for a century each. In chemistry, from Berzelius to the present day, we have scarcely one such step. In electrical science, we are less than a century distant from Ohm and Green. In meteorology, considered as an application of physics, we began with Gay's work of 1850, but considered as a branch of mathematical science we begin with Faraday's work of 1856. The development of a correct "Theory meteorologica" has made good progress during the past twenty years, but we are still at work on the introductory chapter. Some would no longer sustain the unnatural stimulus in response to the fourfold anxiety of the people and the daily newspapers, but we must be content to await the sure results of a slow but natural growth. Personally, I hope I may live to see the day when some of our universities will offer attractive courses in dynamic, experimental, and observational meteorology to advanced students of mathematics and physics, when those who are prepared to profit by such lectures may in their turn contribute to the advancement of our knowledge. It will not do for us to be so absorbed in so-called practical work as to neglect the research work that is still more practical. The practical work of today is but the application of the results of the past research. The research of to-day will be the basis of the practical work of to-morrow, and so on, step by step. At the present time this important branch of physical and mathematical science is recognized in German and French universities, but has not yet taken its proper place in American or English institutions. It demands not merely a few lectures or an occasional mention, but the complete devotion of at least one professor and one post graduate student annually.

At the present time it is of course impossible to make long-range forecasts of the details that make up the daily weather, but there is a large class of the phenomena that would be greatly benefited and perhaps perfectly satisfied if we could forecast the general features of a season, such as a week, or a month, a spring or summer, an autumn or winter. This class of work we call seasonal or climatological forecasts. It is desired to know whether on the average there will be many fogs or severe freezing weather, whether the range of temperature will be large or small, whether it will be especially cloudy or sunny, whether it will be abnormally large or small, or whether falling in abundance it will evaporate too rapidly to be utilized for irrigation. Such seasonal forecasts have been conceived as a possibility, even though accurate long-range weather predictions may not be so. The anxiety of farmers with regard to their future crops has led them from time immemorial to look about for natural signs, and they find them everywhere. If the moon is in a certain position, they say that it indicates a wet month; if this rule is reversed, they watch on their journey northward, it indicates a dry summer; if the woodchuck goes back into his burrow, it means a long cold spring; if the cattle milk in the Northwest direction when the farmer happens to look at it, it means a prevalence of cold, northwest winds; if the trees leave out early, it means an early spring; if the fur of the wild animals is unusually thick, or if a squirrel is laying up a large store of food, it means a long, hard winter; and so on. We might go on indefinitely, as though the animals and even the trees know more about the laws of nature than man himself. When man stoops to learn from those about matters that he ought to study out for himself, he is on the downward road, wandering away from the higher intellectual light that illumines his path. The little that the animals have learned and inherited after ages of experience and the little that man learned from the laws of nature during his unenlightened ages of cruelty and barbarism are as nothing compared...
Mexico section director, in which he excerpted The Autograph Cook Book, written by Mrs. C. L. Herrick and issued by the Ladies’ Guild of St. John’s Episcopal Church in Albuquerque. “It is a matter of common observation among housekeepers in New Mexico that recipes and practices found reliable elsewhere, fail to achieve the expected results on the plateau,” Herrick wrote, citing differences in altitude as the cause of culinary catastrophes. “One of the difficulties has been with our cake mixing and baking. It took me a long time to discover that the use of the same number of eggs I had been accustomed to in lower altitudes caused my cakes to be a failure.” This led Abbe, as Monthly Weather Review editor at the time, to comment, “We believe that the Weather Bureau observers on Pikes Peak were never able to boil their dried beans so as to make them palatable” (MWR 1900d). Meanwhile, several newspapers across the country, including in the town of Virginia, Minnesota, on the Mesabi Iron Range, published a short piece based on the Monthly Weather Review note. “As attempts are being made to found a domestic science and to introduce exactitude into the operations of the kitchen a note in the Monthly Weather Review recording the actual experience of a housekeeper at Albuquerque, N. M., is of interest,” it read. In what could be considered a journalistic oversimplification, the headline of this brief article—at least as it appeared in The Virginia Enterprise—read ingenuously: “Cook Books Are Useless” (The Virginia Enterprise 1901).

Another contribution among more scientific articles in Monthly Weather Review included a note published in the December 1903 issue titled, “Meteorology and the Art of Flying” (MWR 1903), one of the earliest accounts of the work of the Wright brothers, who that month achieved the first controlled, powered, heavier-than-air flight in human history. An editorial comment on the facts conveyed directly by the Wrights through correspondence added, “Their success is undoubtedly due in great part to the preliminary careful study of the winds, and for this reason, although machinery is essential, yet we consider that meteorology also has played an important part in their work.” Previously, Abbe wrote to the Wright brothers inviting them to write up their observations for an article in Monthly Weather Review (Fig. 4).

Other notable contemporaries with whom Abbe corresponded and from whom he solicited contributions to Monthly Weather Review included Theodore Roosevelt (who at time served as U.S. civil service commissioner) and John Muir, though there is no record of either contributing anything (Potter 2020, pp. 231, 260). Abbe did include material provided by Alexander Graham Bell, with whom he was well acquainted, as part of a note titled, “Spool Kites and Kites with Radial Wings,” which appeared in the April 1899 issue and included several diagrams of kites designed by Bell (MWR 1899c). Bell later acknowledged the inclusion of his illustrations in Monthly Weather Review in an article he published in the June 1903 issue of The National Geographic Magazine (Bell 1903).

2) EDITORIAL OPERATIONS

Each issue of Monthly Weather Review included data from its eponymous month. The question naturally arises as to how long that process took to assemble the issue and get it to subscribers and observers. That question was answered by a note published in the February 1899 issue (MWR 1899a), which described the process by which an issue was assembled:

The Editor occasionally receives a complaint to the effect that the MONTHLY WEATHER REVIEW for any given month is published too late or contains ancient data, or is in some other respects not quite up to the standard of the critic… In order to gather together this data as promptly as possible all the forms for a given month, both for regular and voluntary stations, are expected to be filled out, summarized, checked, and received at the Central Office in Washington by the 25th of the following month; [sic.] of the more distant stations, only those in Alaska are excepted… The work of the draughtsman, the compositor, and the proofreader begins at once and occupies at least two weeks, from the 25th until the 10th of the following month. The first copies of the complete MONTHLY WEATHER REVIEW are due on the 15th, or six weeks after the close of the month. The other portions of the review relative to forecasts, rivers, crops, and the short articles contributed to the text are usually prepared before the work on the climatological tables begins… Delays must sometimes occur, owing to sickness, or the press of other work, or to the addition of a few extra pages and charts. It, therefore, frequently happens that instead of receiving the MONTHLY WEATHER REVIEW within seven weeks after the close of any month, our correspondents will find it delayed a week or two longer.

Other details concerning the preparation of early issues of Monthly Weather Review are discussed in Myer (1873), including the policy at the time that all proofs of the journal “will be marked in pencil with the name of the sergeant in charge, and sent over promptly to the officer in charge of room for proper disposition; when returned the proof will be checked with the name of the officer responsible for its preparation. All other proof [sic.] will be sent to the same officer, but need not be checked.”

3) EDITORIAL PHILOSOPHY

One aspect that distinguished Monthly Weather Review in the years beginning with Abbe’s editorship was its acceptance of contributions from a wide range of authors. The November 1895 issue included a brief note (MWR 1895) with an extract of a circular letter Weather Bureau Chief Willis Moore had issued, encouraging observers and officials of the bureau to submit items for possible publication:

By direction of the Chief of Bureau, I am requested to say that any short article that you may desire to offer for publication in the MONTHLY WEATHER REVIEW will be taken into favorable consideration. Papers that are too technical for publication in the daily newspapers or popular journals, or in the
monthly bulletins of the State Weather Services, or those that relate to matters of general rather than local interest, are appropriate to the MONTHLY WEATHER REVIEW.

If the article should not be accepted for the REVIEW, it will be returned to you, with such suggestions, relative to its publication, as may seem proper to the Chief.

Abbe’s editorial style was described in entries in the March 1904 and April 1906 issues. Abbe (1904) wrote:

The authors whose papers appear in the MONTHLY WEATHER REVIEW will sometimes observe that changes have been made in their phraseology, sentences have been omitted, textual matter converted into tabular matter, explanatory notes added.

FIG. 4. Letter written on 26 Sep 1903 from Cleveland Abbe to Wilbur Wright requesting a submission to *Monthly Weather Review*. Courtesy of the Wilbur Wright and Orville Wright Papers collection of the Manuscript Division of the Library of Congress.
by the Editor, etc. As these changes have been made in good faith and under the conviction that they avoid introducing problematic questions, make the text of the article clearer, and increase its value to the readers of the Review, therefore the Editor hopes they will not be taken amiss, and that his changes will not be considered as a case of officious meddling. No one can have the interests of the Review more thoroughly at heart than the Editor. His duty is to make it a medium of instruction to all.

This philosophy was later reprinted in the December 1925 issue (Henry 1925a). Abbe (1906) wrote:

As the Chief of Bureau has made the Editor largely responsible for the character of the material published in the Review he has endeavored, by allowing the greatest freedom of publication, to encourage everyone interested in meteorology to publish his best ideas and to philosophically accept honest and kind criticism when the latter is animated solely by a desire to advance our knowledge of the subject. Of course criticism has always been something of a personal aspect; it is liable to arouse opposition, replies, and counter replies, and to wound one’s personal pride, but by many years of experience we have learned that there are many who hold the progress of science as something far more important than their own personal triumphs. There are those who can calmly weigh the arguments pro and con, and decide with fairness whether a certain view or theory is in accordance with the facts and in accord with the present state of our knowledge; whether it is an error long since overthrown or whether it is a hypothesis too far in advance of our present knowledge to be demonstrable now and one which must therefore be left to future generations to settle.

The sciences can advance only step by step. No one can tell where or when the next important step will originate. Many humble beginners may suggest good ideas that will be confirmed by more eminent investigators after years of work. We must be careful not to ridicule a new hypothesis, but equally careful not to adopt it as a well established principle for fear lest thereby we may be led astray. There has always been a contest between the dullards and conservatives on one side and the bright theorists on the other. The legitimate use of the imagination is the most important consideration to a man engaged in research, but the illegitimate use of the imagination is very dangerous.

If the Editor of the MONTHLY WEATHER REVIEW occasionally allows the publication of a memoir in which the imagination is more prominent than the facts, it is not that he wishes to assist in the propaganda of some new idea, but because he is confident that the ability of the investigator will eventually enable him to right himself and find his way out of the woods into the clear light of some important truth as yet unknown to us all.

If, on the other hand, the Editor sometimes rejects a communication in which imagination is more prominent than the facts, or in which the facts have been distorted so as to appear to support a preconceived theory, this may be because meteorology is overburdened with ill-founded notions, and students must be discouraged from pursuing really foolish or unimportant lines of work while the important problems of meteorology are almost neglected on account of their difficulty.

The MONTHLY WEATHER REVIEW is therefore a medium for honest, rational discussion of every important problem of meteorology, whether it be approached from the statistical, the experimental, or the mathematical side. It is not carrying on an unreasonable propaganda.

This editorial policy appears to have existed, at least to some extent, prior to Abbe’s formal tenure as editor. Isaac Cline, who would later become famous for his role during the 1900 Galveston Hurricane (e.g., Larson 1999), wrote in his memoir of an unusual event he experienced in August 1885 while stationed as a private in the Signal Service at Fort Concho, Texas. Cline described how frigid meltwater from a severe hailstorm flowed into the Concho River, temporarily paralyzing fish due to the sudden decrease in temperature. In an effort to officially record the strange phenomenon, Cline wrote a detailed paper and submitted it for publication in Monthly Weather Review, only to have it rejected, apparently due, in part, to Cline’s having consulted with certain law students during his college years. “The editor of the Review, to my surprise and chagrin, wrote me that the story could not be published, and remarked that it is evident that my association with the disciples of [eighteenth-century English jurist Sir William] Blackstone had developed an unusual capacity for exaggeration,” Cline (1945, p. 52) recalled.

While the nation’s weather service consisted almost exclusively of white men well into the twentieth century, glimmers of the inclusiveness that is more characteristic of the modern-day MONTHLY WEATHER REVIEW can be seen in early works published in the journal by Anne Louise Beck (Beck 1922), Alicia DeRiemer (De Riemer and Abbe 1898), and Oscar Hammonds (Hammonds 1909; Alps and Hammonds 1920). Beck, who received a master’s degree in 1922 from the University of California, Berkeley, after spending a year studying meteorology with members of the Bergen School in Norway, based her Monthly Weather Review submission on her master’s thesis, though the accompanying map (only one of several submitted was published) “was heavily manipulated and distorted by a prejudicial editor, A. J. Henry” (Fleming 2016a, p. 59). DeRiemer was a faculty member at Stevens Point Normal School (now the University of Wisconsin–Stevens Point) in Wisconsin, who, during the summer of 1898, “devoted herself to work at the Weather Bureau in special lines of investigation, and, among other things, compiled the article on ‘The average frequency of days of hail during the years 1893–97’ published in Mounthly Weather Review for December, 1898.” (Abbe 1903). Hammonds, who served in the Weather Bureau from 1907 to 1942 (most of that time as an observer in Reno, Nevada), was one of the first African Americans to realize the dream of a professional career in the nation’s weather service.

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2 This actual title of this article was “The average frequency of days of hail during 1893–1897” (De Riemer and Abbe 1898), and her name was misspelled with the extra space.
4) HIGH DEMAND FOR BACK ISSUES

By most accounts, *Monthly Weather Review* was a success as part of a larger collection of publications of the Weather Bureau that included the *Daily Weather maps, Climate and Crop Bulletin, Snow and Ice Bulletin*, station maps, and other books, pamphlets, meteorological charts, and forms (MWR 1904b). In one year, 57,600 copies of *Monthly Weather Review* were printed (divided by the 13 issues that year, that would imply a printing of 4,400 copies each month). And, by the Weather Bureau’s own reckoning, the demand seemed nearly insatiable (“back numbers, and especially complete sets of back numbers, of these monthly section reports are rare and much to be desired;” MWR 1904a), in part because of government efforts to limit the costs of producing, printing, and mailing publications (MWR 1906a). Early issues sometimes included requests by others for copies of back issues (e.g., for the Canadian Institute in Toronto; MWR 1898b), as well as a request by the editor urging voluntary observers who received complimentary copies “to carefully preserve them, and see that eventually they are deposited where they will be permanently cared for and frequently used” (MWR 1904a). Writing in MWR (1898b), the editor said:

In general, the recipients of the *MONTHLY WEATHER REVIEW* will do well to preserve their sets in good order and offer them to libraries or second-hand book dealers if they do not wish to retain them for their own use. It is already quite impossible for the Weather Bureau, or the Superintendent of Public Documents, to supply the demand for past volumes, as no great stock is kept on hand.

In a similar vein, the October 1899 issue included a note titled, “Save Your Sets of Monthly Weather Reviews” (MWR 1899b), which described how, upon deaths or other changes among voluntary observers, “the thermometers and the rain gages are sometimes forwarded to the section center, for use by other observers,” but questioned, “what becomes of the files of *MONTHLY WEATHER REVIEW*?” Noting that copies of the journal “are greatly in demand by schools and colleges” but admitting that the Weather Bureau lacked the resources to collect old issues and bind them in volumes for use in schools, the note suggested that “any observer who has a mind to keep the REVIEWS in good condition can do so by tying them up between two squares of thick pasteboard.”

The Weather Bureau’s desire to get copies of *Monthly Weather Review* into the hands of students reflected the view of *Monthly Weather Review* being an effective outreach tool. For example, in a note titled, “The Weather Review and the High Schools” (MWR 1899d), Abbe wrote:

During the past year the Chief of the Weather Bureau has received an unusually large number of requests for copies of the *MONTHLY WEATHER REVIEW* and other publications of the Bureau; so many, in fact, that it has become difficult, if not impossible, to accede to them all. One can but suspect that the great stimulus given to the study of meteorology by the widespread introduction into progressive high schools of the beautiful works on physical geography by Davis, Tarr, and others has led to this increased demand upon the resources of the Weather Bureau.

Professor Willis Moore is very desirous of encouraging the study of our science, and is quite willing to respond to requests for publications whenever practicable; but, as the editions are soon exhausted, he takes the liberty of suggesting that voluntary observers and, indeed, all who have received copies of the *MONTHLY WEATHER REVIEW* or any other publication of the Bureau, will do him a favor if, after using such public documents, they will kindly deposit them in the library of some college or high school, or in some public library, where they may be accessible to others. Those who prefer may, of course, return them to the Weather Bureau by mail, for which purpose penalty envelopes will be provided.

As part of that outreach effort, Abbe wrote to Booker T. Washington in 1900 (Fig. 5), offering to send copies of *Monthly Weather Review* and other Weather Bureau publications to aid in the instruction at Tuskegee Normal and Industrial Institute (Potter 2020, 257–258).

c. Abbe’s removal as editor, back to being a climatological publication, followed by two brief Abbe editorships (1909–18)

The changes Abbe incorporated and fostered as editor of *Monthly Weather Review* came to an abrupt end in 1909, when Weather Bureau Chief Willis Moore announced sweeping changes to the journal’s makeup and focus that resulted in what Corzine (1972) referred to as “the second era of data publication” (Fig. 2). Moore’s order was reprinted in the February 1909 issue (Moore 1909a). “The Review will hereafter be a monthly report of the weather and climatology of the country, and there will be excluded from its pages everything technical that is not of a purely climatological nature or a current report of weather conditions,” he said, adding that the revamped journal would contain “no mathematical discussion or formulas.” Even more mechanical and logistical matters were addressed, including the formatting of the title page and the color of the cover (both of which remained unchanged), as well the weight of the paper and the number of each issue to be printed, which was limited to 5000 copies.

The Weather Bureau did more than simply revert *Monthly Weather Review* to being a mostly climatological publication. It adopted fundamental changes to how climatological data were collected and reported in the United States. Chief among these changes was the division of the country into 12 large climate districts “generally having the same boundaries as the great drainage basins of the country, these boundaries being marked off by the natural topographical divides” (Moore 1909b). The changes to *Monthly Weather Review* were, in part, an effort to conform to the changes surrounding the new climate districts (Fig. 6). “The Weather Bureau has thought it convenient to bring together under one publication, namely, the *MONTHLY WEATHER REVIEW*, representative climatological data covering the general climatology, the daily precipitation, and daily maximum and minimum temperatures of the respective districts” (Moore 1909b). Looking back now, breaking up the weather across the United States may have conformed with the 12 districts, but produced duplications across the written district reports and only a brief nationwide
synthesis in a department called “Weather, Forecasts, and Warnings for the Month.”

During 1908–13, research articles of a more technical nature were published in a new Weather Bureau journal, the *Bulletin of the Mount Weather Observatory*, with Abbe serving as its editor beginning in 1909. Despite notifications published in *Ward (1908)*, as well as the February and March 1909 issues of *Monthly Weather Review (MWR 1909a,b)*, many readers were unaware of the change, as *Abbe (1909)* indicated in a third notice, which appeared in the May 1909 issue:

> It appears that there are many who have not read these notices and outlines of prospective changes, and the Weather Bureau is still frequently requested to renew or add to its subscription list recipients who apparently do not realize the character of the new publications.

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Our readers are therefore informed that beginning with the issue for July 1909, the MONTHLY WEATHER REVIEW will be restricted to statistical tables of general climatological data for the whole of the United States. The relatively small amount of accompanying text will summarize the weather conditions of the month in the different districts. It is thus evident that hereafter the REVIEW will be of value only to those advanced students of climates, engineers, etc., who need detailed data for their own discussion.

The reduction of the editorial content in Monthly Weather Review also limited its usefulness as an outreach tool. "Few papers of general interest to teachers, except as related to climatology, will be published in the MONTHLY WEATHER REVIEW, and it is not probable that the publication will be of value to those public schools and high schools that have been receiving it heretofore," Abbe (1909) wrote. "These circles of readers must now turn to the editors of already existing journals to supply their needs along those lines formerly met, perhaps, by articles in the MONTHLY WEATHER REVIEW."

Further insight into the shake-up was reported by the editor at this time, Frank H. Bigelow (1909), who noted: "This departure from the practice of providing weather summaries or other editorial comments in the Monthly Weather Review was the result of a decision made by the Editorial Board, and was prompted by the desire to avoid the repetition of material already available in the various state and regional publications. The reduction in editorial content was intended to enable the Review to focus more on the dissemination of detailed climatological data, which would be of greater value to advanced students of climates and to professionals in related fields."


Fig. 6. Excerpts of data tables from various cooperative observers in District 8 Texas and the Rio Grande Valley in January 1911 (excerpts from Tables 1 and 2 in Bunnemeyer 1911). Scans courtesy of Deirdre Clarkin, NOAA Central and Regional Libraries.
new questions” were being placed upon climatology “that
demand scientific attention,” adding:

In order to meet this demand more fully, the Chief of the
Weather Bureau has separated its current publications into
two general parts, placing climatology and its problems in the
new Monthly Weather Review, and meteorology and its prob-
lem in the Mount Weather Quarterly Bulletin.

There is no question, however, that Moore was unhappy with
Abbe around this time (Potter 2020, p. 247). It is the reason
Abbe was temporarily transferred to Baltimore for several
months and then to Mount Weather for about a year—as pun-
ishment, it seems, for having criticized the establishment of
the Mount Weather Observatory. Abbe’s son Truman (Abbe
1955) described it later:

His interval of absence [as editor of Monthly Weather Review]
followed an unfavorable report he made on a pet scheme of
the chief of the Weather Bureau. He was relieved of his post
as editor and transferred, first, to the small Weather Bureau
station in Baltimore, with a cut in salary from $3,000 to $2,500
(though retaining the title of Professor of Meteorology), and
then to the Mount Weather station at Bluemont, Virginia.
There he was editor of the Mount Weather Bulletin of Special
Research [Bulletin of the Mount Weather Observatory]. It was
against establishment of the station on Mount Weather that
he had reported adversely a year or two earlier.

This second era of data publication ended in 1914 (Corzine
1972). The Bulletin of the Mount Weather Observatory only
lasted for six volumes (Abbe 1914). In January 1914, Abbe
returned to the helm of Monthly Weather Review (Table 1)
and reorganized it yet again. He described the new structure
of Monthly Weather Review, to be comprised of six sections:
Aerology, General Meteorology (“special contributions by
any competent student bearing on any branch of meteorology
and climatology, theoretical or otherwise”), Forecasts and
General Conditions of the Atmosphere, Rivers and Floods,
Bibliography (“recent additions to the Weather Bureau
library; recent papers bearing on meteorology”), and Weather
of the Month (which included the eight monthly charts from
the past). Abbe would remain editor through the June 1915
issue, when he was forced to take a leave of absence from his
work at the Weather Bureau following a stroke (Potter 2020,
p. 263).

Abbe died in October 1916 and was succeeded as editor of
Monthly Weather Review by his son Cleveland Abbe Jr., who
had served as acting editor since his father’s leave of absence
and who became permanent editor beginning with the August
1916 issue (Table 1). His tenure would be short-lived, how-
ever, when, after marrying a woman from Braunschweig,
Germany, he became caught up in the anti-German sentiments
for Germanism and who became permanent editor beginning with the August
1916 issue (Table 1). His tenure would be short-lived, how-

Another major change in the format of Monthly Weather Review
took place in late 1919 when the journal’s size was reduced from an average of 75–80 pages per issue to an aver-
age of 60–65 pages (Fig. 2). “The curtailment, which began
with the November issue, has been rendered necessary
because of a number of factors,” according to an editorial
notice published in the January 1920 issue (MWR 1920c).
These factors included a 20% increase in the cost of publica-
tion; an increase in the amount of aerological data to be
published; the size of the journal in 1919 (which totaled 911
pages); and the additional expense for, among other things,
the increased demand for “separates” (otherwise known as
offprints or reprints) of individual articles. The average space
allotment planned for each issue included 23 pages for con-
tributions; 20 pages for abstracts, reviews, notes, reprints, and
bibliographies; one page for solar data; 14 pages for the
weather of the month; and four pages for seismology data.
“Since the cut falls almost exclusively on the space available
for contributions, yet still leaves a good opportunity for pub-
lishing them, it is hoped that there will be but little loss in the
usefulness of the REVIEW in spite of the reduced number of
pages,” the notice concluded. A similar notice published in
the January 1920 issue of Weather Bureau Topics and Personnel3
noted that limited funds available for publishing that year “may
necessitate the diversion of some papers to other journals, and
some limitation to the extensiveness of others,” but still encour-
aged employees “to submit, as heretofore, papers and notes on
local weather peculiarities or unusual happenings which may be
of general interest, as well as meteorological abstracts or
reviews” (U.S. Weather Bureau 1920).

These changes coincided with a shift in editorial policy in
which the journal’s editors made “a serious attempt to obtain
timely articles, to add discussions to them, and to prepare
notes and abstracts of all important meteorological articles

3Weather Bureau Topics and Personnel (1915–47), later
Weather Bureau Topics (1948–61) and Topics (1962–65), included
personnel notices, newsworthy operations, and other information
to promote teamwork and efficiency. https://library.noaa.gov/
Collections/Digital-Documents/WB-Topics-Personnel.
and publications received at the Central Office,” noting that major topics to be covered in forthcoming issues would include the sun and the weather; aeronautical and military meteorology; clouds and the use of cloud observations in forecasting; agricultural meteorology, general circulation of the atmosphere, cyclones and anticyclones; and recent advances in forecasting (U.S. Weather Bureau 1919).

Additional changes two years later, in 1922, brought modifications to the charts that appeared in each issue of Monthly Weather Review, including the adoption of the terms anticyclones and cyclones instead of highs and lows (MWR 1922a). In addition, a new department, titled Free-Air Conditions, was introduced, authored by Willis R. Gregg (MWR 1922a), who would later go on to serve as chief of the Weather Bureau (1934–38). This section would serve as:

...a brief summary of the free-air conditions during that month, as observed by means of kites, balloons, airplanes, etc. The main purpose will be to discuss these conditions in relation to those at the surface and in relation to normal values at different levels—in effect, to present a review or survey of free-air conditions while they are still of current interest (Gregg 1922).

During this time, as Weather Bureau officials modified the format and content of Monthly Weather Review, they made efforts to encourage employees at all levels to take an active role in reading and using the journal to the fullest extent possible, as the following note, which appeared in the March 1922 issue of the publication Weather Bureau Topics and Personnel (U.S. Weather Bureau 1922), indicated:

Occasionally employees in the lower grades express a desire to subscribe to the Monthly Weather Review. From the viewpoint of the Central Office it should not be necessary for any member of the Weather Bureau to subscribe to the Review, as the numbers are furnished to all Weather Bureau stations as soon as published. The fact that requests of this kind are received would indicate, first, that there is a desire to read the current numbers as they appear and, second, that all employees do not have convenient access to the current numbers. It is desired to encourage the regular reading of the Review, in which reference and discussions concerning current problems in meteorology offer many suggestions for independent study. To this end it is desired to urge on officials in charge of stations that arrangements be made so that all employees will have access to the numbers as they appear.

The Central Office will gladly furnish separates when available or copies of any numbers that contain matters of permanent interest or value to employees.

Although fewer than one-fifth of the copies of Monthly Weather Review printed around this time were circulated among Weather Bureau stations, the journal was “edited primarily for the U.S. Weather Bureau personnel,” and bureau officials expressed a hope that “this magazine will meet all our meteorological needs. If it does not, helpful suggestions will be welcome at any time” (U.S. Weather Bureau 1919). The perception that Monthly Weather Review was a publication primarily for Weather Bureau employees was less evident by 1926, when officials at the Weather Bureau Central Office issued a notice discouraging the publication of “special commendations, from sources outside the bureau” in the journal. “Our desire is to raise the ethical standard of the Monthly Weather Review as a scientific journal,” the notice stated. “One way to do this is to refrain from printing anything that might be interpreted as ‘blowing our own horn’, even though the power for the horn be supplied by appreciative persons outside the bureau” (U.S. Weather Bureau 1926).

The year 1922 also marked the end of the first 50 years of Monthly Weather Review’s existence. Noting this fact, the Weather Bureau’s annual report (Marvin 1922, p. 27) included a brief summary of how the journal was regarded at the time:

The Monthly Weather Review presents under a single cover fairly complete statistics and a discussion of the weather in all parts of the United States and to a lesser extent the adjacent oceans. This purely statistical record alone is highly prized and extensively used by various marine, commercial, and agricultural interests. The Review also serves as an important aid in the teaching of meteorology in primary and secondary schools; also as a medium of exchange for workers in the field of theoretical as well as applied meteorology.

During the 1920s, the development of polar-front theory through the application of airmass and synoptic analysis from a small geophysical institute in Bergen, Norway, would revolutionize synoptic meteorology (e.g., Friedman 1989; Davies 1997; Newton and Rodebush Newton 1999; Schultz et al. 2020c). Monthly Weather Review, with Editor Alfred J. Henry at the helm (Table 1), followed these developments, at times enthusiastically, at times cautiously, and at times critically. The journal published a number of articles by Vilhelm Bjerknes on topics such as weather forecasting and observations from Greenland (V. Bjerknes 1919a,b, 1922), followed by discussion from Henry (1922a). As described in Schultz et al. (2019, p. 16.2), Monthly Weather Review was one of two journals that published J. Bjerknes (1919), which laid out the structure of an idealized extratropical cyclone, introducing the steering line and the squall line (what would later be called the warm front and cold front, respectively; Fig. 7). Monthly Weather Review also published reviews of Bjerknes and Solberg’s (1921) “Meteorological Conditions for the Formation of Rain” (Henry 1922c) and Bergeron’s (1928) “Über die dreidimensional verküpfende Wetteranalyse. Erster Teil: Prinzipielle Einführung in das Problem der Luftmassen und Frontenbildung”4 (Björkdal 1931). Monthly Weather Review reported on the “New Norwegian Weather Maps” using the Bergen methods (Henry 1922d) and the “Climatological Atlas of Norway” (MWR 1922b, p. 489).

As a venue for open discussion of ideas, Monthly Weather Review published case studies and maps analyzed using the Bergen methods. For example, Andrus (1921) published an

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analysis of so-called Bjerknes convergence lines leading to the development of secondary lows, Bjerknes and Giblett (1924) analyzed a westward moving cyclone in the northeast United States, and Rosby and Weightman (1926) presented a case of a central U.S. cyclone with multiple air masses and fronts. Monthly Weather Review also published Beck’s (1922) summary of her visit to Bergen on a fellowship, her analysis of a U.S. extratropical cyclone in the Norwegian methods, and Henry’s (1922b) “discussion” criticizing her analysis, described more fully in Fleming (2016a, 52–59, excerpted as 2016b) and discussed in section 3b(3). Even discussion about the Norwegian methods from the Royal Meteorological Society was reported, as excerpted from The Meteorological Magazine (MWR 1923): “the observational evidence fails to support the hypothesis that the superposition of equatorial over polar air is a characteristic feature of the structure of a cyclone.” Although not known as a scientific powerhouse at the time, Norway certainly appears to have touched a nerve, yielding an outsized influence during the 1920s on Monthly Weather Review.

Efforts to encourage author participation in Monthly Weather Review would lead to its peak number of items published in the early 1920s (Fig. 2). However, that trend soon reversed. In 1924, the inclusion of seismological data, which

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Fig. 7. Figure 5 of Bjerknes (1919) showing the clouds and precipitation associated with an extratropical cyclone, as well as vertical west–east cross sections north and south of the low center.
had been present within the pages of *Monthly Weather Review* to varying degrees since the second volume, was discontinued “[i]n view of the necessity of effecting economies in the conduct of the work of the Weather Bureau” (MWR 1924).

By the beginning of the following decade, editorial content submitted to *Monthly Weather Review* had declined, as reflected in a notice that appeared in the January 1931 issue of *Weather Bureau Topics and Personnel* (U.S. Weather Bureau 1931). “The supply for manuscripts for the Monthly Weather Review is at a rather low ebb; the editor would, therefore, suggest that if any employee has a manuscript suitable for publication that he submit it at an early date; others who may have appropriate articles in course of preparation are asked to bring them to completion for submission within the next two or three months, if practicable,” the notice read.

Even if sufficient manuscripts existed, it is likely they would not have been published anyway. By 1932, the financial constraints brought on by the Great Depression took their toll on the Weather Bureau. “Drastic economies, retrenchments, and suspensions of public service have characterized the program of Weather Bureau work from the beginning of the fiscal year 1932 to the present time,” began the Report of the Chief of the Weather Bureau for 1932–33 (Marvin 1933). In addition to the closure of more than 20 first-order stations and the dismissal of some 300 employees, the budget shortfall resulted in a major reduction to the size of *Monthly Weather Review*. An editorial note published in the March through June 1932 issues described the situation with respect to *Monthly Weather Review* (e.g., MWR 1932). “Owing to the necessities of drastically reducing the printing cost of the REVIEW to keep within the funds for the fiscal year all ‘contributions’ are omitted in this issue. However, it is hoped that ‘contributions’ may be resumed later,” read the notice.

Writing in the August–September 1932 issue of the *Bulletin of the American Meteorological Society*, AMS founder Charles F. Brooks blasted the budget constraints that led to the reduction, saying that government economy seemed “to be falling unevenly and unwisely” if a note such as the one published in *Monthly Weather Review* were necessary. “This amounts to temporary suspension of America’s publication of the longer meteorological papers from various sources,” Brooks (1932) wrote. “The United States Weather Bureau, with appropriations even now of about $4,000,000 a year does not have a cent for the publication of the results of the researches of meteorologists in this country! How is American meteorology to maintain its advance when this great bureau is provided no outlet?”

The situation appeared to be improving by January 1933, when that month’s issue of *Bulletin of the American Meteorological Society* included a brief note from Weather Bureau Chief Charles Marvin, in which he said the AMS and others “may be assured resumption of our former publications is quite certain to come about as the fiscal affairs of the Government take on better prospects” (BAMS 1933). As was the case with the financial situation, this “editorial depression” also began to turn around by 1933, when it was “announced, with pleasure, that sufficient funds have been provided for the continuation of the publication of scientific articles in the *Monthly Weather Review* during the fiscal year” (U.S. Weather Bureau 1933). As shown in Fig. 2, the number of pages published annually dropped almost in half, from 500 in 1931 to 270 in 1933, with a similar (though slightly less drastic) decrease in the number of articles published during the same period, from 423 to 294. Both the number of pages and the number of articles published rose again in 1933, though it would be nearly three decades before the journal again published 500 pages or more per year, and it has not since published the number of articles annually that it did in the 1920s through 1931. (The recent maximum, in terms of both pages and articles published annually, was in 2008, which saw 5255 pages and 302 articles published.)

The U.S. involvement in World War II further resulted in a drastic curtailment of many Weather Bureau activities, with a redistribution of resources dedicated to the war effort. *Monthly Weather Review* was not spared from these changes and the restrictions placed upon it forced the journal into the third, and final, data period (1942–48) described by Corzine (1972) (Fig. 2). During this period, *Monthly Weather Review* consisted primarily of climatological summaries, tables, and charts, with relatively few articles published, resulting in the fewest number of pages published since its earliest years (Fig. 2).

The data published in the January 1943 issue—and the amount of time it took for the issue to be in final form (which did not differ greatly from issues published before or after the war)—were the subject of a tongue-in-cheek newspaper article by United Press staff correspondent Joseph L. Myler (1942). The article, which appeared in newspapers across the country on 23 April, with headlines such as “Isn’t It Cold Last January?” and “State Military Secrets Reveal a Cold January,” poked fun at the delay in publishing the issue and attributed it more to wartime censorship policies than to the general practices of the Weather Bureau at the time. “In a now-it-can-be-told sort of publication called ‘Monthly Weather Review,’ the Commerce Department published for all the world to see—although three months late—long columns of facts about January’s weather which couldn’t be printed when they were news because of wartime censorship,” the article said. “The rumor-mongers, it must be admitted at the outset, were right last January when they went around mumbling, ‘Cold, ain’t it?’ You may have wondered what the weather man has been doing with his time since spot meteorological data became a military secret. Well, he hasn’t just been sitting on his hands. During January, for example, he was compiling rafts of statistics about everything from mean precipitation to sunspots.” Myler went on to discuss the issue’s sole article, “On a hypothesis concerning the normal development and disintegration of tropical hurricanes,” by Willard F. McDonald (McDonald 1942), who served as special assistant to Weather Bureau Chief Francis W. Reichelderfer. “It is pretty tough reading but Mr. McDonald’s theory appears to be that tropical hurricanes operate according to ‘a cycle of development, growth, and degeneration.’” Myler noted.

Shortly after the end of World War II, as so often happened with *Monthly Weather Review*, another reorganization occurred, and the last major one. In December 1947, sunspot data were discontinued, thenceforth being published by the U.S Naval
Observatory (MWR 1947). Apparently, not everyone got the word, as the Weather Bureau continued to receive “frequent inquiries about sunspot data” and found it necessary to reprint the note at the end of the December 1948 issue, “for the information of readers who may have overlooked the original notice.” Starting in the January 1950 issue, monthly climatological data would be published in the publication Climatological Data, National Summary (MWR 1949), and Monthly Weather Review would publish a monthly summary called “The Weather and Circulation of [Month],” a popular article written by a staff member in the bureau’s Extended Forecast Section (eventually the Climate Analysis Center). Harry Wexler, who served as chief of the Weather Bureau’s Scientific Services Division, and, later, as director of meteorological research, was instrumental in initiating this feature (O’Connor 1963), and it would last until February 1982 (Pielke 1982). The 17 charts that were published in Monthly Weather Review (MWR 1957) were transferred to Climatological Data, National Summary in January 1959 (MWR 1959). These moves were the last time that the struggle between Monthly Weather Review being a collection of data and maps and a scientific journal would be manifest.

In May 1947, it was announced that “plans have been made to resume the publication of a limited number of special articles,” with the understanding that such articles would consist of brief contributions mainly to the fields of synoptic meteorology and applied climatology (U.S. Weather Bureau 1947). The following year, a notice published in Weather Bureau Topics declared that developments during the preceding year allowed for “a limited expansion in the program of publishing papers in the Monthly Weather Review,” adding, “It is hoped that a special article may be published in almost every issue.” The notice further explained that an increase in papers published would depend “primarily on the efforts of research-minded Weather Bureau meteorologists,” acknowledging “that pressure of regular work slows progress of research undertaken by many meteorologists and delays the preparation of manuscripts for publication” (U.S. Weather Bureau 1948).

Shortly after these announcements regarding a resumption of scientific articles, the National Science Foundation issued a report based on a survey of scientific journals that examined such factors as the number of articles published, the backlog of accepted articles awaiting publication, financial problems, and circulation. As reported in the April 1953 issue of Weather Bureau Topics (U.S. Weather Bureau 1953), the average backlog for journals publishing 500 pages or fewer annually was 5.3 months. “Comparison between the situation of the Weather Bureau’s scientific periodical, the Monthly Weather Review, and that described as average by the report brings out one important difference,” the article noted. “The Review usually has a backlog of accepted papers of only one or two months. Also most issues in the recent past could have carried more articles had acceptable manuscripts been available, for the Review seldom reaches its page quota.”

By the early 1950s, 30 years of economic depression, a world war, shrinking budgets, datasets and maps being spun-off into other government publications, and overall bureaucratic neglect had taken their collective toll on Monthly Weather Review, drastically reducing the diversity of published items from its peak in the early 1920s (Fig. 2). It was during this time that a 1953 report of the Department of Commerce Advisory Committee on Weather Services (Department of Commerce 1953) noted that, prior to the war, “the Weather Bureau was a leader in the field of meteorological publications,” but that its dominance had waned in the years following, due to additional factors that included competing journals published by scientific organizations and undue influence and control by the government as a publisher. According to the report:

Although the Monthly Weather Review has never regained the stature it enjoyed before 1940, it is a well-edited, high quality type of publication on the subject for which it is named. With the increase in the number of periodicals and journals outside the Weather Bureau, it is apparent that articles of a scientific and technical nature by Weather Bureau personnel should be submitted to existing journals of scientific societies and organizations.

Many excellent research and technical papers have been published in the last decade. However, there is little evidence of encouragement of the field personnel to submit such papers. In fact, the Committee feels that considerable unnecessary censorship is exercised in the Central Office in the reviewing and editing of their research efforts.

Regaining the prestige of the journal would follow from these recommendations. First came the support of the scientists who published in Monthly Weather Review, including Wexler, who supported and encouraged the scientific development of the journal and its staff (Reichelderfer 1963). Second came the leadership of the longest serving editor of Monthly Weather Review, James E. Caskey Jr. (1948–68; Table 1), who would oversee changes that would lead the journal to “its current status as a primary scientific journal in the field of meteorology” (Corzine 1972).

e. Evolution to a scientific journal: No looking back (1959–73)

By 1959, Monthly Weather Review had become a journal devoted only to publishing scientific articles (Fig. 2). The only vestiges of being “the monthly weather review” were monthly features entitled, Weather Note, The Weather and Circulation of [Month], or both. Both the annual numbers of pages and articles nearly doubled during the 1960s (Fig. 2). Manuscript receipt and revision dates on published articles at this time suggest that a form of peer review was likely in place (Golden and Schultz 2012). Starting in January 1961, the publication schedule was changed from the month for which the issue was assembled to the month in which the article would be published (MWR 1960). To adjust to this new schedule, the ninth and final issue of 1960 was designated as September–December 1960.

In 1965, the Weather Bureau was subsumed into a new organization within the government, the short-lived Environmental Science Services Administration (ESSA), before being reorganized once again into the newly created National
Oceanic and Atmospheric Administration (NOAA) in 1970 (though it remained part of the U.S. Department of Commerce). *Monthly Weather Review* was published by ESSA and NOAA during this period.

*Monthly Weather Review*’s burgeoning success in the 1960s came with a price, however. For many years, there were no page charges imposed upon authors. By 1972, *Monthly Weather Review* had “begun requesting the author’s organization to share the editorial production costs of his article by paying a charge of $40.00 per page. Rising costs have made this new policy necessary” ([MWR 1972](#)). This change, although clearly unpopular, made possible the eventual growth of *Monthly Weather Review* into a formal scientific journal that accepted all submissions passing peer review. As all articles would now pay their own way, *Monthly Weather Review* could expand to as large as it could be. In fact, these 1972 page charges would be more than $250 today, when the current page charge cost is only $120. But, page charges would not be the only change—a bigger change was in the offing.

On page 890 of the December 1973 issue, NOAA provided its final notice to authors and subscribers, indicating that after 101 volumes “NOAA has concluded that the public interest would be better served by a *Monthly Weather Review* under non-government sponsorship” and announced the new publisher and editor ([MWR 1973; Fig. 8](#)). The result is that some library and personal collections of *Monthly Weather Review* are missing the December 1973 issue, a stolen souvenir of the last of its era.

4. History: American Meteorological Society
(1973–present)

As early as 1898, *Monthly Weather Review* (likely through the persona of Cleveland Abbe as editor) began advocating for the formation of “an American meteorological society” ([MWR 1898a](#)). When the AMS formed in 1919, *Monthly Weather Review* was a supportive venue, publishing articles and news stories about the founding of the AMS ([Brooks 1919](#)), announcing its meetings (e.g., [MWR 1919, 1920a; Brooks 1921; Beals 1923](#)), and publishing papers and abstracts from the meetings (see the lists in [MWR 1920b, 1925](#)). In return, from the first issue until many years after, the *Bulletin of the American Meteorological Society* published a column called, “Contents of the Monthly Weather Review,” which abstracted and summarized its most recent issue (e.g., [BAMS 1920](#)).

a. The transition to the AMS (1973)

On 30 April 1973, Robert White, who served as the first administrator of NOAA, approached the AMS about taking over responsibility for owning and publishing *Monthly Weather Review* beginning in 1974 ([AMS-UCAR 1990](#)). NOAA was trying to absolve itself of costly responsibilities unrelated to its public charter. For example, of the 3878 monthly copies of *Monthly Weather Review* that were published as of 31 May 1973, only 1751 were paid subscriptions or sales. The rest were free copies distributed by NOAA or the superintendent of documents, archival copies for legal requirements, or exchanged for foreign publications. In addition, NOAA felt that publishing a scientific journal would be better served by a scientific society. A proposal was made to the AMS, and the AMS Council approved it. NOAA would subsidize the AMS $170,000 for the first three years to help the journal reach self-sufficiency by 1977.

AMS President William Kellogg wrote about his concerns for this new journal in the AMS stable. “In arriving at this decision to publish the *Monthly Weather Review* we had to consider two important matters: Whether it would needlessly duplicate the other journals that we already have, and whether we could succeed in making it pay for itself in three years” ([Kellogg 1973](#)).

The first issue was resolved through the Publications Commission (led by Publications Commissioner Glenn Hils) producing a report, “Policy Guide for Publications of the American Meteorological Society, 1974–80” ([AMS 1973](#)). This guide laid out the plan for the three society journals—*Journal of the Atmospheric Sciences* (JAS), *Journal of Physical Oceanography* (JPO), and *Journal of Applied Meteorology* (JAM, now *Journal of Applied Meteorology and Climatology*)—to slightly adjust terms to allow *Monthly Weather Review* into the fold. Specifically, the report stated, “*MWR* be developed as the vehicle for publication of articles on the meteorological topics of weather forecasting, observations, and instrumentation, and JAM be directed to the application of the atmospheric sciences and of meteorological information to problems where this information is critically important, but not sufficient for optimal solutions.” A later editorial in all AMS journals explained topic by topic where manuscripts would be published ([Craig et al. 1975](#)).

The second issue was resolved in a different manner. In 1973, AMS members received a subscription to the *Bulletin of the American Meteorological Society* and one technical journal (JAS, JPO, JAM) in their $20 annual membership dues. As costs of printing, paper, and mailing rose, this benefit would no longer be viable, so the decision was made for members to pay for a subscription of *Monthly Weather Review*, if they so desired ([Kellogg 1973](#)). Soon thereafter, AMS stopped including complementary subscriptions to any specialty journal as part of the membership dues.

b. The AMS years begin (1973–78)

In August 1973, the AMS Council approved Chester Newton of the National Center for Atmospheric Research (NCAR) to be the first editor of *Monthly Weather Review* at the AMS ([Fig. 9; Table 1](#)). His wife, Harriet Rodebush Newton—a former Navy forecaster and later a research meteorologist before leaving the field to start their family—would serve as the assistant editor at a salary of $83.33 per month. In an oral-history interview ([AMS–UCAR 1990](#)), Newton described his time as editor:
The National Oceanic and Atmospheric Administration announces that the Monthly Weather Review will become a publication of the American Meteorological Society beginning with Volume 102, No. 1, January 1974. During 101 years of publication by NOAA and its predecessors, the Monthly Weather Review has served as a medium for meteorological information originating both within and outside the Federal Government; in recent years, as a research journal, its contributors have been a representative cross section of the entire meteorological community, both national and international; now more than half of the authors have non-NOAA affiliations. Under these circumstances, NOAA has concluded that the public interest would be better served by a Monthly Weather Review under non-Government sponsorship.

The American Meteorological Society, as a major scientific society and publisher of several important journals serving atmospheric and hydrodynamic scientists throughout the world, is uniquely qualified to continue publication of the Monthly Weather Review. Under the editorship of Chester W. Newton, the Monthly Weather Review will continue its basic emphasis on the meteorological topics of weather observation, analysis and forecasting, and instrumentation. For further information, the reader is referred to the August 1973 issue of the Bulletin of the American Meteorological Society.

INFORMATION FOR AUTHORS

The American Meteorological Society announces that henceforth manuscripts (Articles and Notes or Correspondence) for the Monthly Weather Review should be submitted to Dr. Chester W. Newton, Editor, Monthly Weather Review, National Center for Atmospheric Research, P.O. Box 1470, Boulder, Colo. 80302 (phone: 303-494-5151). Authors may be members or nonmembers of the Society, and of any nationality, but only manuscripts in the English language can be accepted. Reference should be made to current issues of the Journal of the Atmospheric Sciences, Journal of Applied Meteorology, or Journal of Physical Oceanography for guidance in the preparation of papers. Authors’ institutions will be requested to pay a publication page charge in conformance with the current rate for all Society journals.

INFORMATION FOR SUBSCRIBERS

The December 1973 Monthly Weather Review will be the last issue available from the Superintendent of Documents; he will make an adjustment on any present subscription that extends beyond that issue. Subscription orders beginning with the January 1974 issue should be submitted to the American Meteorological Society, 45 Beacon Street, Boston, Mass. 02108. The Society announces that the Monthly Weather Review will be available on a calendar year subscription-only basis at an annual rate of $60 (20 to AMS members). The single issue price will be $8 (93 to AMS members).

FIG. 8. Announcement of the transfer of Monthly Weather Review to the AMS, which ran in every issue from June to December 1973 (e.g., MWR 1973).

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pressure to “publish or perish” in academia, and the increase in the average length of the text and in the number of figures/tables. The increasing number of articles also led to increased demand for reviewers, as discussed more recently by Golden and Schultz (2012). Monthly Weather Review responded with requests to authors to limit the length of their submissions (e.g., Ray 1994) and eventually an AMS journal-wide word limit of 7500 words per submission.

Fig. 9. Letter written on 31 Aug 1973 from William Kellogg to Chester Newton about the AMS Council approving his editorship of Monthly Weather Review. Scan courtesy Sophie Mankins from the Kenneth Spengler archives at the AMS.

Since the AMS took over Monthly Weather Review in 1974, until 1996, the format and layout of the articles it published (as well as its means of production of the journal) had remained relatively constant. Even the font types remained remarkably similar (likely Century during the NOAA era, Baskerville in the early AMS era, and Times New Roman at present, in case you were wondering). Starting in January 1997, changes in production and changes in the overall publication landscape led to dramatic changes in the way articles were submitted, reviewed, and published across all AMS journals, including Monthly Weather Review. The methods of publishing at the AMS during this period of relatively rapid change were documented in Seitter (1996), Jorgensen et al. (2007), Seitter and Heideman (2009), LeMone and Jorgensen (2010), and Rauber and Heideman (2014). These changes included the introduction of digital publication, the increased speed of the publication process, the inclusion of color figures, the ability to submit manuscripts to the journal offices electronically rather than requiring five hard copies to be mailed in, and an increase in the number of editors in response to an increase in submissions.

First among these changes was a system by which journal articles were produced and made available online in digital format. Making all the historical content of Monthly Weather Review available online required the coordination of three components. For the pre-1974 content, the AMS depended upon NOAA’s participation (e.g., Nathans 2002; Seitter 2003b). Next was the AMS Legacy Project (Schubert et al. 2001; Seitter 2002) to scan in the 1974–96 content, which only existed in print form. Finally, since 1997, all content has been digitally produced and published online, requiring little additional effort to comply with the new digital publishing standards. With all parts fully assembled, the AMS was one of the first publishers to make their journal archives available digitally. Furthermore, with this digital content, AMS has made its back catalog of journals freely available online five years after publication since 2006 (Seitter 2005); this period was reduced to two years in 2010 (Seitter 2010a), and then one year (Rauber 2017a). In 2012, the AMS introduced Open Choice for authors to select their articles to be open access upon publication (Heideman 2012; Seitter 2012). Moreover, due to the COVID-19 pandemic, all journals became freely accessible to allow researchers working remotely to access the journals more easily (25 March–31 August 2020).

Discussing this transition, Joseph Klemp, publications commissioner during much of this period, reported that the AMS avoided the problems that other societies had faced when moving to an all-electronic publication process: “We’ve moved at an amazing pace without compromising scientific standards” (Thomas–Medwid 2003b). Reflecting on his role as deputy executive director of the AMS, Keith Seitter said, “I think the thing I am most proud of so far in my time here [at the AMS] is my role in getting the journals from print-only publications to a robust form of electronic delivery that can serve our community very effectively.” Recognizing that it was a team effort that made it happen, Seitter added, “We have a really terrific staff here at Headquarters across all the programs, and they bring a level of creativity and expertise that make working on new initiatives really exciting” (Thomas–Medwid 2003a).

During this time, the number of print subscriptions declined, and the AMS debated whether to cease print publishing altogether (e.g., Seitter 2003c,d). The push for online distribution and new modes of journal publication was so strong that there was a significant risk that Monthly Weather Review might have been discontinued. Randall and Emanuel (2003) proposed forming a new Journal of the American Meteorological Society that would have combined the articles from all the journals into a single online-only journal. Although Monthly Weather Review was not mentioned specifically, this proposal would have ended Monthly Weather Review (as well as all other AMS journals) as a separate entity. Fortunately for the survival of Monthly Weather Review and the other AMS journals, the AMS Publications Commission robustly debated the issue, and then—finding no compelling reason to eliminate the value and continuity that discipline-specific publications and the information the journal names provided—opted not to pursue it further (D. Jorgensen 2021, personal communication).

Second was the speed of the publication process. Time to publication was often a concern raised by authors and editors (e.g., Schubert 1999; Schubert et al. 2001), with the increasing number of submissions and staff shortages at the AMS leading to increases in the time from submission to acceptance (i.e., a measure of the speed of the peer-review process) and the time from acceptance to publication (i.e., a measure of the speed of the publication process). For example, the time from acceptance to publication had increased from about 8 months in the early 1990s to 12 months in the late 1990s. It is presently about 4 months.) A large number of innovations were put in place within both the peer-review process and the publication process to ensure that these two numbers decreased and to further improve the speed of the publication process (e.g., Thomas–Medwid 2002, 2005; Jorgensen et al. 2007; Rauber and Heideman 2014). Among these speed-ups were TÉX macros for manuscript preparation (Krishnamurti and Ray 1992), electronic manuscript submission, emailed manuscripts and reviews, and electronic workflow (e.g., Seitter 1996). Krishnamurti and Ray (1992) continued:

Our first step is to encourage the submission of manuscripts on disks to the AMS when a paper is accepted in its final form. As an incentive, AMS will offer the choice of either free covers on reprints or 50 extra reprints for papers submitted in TÉX using AMS macros. While there is no explicit incentive, the AMS continues to encourage the submission of diskettes in other formats as well. Acceptable formats are WordPerfect, Microsoft Word, and Wordstar.

Krishnamurti and Ray (1992) and Schubert (1999) were already recommending reviews to be sent by e-mail rather than by postal mail, and Schubert et al. (2001) recommended
electronic submission of manuscripts onto an AMS server. Under the leadership of Co-Chief Editors David Jorgensen and William Kuo and their Editorial Assistant Mary Golden, *Monthly Weather Review* pioneered, then accelerated, electronic submissions. The AMS built a software platform called the Manuscript Tracking System, which was completed by 2008 (Schultz 2008). D. Jorgensen (2021, personal communication) described that period:

My most vivid memory from the time I was MWR Co-Chief Editor… was the sudden transition from all paper to all digital record keeping in the mid 90s. It wasn’t that the online Manuscript Tracking System (MTS) was that complicated to understand or use, but our Editorial Assistants were beginning to be phased out at nearly the same time. I suppose you could say I may have gotten a bit lazy depending on my Assistant to send out letters to potential reviewers asking for reviews, or sending out reminders for late reviewers or even manually keeping the records (mostly decisions and dates) that were necessary for the annual Editorial Reports that the AMS expected. It did seem like my workload went way up once I had to do all that stuff for myself even with the MTS! I’m not sure how the transition affected all the field editors… but I did get an earful from a few of the MWR editors! Eventually, the MTS settled down, and it [did] provide a more efficient way of tracking manuscripts going through the AMS editorial system. But there were many hicups in the beginning like lost manuscripts, dates not entered correctly, and letter templates that had to be tweaked constantly (or so it seemed). It was also much easier for the authors not having to mail in 5 hard copies of their manuscripts upon submission or final acceptance, as well as savings on postage fees.

In 2010, AMS began evaluating alternatives to the Manuscript Tracking System in the form of commercially available submission systems, which many journal publishers had begun adopting as the costs and risks of maintaining and developing in-house systems were rising. Coincidentally, in July 2010, the AMS server that hosted the Manuscript Tracking System suffered a catastrophic failure and files were lost for manuscripts in review and production (Seitter 2010b). Publications staff were able to manually restore files to the Manuscript Tracking System over a period of many weeks, and later that year AMS moved to the present Editorial Manager system (Seitter 2010b). Further efficiencies were found from this and other electronic workflows (e.g., Heideman 2005; Jorgensen et al. 2007; Rauber and Heideman 2014). Another acceleration of the publication process happened in 2007 when special issues would no longer be held up by the slowest-moving individual articles, but be published online as Special Collections instead (Jorgensen 2007). Director of Publications Ken Heideman reflected on his role early in this period. “Important research is now getting out to the community much faster through our journals and that’s what scientists need and want. That achievement is what I am most proud of in the last four years,” Heideman said. “It was a great team effort!” (Thomas-Medwid 2002).

Third was the increasing need for color figures in print. Although color figures were printed on separate end-of-issue charts for storm tracks and surface analyses since the early days (e.g., Beck 1922, and looking forward to Figs. 10–13), regular color figures had rarely been published during the AMS era. Rare examples can be found in the color photos and analyses of Fujita (1989, his Figs. 5–8, 10–13) and color radar imagery of Carbone et al. (1990, their Figs. 9, 10, and 18). The cost was quite prohibitive for many authors, as much as $1600 per color figure in the mid-1990s (Jorgensen et al. 2007). More and more authors saw the value in communication afforded by color figures, and chief editors were among those who lobbied the AMS to bring the costs down. Former *Monthly Weather Review* Co-Chief Editor Rich Rotunno (1986–90; Table 1) reflected on this time:

At one of the first publication meetings, Joe [Klemp] and I were making the case for color graphics. As I recall there was push-back because of the technical difficulty ([and especially the added] cost), it’s not really necessary, etc. These meetings were... held in the AMS headquarters, a beautiful old Victorian mansion that fronts onto Boston Common. During the lunch break, I wandered into the library in a nearby room to browse the venerable, collector-item-type books. I noticed that there was the MWR collection going back to the beginning. Curious about how things had changed, I picked up one of the first volumes. And, lo and behold, within there were weather maps—in color! Triumphant, I brought the old volume back to the meeting. I can’t say that it moved anyone to change his or her mind, but it felt pretty good (R. Rotunno 2021, personal communication).

Eventually, the expensive cost increment for printing color came under scrutiny by David Jorgensen, *Monthly Weather Review* co-chief editor and, later, AMS publications commissioner. In the early 2000s, the cost of color figures was $1200 for the first two color figures. In 2009, the cost was dropped to $150 per color figure (Seitter 2009). By 2011, the cost had dropped to around $90 per color figure (BAMS 2011; Heideman 2012), and reached zero in 2013 (Seitter 2013). Thus, within the span of just a few years, Jorgensen and the AMS Publications staff worked first to have the electronic version be the version of record (allowing noncolor figures in the print version as a less expensive alternative, but color figures in the online version; Seitter 2003a), and then to bring the costs of the per-page print charge down. Finally, with new advances in printing, the color figures cost was eventually eliminated and even the printed copies of the journals incorporated color figures.

Fourth, since 1978, *Monthly Weather Review* had maintained a small number of editors (typically three, but ranging from two to five) who handled topics relevant to their individual specialties (e.g., numerical weather prediction, synoptic meteorology, severe convective storms). By 1998, *Monthly Weather Review* was publishing more pages than any other AMS journal (Jorgensen and Kuo 1999). Starting in 2008, the number of editors was gradually increased from 7 to 20 in 2021 (Table 1). This increase was to account for several factors: to reduce the workload of individual editors, who had been handling as many as 50–60 manuscripts a year; to increase redundancies on the Editorial Board in case of conflicts of interest, personal leave, and field campaigns; to increase the number and diversity of early career researchers
on the board; and to better balance editor workloads to be more equitable.

More recently, the changing landscape of scientific publishing has led to other changes at *Monthly Weather Review*, including open data archiving and citation (e.g., Mayernik et al. 2015; Schultz et al. 2020b), plagiarism detection (Schultz et al. 2015), and significance statements to benefit wider communication of scientific results (e.g., Schultz et al. 2020a). Beginning in March 2019, *Monthly Weather Review* became the first AMS journal to join Twitter, with @MonWeaRev tweeting about different topics, including “#OTD [On This Day] in #MonWeaRev History,” tributes to authors who have passed or won awards, and newly published articles. The next big step in publishing will be the inclusion of animations as part of the PDF files (M. Friedman 2021, personal communication), bringing a touch of Harry Potter magic to AMS journals. Compared to the efforts required to move from all-paper to all-electronic submission, review, and publishing, it would seem moving to animated figures is a small task!

5. The contents of *Monthly Weather Review*

As has been discussed in sections 2–4, the contents of *Monthly Weather Review* have undergone many changes through its 150-yr history. In this section, we discuss some of these different types of content, including data and charts in section 5a, the various departments in section 5b, special issues in section 5c, the most-cited articles in section 5d, a sampling of influential publications in section 5e, and some examples of the impact of the data and articles in *Monthly Weather Review* in section 5f.

a. Data and charts in *Monthly Weather Review*

The first issue of *Monthly Weather Review* was a qualitative discussion of weather across the United States (Fig. 1). During the late 1800s, the network of observations grew so that, by 1900, the total number of observing stations had plateaued at around 3100 stations (MWR 1900a):

The *MONTHLY WEATHER REVIEW* for January 1900, is based on reports from about 3,103 stations furnished by paid and voluntary observers, classified as follows: regular stations of the Weather Bureau, 158; West Indian service stations, 12; special river stations, 132; special rainfall stations, 48; voluntary observers of the Weather Bureau, 2,562; Army post hospital reports, 27; United States Life-Saving Service, 9; Southern Pacific Railway Company, 96; Canadian Meteorological Service, 32; Mexican Telegraph Service, 20; Mexican voluntary stations, 7. International simultaneous observations are received from a few stations and used, together with trustworthy newspaper extracts and special reports.

By 1935, there were nearly 5000 cooperative observers, of whom more than 300 were women, three of whom had more than 40 years of service and whose photos were presented in the November 1935 issue: Louisa B. Knapp of Plymouth, Massachusetts, Annette Koch of Pearlington, Mississippi, and Alice B. Scudder of Moxee, Washington (Kincer 1935). As the voluntary observer network grew, *Monthly Weather Review* responded with more quantitative data, analysis of that data, and presentation of that data in various charts and tables (e.g., Fig. 6), including annual reports on storms and hurricanes. Eventually, the individual station data (e.g., Fig. 6) were replaced by a condensed climatological summary roughly by state in the 1920s, which lasted until the end of the third data period in 1949 (Fig. 2).

Charts depicting the paths of low pressure centers were there from the very first issue (e.g., Fig. 1), although they were not produced until later, according to Hunter (1923). “As for charts, that showing storm tracks, … seems not to have been printed till a year or two after the sheet of text had been distributed; while those for total precipitation and for isobars, isotherms, and prevailing winds were printed fully ten years later yet, during the later eighties [1880s].” Eventually the number of charts increased to include those depicting the monthly mean temperatures, winds, monthly precipitation, paths of high pressure centers across the United States, and snowfall and snow depth in winter months (Figs. 2, 10). Charts for the Northern Hemisphere (and some Southern Hemisphere locations) monthly mean wind, temperature, and pressure, as well as cyclone tracks, were also published during 1879–82 (Fig. 11). Charts of monthly mean upper-air data were also published during three periods (Fig. 2) and included a variety of different charts at different levels in different coordinate systems:

- constant-height charts of mean isobars and isotherms at 3500 and 10 000 feet (1903–05, the construction of which is described in Bigelow 1903),
- constant-height charts at 5000 feet, and 1500, 3000, 4000, and 5000 m (1939–45),
- an isentropic chart on the 295-K surface in January 1939 (Fig. 12),
- tropopause height and temperature charts (January 1940–41), and
- constant-pressure charts at 850, 700, 500, and 300 hPa (1946–49).

Other charts were published only briefly, including charts of the West Indies (1899–1903), North Atlantic (1917/18), and charts supporting case studies described in the articles (irregularly from 1889 to 1940; e.g., Fig. 13). During 1889–1908, *Monthly Weather Review* published a thirteenth issue in January of the following year with a written annual summary and a number of annual-mean maps (e.g., isobars and winds, temperature and departures from normal, precipitation and departures from normal, maximum and minimum temperatures, temperature range, percentage of clear skies, number of thunderstorm days).

b. Articles and departments in *Monthly Weather Review*

Although early contributions attributed to individual authors appeared under specific sections of the journal as early as 1886, original standalone articles were not published until several years later. The earlier contributions included a discussion by Signal Service Professor Henry A. Hazen (who...
Table 1) of thunderstorms across the United States in July 1886 (Hazen 1886). In another contribution appearing in the same issue, Signal Service Professor Thomas C. Mendenhall discussed measurements of electric potential in the air using an electrometer atop the Washington Monument, as well as at Yale College, Boston, and Cornell University, at various dates during July 1886, with an accompanying chart (Chart VI of that issue) showing graphs of the observations (Mendenhall 1886). Both of these contributions appeared as part of the Atmospheric Electricity department in the July 1886 issue.

Similarly, Lieutenant John P. Finley, who conducted pioneering work in tornado research (e.g., Galway 1985; Murphy 1996), published a brief article analyzing several tornado outbreaks across parts of the United States that occurred on 12, 16, and 18 September 1886 (Finley 1886). In addition to discussing the synoptic conditions associated with each outbreak, he included a surface map (Chart VII of that issue), displaying isobars, isotherms, and wind directions for 1500 eastern time 16 September, the day of the most destructive tornadoes that month—with the general tornado paths overlaid. This article appeared under the Winds department in the September 1886 issue.

Dunwoody (1889) discussed the various distinct “articles” and other content occasionally published in *Monthly Weather Review* at the time:

The Monthly Weather Review, which for several years has been regarded as one of the most valuable meteorological publications extant, has contained during the year, from time to time, special articles, charts, etc., bearing upon subjects of interest to meteorologists as well as to the general public. In addition to the usual current matter presented during the year the following may be mentioned as some of the specific features: Discussion of the subject of fog predations for the banks for Newfoundland; charts showing for selected stations normal and current temperature curves; soil temperatures and moisture, notes and charts; coincidence of sun spots with thunder storms and auroras; effect of rainfall upon temperature of the air; mean temperatures determined from observations of maximum and minimum thermometers; observations on the

![Chart VII. Total Snowfall for February, 1906.](image-url)
thermal belt of Polk County, N. C.; meteorological and health chart for Ohio, August 1887; direction of movement of areas of low pressure; rain and snow from a cloudless sky; variation of atmospheric pressure; Chinook winds; self-registering barometers and thermometers; chart showing average date of last killing frost; charts illustrating conditions attending the great storm of March 11–14; normal rainfall charts for the months April to July.

Dunwoody’s mention of “the great storm of March 11–14” (the Blizzard of 1888) alludes to the fact that, throughout its early years and well into the twentieth century, Monthly Weather Review...
Weather Review served as the meteorological chronicle of record for some of the most extreme—and historic—weather events affecting the United States, including the Blizzard of 1888 (MWR 1888), the 1900 Galveston Hurricane (Cline 1900; Garriott 1900), the 1922 Knickerbocker Storm (Day and Fergusson 1922), the 1925 Tri-State Tornado (Henry 1925b), the 1935 Labor Day Hurricane (McDonald 1935), and the Great New England Hurricane of 1938 (Pierce 1939). Ranging from basic summaries to detailed meteorological analyses and often including specialized charts, maps, and other figures, these accounts serve as a valuable resource to meteorologists and historians alike and provide insight into the data gathering and analysis techniques at the time the events occurred.

Beginning with the July 1891 issue—the first to be published under the auspices of the newly created U.S. Weather Bureau—Monthly Weather Review included a new department, Contributions and Original Articles, which appeared occasionally in the journal through the November 1892 issue. The July 1891 issue included two articles. The first was a discussion by Alexander McAdie of the Weather Bureau from a paper he read before a meeting of the American Association for the Advancement of Science in Washington, D.C., in August 1891 on observations made of atmospheric electricity at Blue Hill Observatory in Massachusetts (McAdie 1891). Immediately following this brief article was one by Professor Henry Hazen on “Fluctuations of Temperature and Pressure at the Base and Summit of Mount Washington” (Hazen 1891a), which was accompanied later in the issue by an unnumbered chart showing tracings of those variables for the months of January, February, and March 1874–75. Similar brief articles on the same topic appeared in the August, September, and October 1891 issues (Hazen 1891b,c,d).

The first nondata article appeared in the January 1892 issue of Monthly Weather Review: “Chinook Winds” (Garriott 1892), also under the department Contributions and Original Articles, which was a general description of the chinook phenomenon followed by a brief description on an event from 18 to 19 January accompanied by surface analyses (Chart VII of that issue). Other articles were published irregularly in...
Fig. 13. Examples of surface weather charts. Solid lines represent sea level pressure every 0.1 in. mercury, and arrows represent direction of surface winds. (top) Surface weather chart for 0800 EST 9 Jan 1889 (MWR 1889). Line of plus signs represents the path of the low center over the past 36 h. Dotted lines present isotherms every 10°F. (bottom) Surface weather chart for 0800 EST 8 Sep 1900 for the Galveston hurricane (MWR 1900c). Line of plus signs represent the path of the low center since 0800 EST 1 Sep.
February, May, and August 1892 and March 1893. One article reported detailed observations and surface data of thunderstorms in New York state (Turner 1892); another reported on heat waves in July and August 1892 (Garriott 1893).

The regular appearance of articles began in August 1893, under Abbe’s editorship. The first appeared under the department General Notes (By the Editor), which described his desire to use terminology such as high, low, storms, tornado, whirlwind, and cyclone uniformly in the journal (MWR 1893). By late 1895, *Monthly Weather Review* increasingly had become a venue for articles, as both the number of pages and the number of articles showed an increase at this time (Fig. 2). These articles involved interesting weather events in the United States and around the world, reports from experimental upper-air observations with kites, lists of recent meteorological publications from around the world, and reprinted articles and stories. With nearly 40,000 articles and more than 210,000 pages (including the monthly weather data and charts) published throughout its 150-yr history, characterizing these would be challenging. Instead, to give a flavor of the kinds of content published, we select a few different aspects of the range of publications throughout its history, such as the various departments in which articles were published.

1) **PICTURE OF THE MONTH**

The first weather satellite, *TIROS 1*, launched in 1960 (e.g., Fritz and Wexler 1960). In January 1963, *Monthly Weather Review* capitalized on the flow of new satellite imagery and launched Picture of the Month (Singer 1963). These one- to three-page articles featured a satellite photo and a brief explanation. Examples include the first Picture of the Month, of actiniform convection (MWR 1963; Fig. 14), followed by jetstream clouds (MWR 1964b; Parmenter 1969), a Tehuantepec (Parmenter 1970), extratropical cyclones (Johnston 1974), and two simultaneous hurricanes in the central–eastern Pacific Ocean (Wann 1974). In 1969, Picture of the Month was opened to more than just satellite imagery (MWR 1969). Picture of the Month was published nearly continuously from 1963 to 1976 and is still published today, albeit less frequently and with more depth. All Pictures of the Month are part of this online Special Collection: https://journals.ametsoc.org/collection/picture-MWR.

2) **ANNUAL WEATHER SUMMARY**

Summarizing monthly weather events had been the primary purpose of *Monthly Weather Review* since its inception. Starting in 1942 (although also in 1922–24, but missing in 1945), annual articles were published that summarized the then recently concluded North Atlantic hurricane season (e.g., Dunn et al. 1956). For many years, two summaries were published—for the North Atlantic and eastern North Pacific hurricane seasons (1969–73, 1990–2011). During 1984–2011, these were published under the department Annual Weather Summary. In 2011, the National Hurricane Center discontinued the Annual Weather Summaries when the effort to create them became too onerous and other online datasets were more timely and easier to produce. Other Annual Weather Summaries included Atlantic tropical systems (1969–79, 1988–97), Eastern Hemisphere tropical cyclones (1995–96), mesoscale convective complexes, now more commonly called mesoscale convective systems (1981–83, 1985–87), tornado seasons (1983–86), and air-stagnation cases (1981–85), the latter two solicited by Chief Editor Roger Pielke Sr. All Annual Weather Summaries are part of this online Special Collection: https://journals.ametsoc.org/collection/AWS-MWR.

3) **REVIEW**

*Monthly Weather Review* was the first AMS journal to publish review articles, called Reviews. In the early 1980s, Chief Editor Roger Pielke Sr. proposed to the AMS Publications Commission that he could invite authors to write review articles, which would go to a larger number of reviewers than just the typical two or three (Pielke et al. 1985). For these earliest reviews, eligible authors were also awarded a $200 honorarium (R. A. Pielke Sr. 2021, personal communication). Dan Keyser, the coauthor on one of these earliest reviews, on upper-level fronts (Keyser and Shapiro 1986), recalls Pielke Sr.’s advice to him: Write the review so that it will still be relevant a number of years afterward. The first review, “Regional models of the atmosphere in middle latitudes,” was published in 1983 (Anthes 1983), but the series gained in prominence with several highly cited reviews following thereafter, namely Liu’s (1986) review on cirrus, Staniforth and Côté’s (1991) review on semi-Lagrangian integration schemes, and Madden and Julian’s (1994) review of the 40–50-day tropical oscillation (now famously known as the Madden–Julian oscillation). A recent push to publish more reviews (Schultz 2008) has led to 14 new reviews, doubling the total number of reviews. Recently, R. A. Pielke Sr. (2021, personal communication) reflected on his time as Chief Editor (1981–85; Table 1):

I enjoyed, for example, the opportunity given to me to have invited review papers and an annual summary of mesoscale convective systems. The Board was open to new ideas to evaluate as MWR had only recently converted from a government publication. Seeing the journal continue the invaluable contributions when the AMS took over, and even expanding its reach has been a joy to follow over the years.

All *Monthly Weather Review* reviews are part of this online Special Collection: https://journals.ametsoc.org/collection/review-MWR.

4) **WEATHER NOTES, AND NOTES AND CORRESPONDENCE**

Reviving the era of eyewitness weather accounts of extreme and unusual events that populated *Monthly Weather Review* in the early days, the journal reinstated them in April 1955, published under the department Weather Notes (Fig. 2). These continued until February 1973, following the publication of nearly 100 of them. While *Monthly Weather Review* was published by the AMS, small research studies not quite the length of a full article were published as Notes under the department Notes and Correspondence, which included Comment and Reply exchanges. Already a staple of other AMS journals by the time *Monthly Weather Review* joined the fold in 1974, the January 1974 issue had three items under Notes.
and Correspondence. Concern over the quality (Ray 1994) and over the increasing length led them to be discontinued and morphed into a short-lived category called Expedited Contributions (Jorgensen 2009) that was meant to accelerate the process for short, high-impact publications; these were later eliminated in 2017 (Rauber 2017b).

5) PUBLICATIONS AND BIBLIOGRAPHIES

Lists of additions to the Weather Bureau Library and bibliographies of articles and books from around the world were commonly published in the early days of Monthly Weather Review, when finding scientific articles on meteorology was much more difficult than a web search (e.g., Talman 1909a,b). This tradition began in March 1896, with such titles as “Publications,” “Recent Additions to the Weather Bureau Library,” “Recent Papers bearing on Meteorology and Seismology,” and “Notes from the Weather Bureau Library.” This tradition was reborn when Monthly Weather Review introduced new departments highlighting publications by the parent organization (e.g., “New ESSA Publications”) or publications by authors employed by its parent organization: “Publications by Weather Bureau Authors” (November 1959–January 1966), “Selected Publications by ESSA Authors” (March 1966–December 1970), and “Selected Publications by NOAA Authors” (January–September 1971).

6) NECROLOGIES

Another interesting feature that occasionally appeared in early issues of Monthly Weather Review was the publication of necrologies. The entire first page of the August 1880 issue, for example, contained a reprint of General Orders No. 63, issued by the adjutant general’s office of the Army, providing notice of the death of General Myer (Fig. 15). The November 1921 issue included notice of the death of Frederica Boerner, a cooperative weather observer from Vevay, Indiana, who succeeded her father in maintaining weather records from that location upon his death, in 1900, a practice he began in 1865 (MWR 1921).

7) SUPPLEMENTS

Between 1914 and 1948, the Weather Bureau published 47 Monthly Weather Review Supplements; the complete list appears in Table 2. These supplements often included atlases, observational datasets, early upper-air observations, climatologies, and temperature normals. Probably the most
recognized of these supplements was Bowie and Weightman’s (1914) Supplement Number 1 on storm tracks over the United States. These supplements are archived by the NOAA Central Library Data Imaging Project: https://library.noaa.gov/Collections/Digital-Collections/Monthly-Weather-Review.

c. Special issues

In the early years, groups of several articles were sometimes clustered around various themes in an issue, such as twilight in the November 1916 issue or the Norwegian analysis methods in the August 1922 issue. In 1963, one of the first (if not the first) named special issues was constructed honoring Harry Wexler, director of meteorological research at the Weather Bureau, after his untimely death in 1962 (e.g., chapter 4 of Fleming 2016a). The October–December issues were merged into one 275-page issue with 30 scientific contributions, owing to the overwhelming response of authors wanting to contribute (Reichelderfer 1963), and sold for $2 per issue (MWR 1964a). Nearly all articles mentioned the influence that Wexler had on Weather Bureau research; even the Picture of the Month was selected because “it displays the sort of unsolved problem that always stimulated Dr. Wexler—the problem of air-sea interaction and the endless complications of atmospheric hydrodynamics” (Hubert 1963).

Later, special issues would be organized around such themes as papers presented at the Sixth Conference on Weather Forecasting and Analysis (Bosart and Pielke 1976), coupled atmosphere–ocean models (Latif 1997), the 1995 hurricane season (Ray 1996; Krishnamurti 1998), or field programs such as the Genesis of Atlantic Lows Experiment (Dirks and Kuettner 1990) and the Taiwan Area Mesoscale Experiment (Jorgensen and LeMone 1991). With the advent of digital publishing and the desire not to hold up the entire issue for the last articles, the AMS evolved to Special Collections, which could be curated digitally (Jorgensen 2007). Special Collections also allowed for the postpublication curation of collections, such as the collections for Monthly Weather Review Reviews, Pictures of the Month, and Annual Summaries described above.

d. Most-cited articles

Monthly Weather Review has been indexed by the Web of Science since 1966. As of 20 August 2021, 10,919 articles are in their database. Table 3 presents the 50 most-cited articles. Many are associated with popular models or model parameterizations and have become highly cited when they are used and cited in subsequent modeling studies. Articles on atmospheric teleconnections, El Niño–Southern Oscillation, and the Madden–Julian oscillation are the most commonly cited articles on weather and climate phenomena. The earliest articles on the list are from 1968 and 1969: Gray (1968) describing the conditions for tropical cyclogenesis, Bjerknes (1969) describing the Southern Oscillation, and Nobel Prize winner Syukuro Manabe5 (1969) illuminating the global circulation model. Interestingly, only one article is from the 1970s: Priestley and Taylor (1972), which presents equations for evaporation and surface fluxes, and which also happens to be the most-cited Monthly Weather Review article published since 1966.

To examine highly cited articles that were published before 1966, a search of the 1000 most-cited Monthly Weather Review articles before 1966 was performed with software called Publish or Perish (Harzing 2007). The software allows search and ranking of articles by the number of Google Scholar citations. The top 25 are presented in Table 4. The rankings in Table 4 will differ from those in Table 3 because of the different sources of information for the citations (i.e., the number of Google Scholar citations is generally larger than those for Web of Science because of the larger number of sources available to Google Scholar). Separating the post-1966 articles from the pre-1966 articles was important because of the different topics of the publications in the two time periods and different citation frequencies.

The most-cited pre-1966 paper (and indeed of all time at Monthly Weather Review, when considering the Google Scholar citations for the post-1966 articles) is Smagorinsky (1963), “General circulation experiments with the primitive equations: I. The basic experiment.” Mahlman (2006) wrote, this “famous paper... literally changed the ‘world’ of physical science.” Follow-up articles (Manabe et al. 1965; Smagorinsky et al. 1965) were also highly cited (Table 4). Although not published in the Wexler Special Issue later that year, Smagorinsky made the following annotation before the introduction: “This work is dedicated to the fond memory of Harry Wexler whose enthusiasm and confidence were a constant source of inspiration.” Other than 10 pages for the Picture of the Month, an announcement of a new Weather Bureau Technical Paper, a Correction, and the monthly weather and circulation article, this 66-page article was the March 1963 issue. Professor Frederick Carr, University of Oklahoma, relates his experiences trying to keep up with the legacy from that article: “When I was a grad student in the 1970s, I kept track of every [general circulation model] paper written since this one, finally giving up in the mid-1980s when their number got too large.”

Numbers two and three of the most-cited articles published before 1966 are Brier (1950) on the verification of probabilistic forecasts using the skill score that now bears his name and Cressman (1959) on the method for producing a gridded analysis from irregularly spaced data that now bears his name (Table 4). The earliest article from Monthly Weather Review in the top 1000 articles is number 7, Bateman (1915): “Some recent researches on the motion of fluids,” which first wrote out and solved Burgers’ equation (or, more properly, the Bateman—Burgers equation), a partial differential equation for fluid motion describing advection and viscosity (Fig. 16). The article is cited in many textbooks on differential equations. Other highly cited

5 Manabe, who shared the 2021 Nobel Prize in Physics, would eventually publish 17 articles in Monthly Weather Review between 1961 and 1984, making him the only Nobel Prize winner to our knowledge to have published in Monthly Weather Review.
TABLE 2. Supplements to *Monthly Weather Review*. There was no Supplement 43. Creation of this list was possible courtesy of the NOAA Central Library Data Imaging Project (https://library.noaa.gov/Collections/Digital-Collections/Monthly-Weather-Review). References are not included in the reference list.

1. Bowie and Weightman (1914): Types of storms of the United States and their average movements.
6. Day (1917): Relative humidities and vapor pressures over the United States, including discussion of data from recording hair hydrometers.
16. Smith et al. (1920): Predicting minimum temperatures from hydrometric data.
18. Welch (1921): Bibliography of the climate of South America.
22. Frankenfield et al. (1923): The spring floods of 1922.
28. Reed (1927): Climatological data for the tropical islands of the Pacific Ocean (Oceania).
29. Frankenfield (1927): The floods of 1927 in the Mississippi Basin.
31. Reed (1928): Climatological data for northern and western tropical South America.
32. Reed (1928): Climatological data for southern South America.
33. Page (1930): Climate of Mexico.
34. Day (1930): The daily, monthly, and annual normals of precipitation in the United States, based on the 50-year record, 1878 to 1927, inclusive.
35. Stevens (1933): Upper-air wind roses and resultant winds for the eastern section of the United States.
articles pertain to early numerical methods articles, tree-ring research, and wind speeds in the 1957 Dallas tornado.

e. Influential articles

Not all important or noteworthy articles in *Monthly Weather Review* are highly cited. In this section, we discuss a very small sampling of such articles.

1) **BJERKNES CIRCULATION THEOREM**

The Bjerknes Circulation Theorem states that the increase in the circulation around a closed curve is proportional to the number of enclosed solenoids (i.e., intersecting pressure and density contours). Vilhelm Bjerknes published his circulation theorem in 1898 in the *Proceedings of the Royal Swedish Academy of Sciences* (Bjerknes 1898). In August 1899, he delivered a lecture on the Circulation Theorem to the Society of German Natural Scientists and Physicians. In 1900, he simultaneously published the original lecture in German in *Meteorologische Zeitschrift* (Bjerknes 1900a) and the English translation in *Monthly Weather Review* (Bjerknes 1900b). More on the theorem can be found in Friedman (1989, 33–39) and Thorpe et al. (2003).

2) **WILSON BENTLEY AND SNOW PHOTOMICROGRAPHS**

Wilson Bentley (1865–1931) was a meteorologist who lived in Jericho, Vermont (Blanchard 1998), and took remarkable photographs of snow crystals, ice crystals, and frost (Fig. 17). Already with 20 years of experience in 1901, Abbe invited him to document his studies in *Monthly Weather Review*. Thus, he began publishing a number of articles (e.g., Bentley 1901, 1902, 1907, 1918, 1924, 1927) in which he meticulously detailed his work, the origins of the crystals, their temperatures, clouds, and classification schemes. In 1902, Bentley wrote, “It is sincerely hoped that the reproduction of the photomicrographs of these marvelously beautiful objects of nature will give great pleasure to many students … the number of individual photomicrographs of crystals in our collection is brought up to somewhat over 1,000, no two of which are alike” (Bentley 1902, pp. 607, 615). By his last contribution to *Monthly Weather Review*, in 1927, he had collected more than 4726 photomicrographs (Bentley 1927, p. 359).

3) **YOSHI SASAKI AND DATA ASSIMILATION**

In December 1970, University of Oklahoma Professor Yoshi Sasaki published three pioneering single-authored papers in *Monthly Weather Review* (Sasaki 1970a,b,c). In these papers, he proposed using a numerical weather prediction model as a constraint in variational methods that would enable deploying multiple meteorological observations in time to obtain a dynamically consistent set of initial conditions for the model. This idea would later lead to the field of data-assimilation research, not only in atmospheric sciences, but beyond to many other geosciences. His idea also laid the foundation for the development of the four-dimensional variational data-assimilation method in late 1980s, which continues to be used operationally in the world’s major meteorological centers to this day.

4) **BOMBS AND THE PRESIDENTS’ DAY STORM**

Professor Frederick Sanders had a long interest in rapidly developing extratropical cyclones, what he coined the meteorological term bombs. He would teach a graduate-level synoptic laboratory at MIT on the best bomb of the past year (L. Bosart and J. Gyakum 2021, personal communication). With grad student John Gyakum, the two began working on their climatology of these cyclones, resulting in the *Monthly Weather Review* article “Synoptic-dynamic climatology of the ‘bomb’” (Sanders and Gyakum 1980). This article defined cyclones whose central pressure fall was at least 1 hPa h$^{-1}$ for 24 h (latitude dependent), linked the cyclones to mobile 500-hPa troughs in the jet stream, showed their preference to develop near the Gulf Stream and Kuroshio, and showed that quasigeostrophic dynamics was insufficient to explain the observed deepening.

At the same time, Professor Lance Bosart was on sabbatical at MIT. On 18–19 February 1979, an extratropical cyclone dumped up to 60 cm of snow across parts of the mid-Atlantic, a forecast bust by the NWS numerical forecast models. The interactions between Bosart, Sanders, and
Table 3. Top 50 most-cited *Monthly Weather Review* articles since, and including, 1966 in Web of Science, for the period ending 20 August 2021. References are not included in the reference list. A longer list of the top 1000 most-cited articles published since, and including, 1966 can be found in the repository (Schultz and Potter 2021).

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<th>Rank</th>
<th>Citations</th>
<th>Article</th>
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<tr>
<td>4</td>
<td>3196</td>
<td>Wallace and Gutzler (1981): Teleconnections in the geopotential height field during the Northern Hemisphere winter.</td>
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<tr>
<td>7</td>
<td>2360</td>
<td>Tiedtke (1989): A comprehensive mass flux scheme for cumulus parameterization in large-scale models.</td>
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<tr>
<td>12</td>
<td>1767</td>
<td>Wheeler and Hendon (2004): An all-season real-time multivariate MJO index: Development of an index for monitoring and prediction.</td>
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<tr>
<td>13</td>
<td>1668</td>
<td>Hong and Pan (1996): Nonlocal boundary layer vertical diffusion in a medium-range forecast model.</td>
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<tr>
<td>14</td>
<td>1621</td>
<td>Hong et al. (2004): A revised approach to ice microphysical processes for the bulk parameterization of clouds and precipitation.</td>
</tr>
<tr>
<td>29</td>
<td>1004</td>
<td>Holland (1980): An analytic model of the wind and pressure profiles in hurricanes.</td>
</tr>
<tr>
<td>30</td>
<td>988</td>
<td>Rafty et al. (2005): Using Bayesian model averaging to calibrate forecast ensembles.</td>
</tr>
<tr>
<td>33</td>
<td>942</td>
<td>Whitaker and Hamill (2002): Ensemble data assimilation without perturbed observations.</td>
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Gyakum fueled Bosart’s (1981) analysis of what became known as the Presidents’ Day Storm. That *Monthly Weather Review* article and a subsequent one (Bosart and Lin 1984) showed that the preconditioning of the environment by fluxes from the ocean produced the conditions favorable for rapid cyclogenesis and that the absence of a latent heat flux parameterization in the models likely contributed to the forecast bust. As L. F. Bosart (2021, personal communication) related:

I can remember giving a seminar at NMC [National Meteorological Center] in 1980 or 1981 on the Presidents’ Day storm of 19 Feb 1979 and getting a lot of push back from the good folks at NMC when I suggested that research findings on this storm pointed to the crucial importance of including significant level sounding data in the model data assimilation process *and* that calculating oceanic surface sensible and latent heat fluxes needed to become a routine part of NWP. I distinctly recall being told that mandatory level sounding data alone was sufficient to “spin up” operational prediction models then in use. I continued to disagree. The publication of Sanders and Gyakum (1980) made the argument to include significant level sounding observations in the data assimilation process and to calculate model-derived oceanic surface sensible and latent heat fluxes in operational NWP model forecasts much more compelling.

Bosart was not the only one doing research on the storm. Louis Uccellini (then at NASA’s Goddard Space Flight Center) and his group had also become interested in the storm. Their focus was on the upper-level processes responsible for the cyclogenesis, resulting in the publication of a number of articles in *Monthly Weather Review* (Uccellini et al. 1984, 1985; Whitaker et al. 1988). L. W. Uccellini (2021, personal communication) described the result:

…our work showed that our initial view that the dynamics working alone was a necessary but not sufficient condition and that Lance was right [with respect to] to the need for the sensible heat release in the boundary layer over the ocean off the East Coast prior to cyclogenesis that Lance emphasized in the first MWR article was also a necessary but not sufficient condition. Lance and I later characterized our to and fro in our MWR papers as “meeting in the middle” and discovered the relative contributions of all the processes and concepts we brought to our views of what had to be the most important process to developing an understanding of how all these processes are important to set up the environment for the storm and also for the subsequent rapid cyclogenesis and record snowfall rates. And we discovered together through the MWR publications and the debates at the cyclone workshops, and later in the AMS Palmén monograph, how all these processes have to be accounted for in operational models in order to be able to improve the public forecasts of these storms.

Furthermore, the debates between the relative importance of diabatic processes versus dry dynamics to extratropical cyclones between the Bosart and Uccellini camps ushered in now-standard analysis approaches such as frontogenesis, quasigeostrophic and semigeostrophic diagnosis, ageostrophic circulations, model verification against observations, potential vorticity, and air-parcel trajectories. These analysis techniques were not only useful in research, but worked their way into operational forecasting, as well.

### Table 3. (Continued)

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<th>Rank</th>
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<th>Article</th>
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<tr>
<td>37</td>
<td>867</td>
<td>Bolton (1980): The computation of equivalent potential temperature.</td>
</tr>
<tr>
<td>42</td>
<td>771</td>
<td>Hansen et al. (1983): Efficient three-dimensional global models for climate studies: Models I and II.</td>
</tr>
<tr>
<td>46</td>
<td>740</td>
<td>Holtslag et al. (1990): A high-resolution air-mass transformation model for short-range weather forecasting.</td>
</tr>
<tr>
<td>50</td>
<td>723</td>
<td>Gregory and Rowntree (1990): A mass flux convection scheme with representation of cloud ensemble characteristics and stability-dependent closure.</td>
</tr>
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</table>
More importantly, the discussion fueled research interest in extratropical cyclones, their rapid development, and their associated precipitation. As a result, another outgrowth of this early research on extratropical cyclones was investment from the National Science Foundation and the Office of Naval Research in understanding the causes of these bombs, leading to field programs with such acronyms as GALE, ERICA, and OCEAN STORMS, as well as further study on the synoptic and mesoscale meteorology of extratropical cyclones. This research persisted as a hot topic for the next few decades. Bosart continued, “The Presidents’ Day storm and Sanders and Gyakum (1980) opened all sorts of research and educational doors, jump-started funding for cyclone-related research, and resulted in the creation of the Cyclone Workshop… a true research progress trifecta.” J. Gyakum (2021, personal communication) wrote:

The fact that [Sanders and Gyakum (1980)] continues to receive attention in the refereed literature is likely related to the fact that there is a huge range of processes that produce these bombs. Though several of these processes are well understood, others are not so. Perhaps what is not so well understood is how these processes interact to produce such rapid intensifications.

In this way, research published in Monthly Weather Review helped to define a discipline, to motivate the need to mobilize resources for research, to promote new research methods, and to serve as the venue for scientific debates on the outcomes.
5) CONCEPTUAL AND TECHNOLOGICAL BREAKTHROUGHS IN TROPICAL CYCLONE RESEARCH

Of all the tropical cyclone research published in *Monthly Weather Review*’s 150-yr history, two items deserve special mention as conceptual or technological breakthroughs. The first was Hubert and Berg (1955), who took the first photographs of a tropical cyclone from space using a rocket-borne motion picture camera, realizing the proposal by Wexler (1954). Their paper preceded the first tropical cyclone photos from TIROS 1 by five years (Fritz and Wexler 1960). The second was Simpson and Wiggert (1969), who constructed the first numerical model of a cumulus cloud and used it to explore the effect of cloud seeding by silver iodide and compare the results to Project Stormfury cloud-seeding experiments.

6) TETSUYA FUJITA AND THE BIRTH OF MESOCONVective-Scale METEOROLOGY

Tetsuya (Ted) Fujita published much of his research in the gray literature, bypassing traditional academic channels; he only published seven articles in *Monthly Weather Review*. However, those articles were important for having examined the formation and evolution of hook echoes (Fujita 1965), analyzed the 1965 Palm Sunday tornado outbreak (Fujita et al. 1970), classified different types of downbursts (Fujita and Wakimoto 1981), and performed a mesoconvective-scale analysis on a high-altitude tornado in the Teton Wilderness and Yellowstone National Park (Fujita 1989).

f. The value of data and articles in old and recent scientific studies

The value of publishing the *Monthly Weather Review* data became apparent beyond the realm of meteorology soon after the journal’s inception. For example, some of the earliest issues from December 1872 to November 1873 were provided to the U.S. Surgeon General’s Office for use in compiling a report on the cholera epidemic of 1873 (Woodworth 1875). Outbreaks of cholera in the 1870s killed more than 50 000 Americans and millions around the world, so any information
Fig. 17. Plate III from Bentley (1902) of snow crystals collected and photographed on 31 Jan, 5 Feb, and 15 Feb 1901 (Bentley 1902, p. 609), just one of 22 plates in that article.
that could be ascertained to limit its spread was deemed useful.

In another example, Wilbur Wright wrote to the Weather Bureau on 27 November 1899, asking for information about winds in the Chicago area for possible flying experiments he was planning to conduct with his brother Orville. Weather Bureau Chief Willis Moore responded on 4 December by sending the August and September 1899 issues of *Monthly Weather Review*, which included average hourly wind speeds at various stations. These *Monthly Weather Review* tables first informed the Wright brothers of Kitty Hawk, North Carolina, and led to them choosing it as the location for their flying experiments (Kirk 1995; Potter 2020, p. 229). Those two issues of *Monthly Weather Review* can be found in the Orville and Wilbur Wright Collection (No. 931), J. Y. Joyner Library, East Carolina University (https://digital.lib.ecu.edu/special/ead/findingaids/0931).

Investigations using these early articles and other content have been useful in a variety of other contexts, as well. For example, Grazulis (1991) used events published in various lists and articles in *Monthly Weather Review* to help build his database of significant tornadoes (e.g., tornadoes F2 or greater in intensity or those causing fatalities), sometimes using the data on the number of fatalities provided from specific events.

Old datasets published in *Monthly Weather Review* have also been used to understand past climates. Professor Stefan Brönnimann, ETH Zurich, used past issues of *Monthly Weather Review* as one dataset to digitize monthly mean upper-air data, allowing him and his collaborators to reconstruct global upper-air fields (e.g., Stickler et al. 2010; Hersbach et al. 2017). This dataset was important for their work on the 1940–42 El Niño–Southern Oscillation (Brönnimann et al. 2004). The dataset now resides online as part of a global collection of early upper-air datasets (https://www.oeschger.unibe.ch/research/projects_and_databases/comprehensive_historical_upper_air_network_chuan/index_eng.html).

In another example, Professor Cynthia Dott, Fort Lewis College, was studying floodplain vegetation dynamics on western U.S. rivers in response to floods, dam-building, and changes in sediment regime (Dott and Gianniny 2021). She was trying to understand the history of vegetation change along the San Juan River in southeastern Utah. She explains:

One of the biggest known flood events on the San Juan River and its tributaries occurred in early October of 1911, and since there were few stream gages in place at that time it is really beneficial to read descriptions of that flooding event as reported in the October 1911 MWR for District 9, “Colorado Valley.” As part of my effort to piece together the stages of vegetation change on the lower San Juan River, I’ve turned to a variety of historical sources to help reconstruct the history of major floods. These include the Monthly Weather Review, US Geological Survey Water Supply Papers, and USGS Professional Papers among others. Thanks for keeping these vital historical documents available and accessible to researchers from a diversity of fields of study! Knowledge of past weather and climatic conditions will always be crucial to our understanding of modern weather events and our changing climate (C. E. Dott 2021, personal communication).

In yet another example, when Professor Lourdes Avilés, Plymouth State University, was doing her research on the 1938 hurricane (Avilés 2013, p. 92), she wanted to know if Pierce’s (1939) *Monthly Weather Review* article on the hurricane was the first to identify extratropical transition of hurricanes. As she wrote, “The language in that article was the language of somebody describing something that they are observing for the first time and that they are surprised to see in their observations” (L. B. Avilés 2021, personal communication). Avilés (2013, 90–91) wrote:

A review of much of the tropical cyclone related literature (mostly from the *Monthly Weather Review* journal publications and supplements and from special Weather Bureau bulletins) from the late 1800s to the time of the hurricane, did not reveal evidence of any other article describing this transition, except for a brief opinion mentioned in a review note concerning typhoon tracks.

As an aside, Pierce (1939) was likely without precedent in *Monthly Weather Review* history at the time it was published. “All descriptions and accounts of previous hurricanes consisted mostly of describing observations and effects of the different storms,” writes Avilés (2013, p. 91). Instead, Pierce’s (1939) 53-page case study was the most detailed case study of a hurricane that had been presented to date, and possibly before the modern era of more lengthy scientific articles. Of those 53 pages, only 5 consisted of text, making it a figure-heavy article. The article is a beautiful and exemplary early analysis in the style of modern case studies: airmass and frontal analysis, interpretation of the weather from single-site observations, and following a “forecast-funnel” approach similar to that later described by Snellman (1982).

One aspect of early issues of *Monthly Weather Review* was the reporting on weather and news from other weather services or meteorological organizations around the world. These articles were in the form of news items, reprinted articles, or excerpts from other publications, such as *The Meteorological Magazine* (U.K.), *Comptes Rendus* (France), or *Meteorologische Zeitschrift* (Germany). One such contribution, “Monthly review of the progress of climatology throughout the world,” ran during May–August 1906 and summarized climatological studies from other parts of the world. Other articles were obituaries, promotions, reorganizations of meteorological societies or agencies, new publications, conferences and other meetings, for example. Indeed, a rich archive of information for historians to use about developments in other countries exists within old issues of *Monthly Weather Review*.

On a more personal note, we authors are frequently surprised while perusing articles in older issues of *Monthly Weather Review* about how much information was collected and known about the weather, even during the late
nineteenth and early twentieth centuries. How often we have come across articles related to present research topics of interest with anecdotes or case studies that we had not heard of before, even as we believe that we are experts in a given topic and have read all the available literature! Indeed, a common complaint today is that there is too much scientific literature, making it difficult to stay abreast of the latest research. To borrow a line by William Shakespeare from his play *The Tempest* (which, appropriately, includes a weather theme), “What’s past is prologue.” Just as yesterday’s forecasts set the stage for the current conditions of tomorrow, there is much still to be learned today from the years of past articles in *Monthly Weather Review* waiting to be revisited in a modern context.

6. What contributes to a journal’s longevity?

Through changes in publishing authorities—from military to civilian government to a professional/scientific society—and advancements in the foundation of meteorological science, *Monthly Weather Review* has remained vital and valuable. The ability of a journal and its leadership to adjust to the following changes over 150 years is astounding:

- a field that was based exclusively on surface observations and associated climatology in the late nineteenth century, to
- a field that began to investigate the theory of atmospheric motions (geostrophic, thermal wind laws, dynamics of Earth’s rotation on its axis) in the late nineteenth century, to
- the development of models of extratropical cyclones and the general circulation through the theoretical and observational work of Vilhelm and Jacob Bjerknes and the Bergen School of Meteorology in the early twentieth century, to
- the use of upper-air observations the early twentieth century that coupled the surface features of weather to the upper air, and
- followed by the great adjustment that came with the computer and numerical experiments and operational numerical weather forecasting in the 1950s, to
- global observations of the weather on Earth from satellites starting in the 1960s, to
- general circulation models in the 1970s, which has led to complex models of the atmosphere–ocean system that now play a role in predicting climate change.

*Monthly Weather Review* has exhibited an impressive robustness to adjust to these major changes in our science, but it is not the only long-lived meteorological journal, nor is it the longest-lived scientific journal in existence. What makes a long-lived meteorological journal? A comparison with others may reveal the answer to *Monthly Weather Review*’s longevity.

As Emeis (2008) described, until the mid- to late 1800s, meteorology was not considered a separate scientific discipline worthy of its own journals. Instead, research on meteorology was often published in physics or general science journals. With the founding of scientific societies and specialized journals dedicated to meteorology during this period, its recognition as a discipline grew. Thus, many existing meteorological journals trace their roots back to this time.

One example is *Quarterly Journal of the Royal Meteorological Society*, which publishes its 148th volume in 2022. The Royal Meteorological Society was founded in 1850 and had two precursor journals, which published scientific articles: *Annual Reports of the British Meteorological Society* (1851–60) and *Proceedings of the Meteorological Society* (1860–71) (Corless 1950). The first issue of *Quarterly Journal of the Meteorological Society* was published in 1873 (likely based on a paper read to the Society on 15 November 1871), although it wasn’t until Volume 3 in 1877 when volumes became numbered yearly. Early issues also contained Society business such as donations, election results, recent meteorological publications around the world, and proceedings of the Society’s meetings. The term *Royal* was added in 1884, when the privilege was granted by Queen Victoria. During 1926–39, the society briefly published a spin-off journal, *Memoirs of the Royal Meteorological Society*, which published more technical papers. The journal was published independently by the Society until 2007 when Wiley took over the publication process.

*Meteorologische Zeitschrift* has been another long-lasting journal, and its history has been described in Emeis (2008), Emeis et al. (2012), and Pichler et al. (2021). Its first issue was published in 1884 by the Deutsche Meteorologische Gesellschaft (German Meteorological Society). In 1886, it merged with the Austrian journal *Zeitschrift der Österreichischen Gesellschaft für Meteorologie*. After World War II, *Meteorologische Zeitschrift* ceased to exist, with separate journals *Zeitschrift für Meteorologie* published in East Germany and *Meteorologische Rundschau* published in West Germany. Following the reunification of Germany in 1990, *Meteorologische Zeitschrift* was reborn in 1992, supported by the national meteorological societies of Austria, Germany, and Switzerland, and in 2000 it absorbed *Contributions to Atmospheric Physics* (formerly Beiträge zur Physik der freien Atmosphäre, or *Contributions to the Physics of the Free Atmosphere*).

These two examples allow a comparison with *Monthly Weather Review*:

- All three meteorology journals have ebbed and flowed with the various trends in meteorological research, maintaining their vitality in that regard.
- *Monthly Weather Review* has had a number of different formats with the relative amount of data versus scientific content varying substantially, depending on the era. In contrast, *Quarterly Journal of the Royal Meteorological Society* and *Meteorologische Zeitschrift* were primarily scientific journals throughout their histories.
- Although *Quarterly Journal of the Royal Meteorological Society* has been continuously published by the same organization, *Monthly Weather Review* has had three different publishers.
- Whereas parts of *Monthly Weather Review* kept being spun off to other governmental publications from time to time, *Meteorologische Zeitschrift* was typically merging with other journals.
The failure of the short-lived American Meteorological Journal (1884–96) due to financial troubles (discussed in section 3) may reflect the lack of a strong sponsoring organization committed to the publication of the journals, a problem that the other three journals did not have.

Thus, the success of Monthly Weather Review, as well as these two other long-lived meteorological journals, comes down to a strong publisher committed to the success of the journal, the ability to adapt to changes in format and the evolution of meteorological research over many decades, and the ability to stay financially afloat.

7. Conclusions

The 150-yr history of Monthly Weather Review is reflected within its pages, and it is one molded by many factors.

As trends in the science and operations of meteorology wax and wane, Monthly Weather Review has evolved with those trends, from climate data, to frontal analyses, to numerical weather prediction, to satellites, to coupled models, to mesoscale convective systems and radar, to data assimilation, and to machine learning. Its pages reflect those trends.

Government and politics led to the creation of Monthly Weather Review, and the journal’s style and content throughout the years reflects those forces, whether it was the makeup of the editorial board and who was in charge, whether it was the tension between being a climatological publication or being a scientific journal, or whether it should even be a governmental publication.

As the landscape of scientific publishing has changed, so too has Monthly Weather Review. Most recently, this was reflected in the transition away from print to electronic publication. However, changes have also been imposed upon the journal from the very earliest years to the present, due to external forces, such as the costs of paper and mailing, the costs of a large number of complimentary subscriptions, and the costs of the entire publishing enterprise being borne through subscription prices and eventually page charges.

From Monthly Weather Review’s earliest years, it was the salaried editors and their staffs who collected the weather and climate data, solicited articles, wrote content, and assembled the issues. Their roles have changed over time, but the now-volunteer chief editors, editors, and associate editors still curate content and oversee the peer-review process, as well as solicit articles from colleagues doing excellent and relevant research worth publishing.

Finally, as a scientific journal, we are shaped by our authors and readers. We can only publish what you submit and what you want to read. Moreover, authors and readers also serve as our peer reviewers. It takes four years of volunteer time donated by peer reviewers to produce one year of issues for Monthly Weather Review (Golden and Schultz 2012). The success of Monthly Weather Review would not have happened without all of you. Each time you submit a new manuscript, agree to perform a review, or check out the latest digital or physical issue, you register your support to keep this 150-yr journey alive.

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Data availability statement. Historical files related to Monthly Weather Review and the datasets used to create the graphics in this article are available at Schultz and Potter (2021).

APPENDIX

Was the First Issue July 1872 or January 1873?

Over the years, there has been some confusion as to when the first issue of Monthly Weather Review was published. Some of this confusion appears to stem from Henry (1929)—noted throughout this Historical Review as a source of much misinformation about the early history of
the journal—who cites October 1872 as the first issue. In fact, the first 1872 issue was prepared for July of that year, not October. In this appendix, we lay out the evidence that the first issue was produced in January 1873, with the July—December 1872 issues produced later.

Abbe (1895) noted that “corresponding reviews for the latter half of 1872 were subsequently written out by Mr. [Henry] Calver for publication in the annual report of the fiscal year 1872/73. From that time forward until 1883, inclusive, the monthly reviews were annually reprinted as appendixes of the Annual Report of the Chief Signal Officer.” General William B. Hazen, who succeeded Myer as Chief Signal Officer in 1880, provided a similar statement several years later, as part of his written testimony submitted to the Allison Commission (1886), a joint congressional commission convened to consider the organization of several scientific agencies and bureaus in the U.S. government, including the Signal Service:

Accordingly the Monthly Weather Review, which had been first compiled by Professor Abbe, for January 1873 (although reviews for earlier months were subsequently made up in order to complete the series), was now by him enlarged to a comprehensive systematic summary of all the reports received by the office for the month of April 1874, accompanied by the proper charts.

A note published in the April 1901 issue (MWR 1901) further clarified confusion surrounding the first number of the journal:

Some bibliographers may have noticed in the list of Weather Bureau publications a statement to the effect that MONTHLY WEATHER REVIEWS have been published since July 1872. The more precise statement is that the publication began with the REVIEW for 1873, since which time it has appeared regularly and been very widely distributed. The first copy and the initial steps toward the regular publication were taken by the present Editor [Abbe], but subsequent numbers were prepared by various officials, alternately.

In describing the history of the Signal Service’s meteorological activities, Goode (1890, p. 99) wrote that in 1873, “was begun the publication of a monthly Weather Review, summarizing in a popular way all its data showing the result of its investigations, as well as presenting these in graphic weather charts.”

The preparation of the 1872 issues deserves mention. Grice (1991) included a personal account of Sergeant Henry Calver, a clerk at the Signal Office in Washington responsible for compiling the Weekly Weather Chronicle publication, in which he recalls assisting Professor Thompson B. Maury, another civilian assistant to the chief signal officer, in the preparation of monthly summaries. Henry (1929) mentioned the Maury–Calver collaboration, but incorrectly assumed that “doubtless the idea of a monthly review grew out of Calver’s weekly report.” The note on the journal’s history published in the April 1901 issue (MWR 1901) described how Calver prepared the Monthly Weather Review for the months July to December 1872 retrospectively, with those for October, November, and December completed in time to be included as an appendix to the 1873 Annual Report of the Chief Signal Officer. Those for July, August, and September 1872 remained unpublished until 1888 (a fact neglected by Henry (1929), who mistakenly cites October 1872 as the issue with the earliest date).

Further evidence comes from Bigelow (1900, p. 86), who wrote:

Another important method of instructing the public in the science of meteorology has been the regular publication of the Monthly Weather Review, first issued for January 1873, which was extended backward to July 1872, and reprinted in the annual volume. For the next ten years these Reviews were reprinted in the Annual Report itself, but since 1884 they have appeared as a separate publication only.

Subsequent editors and assistant editors of Monthly Weather Review, including Hunter (1923) and Corzine (1972), as well as meteorological historians Weber (1922), Whittnah (1961), and Fleming (2000), have also referred to the January 1873 issue of Monthly Weather Review as the first. This result would be consistent with the numbering scheme introduced by the Signal Service at volume 11 in February 1883, indicating that chronologically the January 1873 issue was the first issue produced.

Another indication that 1873 was the year Monthly Weather Review was first published, and not 1872, is the fact that no mention of the journal appears to exist in newspapers or other scientific journals prior to February 1873, whose issue was reprinted by The Chicago Daily Tribune (section 2). At a time when the Signal Service’s activities were heavily scrutinized within the larger scientific community, as well as by the general public and the popular media, it is difficult to imagine that newspapers such as The Chicago Daily Tribune would wait to report on or reprint a new publication such as Monthly Weather Review, rather than doing so shortly after its initial publication. Thus, no mention of Monthly Weather Review in the press in 1872 seems to suggest that issues of the journal for that year were produced after the fact. In contrast, mention or reprinting of the Weekly Weather Chronicle (Heddinghaus and Le Comte 1992) appeared in several newspapers across the country, including The Chicago Daily Tribune, throughout the latter part of 1872.

Thus, as MWR (1901) concludes, “It is, therefore, proper to say that the regular publication of the MONTHLY WEATHER REVIEW began with the number for January, 1873, and that the earlier numbers were written up and printed subsequently.”

REFERENCES


Kellogg, W. W., 1973: President


