

THE QUESTION OF CLIMATIC STABILITY IN AMERICA BEFORE 1900

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Abstract. Belief that regional climates had significantly changed in historic times, possibly as a result of human activities, is firmly established in the Western tradition. Europe itself was believed to have undergone such changes, especially a warming trend, since ancient times. It was also widely believed that the European colonization of North America would duplicate many of the changes that had occurred in Europe, including the climatic changes that were supposed to have taken place. In the New World, it was at first believed that climatic change was occurring, as a result of human settlement and land use changes, but these views gave way to the idea of climatic stability. The first extensive compilations of reliable North American precipitation and temperature data in the latter part of the nineteenth century seemed to support the notion of stable climates. Ideas relating to macroclimatic change and stability that were entertained in America before 1900, mainly between 1770 and 1870, are examined.

The idea that regional climates had substantially changed in historic times, possibly as a result of man's activities, is an antique notion in the Western tradition. Such ideas had widespread currency in late medieval and early modern times. Europe was believed to have undergone such climatic changes, specifically a warming trend since ancient times. Many observers believed that the United States in its early years would provide a model of climatic change that was somehow related to the spread of human settlement. Such views gained wide credence in America. However, about the middle of the nineteenth century the view increasingly prevailed that the climate was completely stable and had long been so. In the later twentieth century the idea of climatic stability has been entirely rejected and much interest centers around the matter of reconstruction of past climates and predicting future trends. This paper examines the ideas relating to macroclimatic change and stability that were entertained in America before 1900, mainly between 1770 and 1870.

Speculation on the subject of climate change in the Western world goes back at least to Classical times. Theophrastus (c. 272-c. 287 B.C.)¹, Pliny the Elder (23-79 A.D.)², and Columella (fl. 1st. cent. A.D.)³, for example, all made reference to the subject of climatic change. Climatic changes were usually seen as part of a widespread warming trend commonly related to land use, especially the clearing of extensive forests. Among the more important early writers who addressed the subject of climate change were St. Albertus Magnus, the thirteenth century scholastic philosopher, John Evelyn (1620-1706), the English diarist and writer on forestry and other topics, the Abbé Jean-Baptiste Dubos (1670-1742), the historian, the Comte de Buffon (1707-88), the naturalist, David Hume

(1711-76), the philosopher and historian, and Edward Gibbon (1737-94), the historian.⁴

Quite possibly the first reference to a supposed change in the climate of the New World is contained in one of the earliest accounts of the infant American colonies of England. This work, entitled *New Englands Prospect* and published in 1634, was by William Wood (fl. 1629-35), and was based on nearly four years first-hand observations. Wood described the climate of New England as being generally suitable for the English and suggested that in the short time since colonization began the precipitation regime had changed significantly. Thus:

In former times the Raine came seldome, but very violently, continuing his drops, (which were great and many) sometimes foure and twenty houres together; sometimes eight and fourty, which watered the ground for a long time after; but of late the Seasons be much altered, the raine comming oftner, but more moderately, with less thunder and lightnings, and suddane gusts of winde.⁵

According to this account the climate was moderating, at least in the important area of rain and thunderstorms.

While the preceding statement was doubtless little more than a casually taken impression, the narrative of another European early visitor to the New World clearly suggests an awareness of the matter of climate change. This visitor was Peter Kalm (1716-79), a Swedish botanist and agriculturalist, and his diary written in 1749 recorded his questioning the old inhabitants of New Jersey as to whether or not they had experienced a change of climate during their residence in the colony. Kalm reported that his elderly informants had "all unanimously" stated that in former times the winters had begun earlier, and produced more snow, than at the time of questioning. Most of Kalm's aged informants were also of the opinion that springtime weather had formerly come later and that it was rainier in past times than at present. All of this writer's sources agreed that "the weather was not by far so inconstant, when they were young, as it is now."⁶

Kalm also visited Canada and noted that similar perceptions were prevalent among the old people of Quebec. The Swedish scientist reported that according to the recollections of the "old folk of this country" the "corn" grown there formerly ripened imperfectly and late. However, "since the woods have been sufficiently cleared, the beams of sun have more room to operate, and the corn ripens sooner than before."⁷

The question of climate change in the American colonies was first systematically examined by a man of science in a paper read before the American Philosophical Society, in Philadelphia, in 1770, by Hugh Williamson (1735-1819).⁸ There is no evidence to connect Kalm's earlier remarks on this subject with the Williamson paper, although such a connection is possible since Kalm published three volumes of his American diaries in Swedish in 1753, 1756, and 1761. The books quickly became popular in Europe, and German and French translations appeared soon after the Swedish edition. An English translation of Kalm's narrative appeared in two volumes, in 1770 and 1771.⁹

Williamson was a medical doctor, as were many pioneer climatologists (especially in America), and his short paper was entitled "An attempt to account for the Change of Climate, which has been observed in the Middle Colonies in North-America." It began with the declaration that persons of long residence in Pennsylvania and nearby have

“generally remarked. . . that within the last forty or fifty years there has been a very observable Change of Climate, that our winters are not so intensely cold, nor our summers so disagreeably warm as they have been.” Williamson attributed this climatic amelioration to forest clearing and cultivation which had affected winds and solar heating.¹⁰ Significantly perhaps, this writer echoed the European theme of climatic improvement and reported that Italy’s climate had been more temperate since Classical times as a result of deforestation both north and south of the Alps. Williamson’s little paper attracted widespread attention, influencing both the naturalist Comte de Buffon and the philosopher Johann Gottfried von Herder (1744-1803). It was translated into French in 1773.¹¹

Thomas Jefferson (1743-1826) summarized some of his views on the topic in *Notes on Virginia* which was first privately printed in Paris in 1784, and dated 1782. In this work, Jefferson described, among other things, the climate of Virginia, partly on the basis of five years of personal weather observations (from 1772 to 1777) made in or near Williamsburg, Virginia. After characterizing the main features of the Virginia climate, including its relationships with the vegetation, Jefferson declared that:

A change in our climate, however, is taking place very sensibly. Both heats and cold are become much more moderate within the memory even of the middle-aged. Snows are less frequent and less deep. They do not often lie, below the mountains, more than one, two, or three days, and very rarely a week. They are remembered to have been formerly frequent, deep, and of long continuance.¹²

Jefferson also averred that formerly, the rivers froze most winters, but recently this seldom happened. In addition, according to Thomas Jefferson, former persistent snows were reduced. These snows had produced severe late winter cold that “kept the buds locked (up)” on fruit trees until danger of frost was over, but diminution of winter snow had caused an “unfortunate fluctuation between heat and cold” in spring that had been destructive to fruit crops. Thus, somewhat paradoxically, crop failure in frost sensitive fruit crops was attributed to a warming climatic trend.¹³

Benjamin Rush (1745?-1813), the celebrated physician, also subscribed to the view that the climate of this country was changing. In an essay on the climate of Pennsylvania published in 1789, Dr. Rush noted:

From the accounts, which have been handed down to us by our ancestors, there is reason to believe, that the climate of Pennsylvania has undergone a material change. Thunder and lightning are less frequent: the cold of our winters, and the heat of our summers, are less uniform, than they were forty or fifty years ago.¹⁴

Another early American proponent of the view that the climate of the colonized sections of the New World was changing was Samuel Williams (1743-1817), author of *The Natural and Civil History of Vermont*, published in 1794.¹⁵ Williams was a Harvard professor with interests in astronomy, meteorology, and history.¹⁶ In his book he claimed that Vermont, and North America generally, had experienced a significant change of climate since European colonization had begun. According to this author, the climate was becoming both milder and more inconstant in temperature, changes which he considered

were “a matter of constant observation and experience.” Further, it was claimed that these climate changes had not occurred gradually, so “as to be a matter of doubt”, but rather were “so rapid and constant, that it is the subject of common observation and experience.” These significant and relatively rapid climate changes, Williams noted, had “been observed in every part of the United States.”¹⁷

While Williams apparently based his convictions on the subject of climate change largely on impressionistic evidence, he was in possession of some climate data going back over 50 years, and had personally conducted meteorological observations at Rutland, Vermont, in the period 1789-91. Williams was convinced that the amelioration of climate that he reported for Vermont (the subject of his book), and the United States generally, was characteristic of all “new” countries. Without going into detail, this author pointed out that even more marked climate changes had occurred in Europe according to the “universal opinion of historians and philosophers.”¹⁸ However, Williams considered the explanations available for climatic change – forest clearing, cultivation, and settlement – inadequate, and he expressed doubt that these human activities were sufficient to account entirely for the change supposed to have taken place.¹⁹

Shortly after Williams stated his own views, and what he claimed was the consensus of Americans on the subject of climate change, similar opinions were being collected somewhat to the north, in Canada. Echoing Samuel Williams’ belief in a climatic warming trend, the French Duc de la Rochefoucault Liancourt (1747-1827) reported from his 1795 visit to Lower Canada (Quebec) that “The heat in summer, it has been observed, becomes more intense and continues longer, and in winter the cold grows more moderate than formerly.”²⁰

Another clear echo of Williams’ ideas came from the widely traveled author Gilbert Imlay (c. 1754-1828?), who had had considerable experience as a surveyor, and published a *Topographical Description of the Western Territory of North America* in 1797 that included observations on climate. Imlay reported that “It is well known that the climate upon the Atlantic coast of America is in the extreme of heat and cold, and that it is more variable than when it was first settled by Europeans; but the winters are milder.” Imlay went on to explain the fluctuations in temperature as attributable to cold air being drawn from the continental interior by the action of the “rarefied air of the torrid zone.” The growing mildness of the winters was attributed to deforestation causing greater warming by the sun.²¹

While there was much agreement that the American climate was changing, there were differences regarding the degree and even direction of change. Most commentators believed that temperatures were moderating, but some thought the opposite. Thus, William Dunbar (1749-1810), who lived on a cotton plantation near Natchez, Mississippi, in a paper read before the American Philosophical Society in 1801, reported that “It is with us a general remark, that of late years the summers have become hotter and the winters colder than formerly.”²² Dunbar, who performed astronomical and other scientific investigations, was a serious student of the environment and his remarks represented a considered position. This same writer was aware of Williamson’s essay, but turned the earlier writer’s arguments around and suggested that limited forest clearing might permit of greater

heating in summer and “free circulation of cold northern air” leading to cooler winters.²³

Strong support for the climate-is-changing belief was furnished by C. F. Volney (Constantin-François Chasseboeuf, Comte de Volney, 1757-1820) a French aristocrat and voluminous writer on geography, philosophy, linguistics, and history, Volney began a three-year visit to America in 1795 and wrote a book entitled *Tableau du climat et sol des États Unis*, published in Paris in 1803. This book appeared in America the next year in English translation under the title of *A View of the Soil and Climate of the United States of America*.²⁴ Volney’s book was based on extensive observation and research, and the author was accepted into American scientific circles (he was elected to membership in the American Philosophical Society in 1797). Volney was in correspondence with Thomas Jefferson. The book by Volney was early acknowledged to have high scientific merit and was widely quoted. It is noteworthy as the first volume to deal extensively with the climatology of the United States.

Volney’s investigations of the American climate revealed to him that “An opinion. . . of late years, gained ground in the United States, that partial changes have taken place in the climate of the country, which have shown themselves in proportion as the land has been cleared.”²⁵ This writer not only cites the authorities for this position, including Samuel Williams and Thomas Jefferson, but offers his own findings in support of the climate-change viewpoint. Thus Volney noted that “I have collected similar testimonies, in the whole course of my journies (sic). . . every where the same changes have been mentioned and insisted on. Longer summers, later autumns, shorter winters, lighter and less lasting snows, and colds less violent, were talked of by every body.” Further, this author noted that the changes of climate “have been always described, in the newly settled districts, not as gradual and slow, but as quick and sudden, in proportion to the extent of cultivation.”²⁶

Volney appears to have concurred in these widely-held views that temperatures were moderating in the eastern United States, although he differed from many members of the climate-change school by denying that the severity of the winter cold was diminishing. Volney maintained that:

What appears to be demonstrated, on this head, is, that winter is shorter, the summer longer, and the autumn later, than they formerly were, but that the cold, as the last ten years sufficiently evince, is as violent as ever.²⁷

The temperature and precipitation changes were attributed by Volney to forest clearing. The process was explained thus:

This extensive change of climate must, therefore, be ascribed to two causes. First, to the clearing of the grounds, and thus producing a mass of warm air, which is constantly increasing. Secondly, to the access of warm winds, through these openings, by which the country is dried more rapidly, and the atmosphere more heated.²⁸

Such a sequence was envisaged by Volney as having previously occurred in other continents in earlier times. Although introducing no evidence in support of these past global climatic

changes, Volney clearly held the opinion as an article of faith since “everywhere in the old world, history represents the climate of all countries as colder formerly than at present.”²⁹

Although the Comte de Volney reported finding no opposition to the idea of an ameliorating climate, either among the common folk or the savants, one notable voice of dissent was raised. This was Noah Webster (1758-1843), the lexicographer and writer on scientific and historical subjects. Webster began a paper read before the Connecticut Academy of Arts and Sciences in 1799 with the declaration “It is a popular opinion that the temperature of the winter season, in northern latitudes, has suffered a material change, and become warmer in modern, than it was in ancient times.” Webster noted how this opinion was held “by many writers of reputation; as the Abbé du Bos, Buffon, Hume, Gibbon, Jefferson, Holyoke, Williams; indeed I know not whether any person, in this age, has ever questioned the fact.”³⁰

However, Noah Webster questioned the fact and posed his questions in the form of a lengthy essay, originally read in 1799 and supplemented with further remarks in 1806. Webster carefully and logically demolished the flimsy arguments advanced to support the idea of climatic change in historic times. Webster’s reasoned arguments and review of evidence ranged through a wide array of sources, starting with the Bible and the Classics, and including contemporary writers. Most of the original paper, and the supplementary remarks, are concerned with Old World sources and examples. Samuel Williams and Thomas Jefferson are the two Americans whose work is examined in detail. Webster not only questions the facts adduced by Williams in support of his climate-change thesis, but also attacks his reasoning and takes him to task for generalizing from insufficient examples. Jefferson comes off no better and is chided for lack of good evidence to support his views as well as placing reliance on what Webster scornfully refers to as “the observations of elderly and middle aged people.”³¹

Webster’s two papers are a *tour de force*, marshalling a wide spectrum of material, and arguing convincingly that the case for a significant macroscale climate change in historic times is not supported by evidence customarily adduced. Webster did, however, acknowledge that microclimate changes had probably occurred as a result of the conversion of forests to fields. Such changes involved diminished duration of snow cover, greater windiness, and greater temperature fluctuations leading to more severe and variable winter conditions.³² Despite these man-induced climate changes, Webster averred that, on balance, regional climates have been essentially stable, and the 1806 paper closed with the declaration that there has not occurred “in modern times, an actual diminution of the aggregate amount of cold in winter, on either continent.”³³

Despite the force and erudition of Noah Webster’s arguments, belief in the notion of climatic mutability continued unabated in many quarters. Perhaps this is hardly surprising given the persistence of established belief, as well as the relatively limited circulation of Webster’s remarks. Quite possibly chauvinistic feelings in the new nation may have reinforced popular belief that the American climate was not only good but getting better. There is evidence to suggest that in early America an exaggeratedly prideful view was taken of the climate. For example, the English traveler Thomas Hamilton (1789-1842),

remarked in 1833 that "on the subject of climate. . . there is no topic on which Americans are more jealously sensitive. It delights them to believe that theirs is in all respects a favoured land."³⁴

While Webster was able to attack the position of the climate-amelioration proponents by a logical and interpretative examination of the evidence, final resolution of the argument required adequate data. Various climatic elements were supposed to be involved in the change of climate, of which temperature was generally conceived to be the most important. Temperature measurement became possible with the invention of the thermometer, the first reliable instruments not subject to rather rapid deterioration being those made by Fahrenheit. The thermometer was probably first brought to the Americas in the late 1730's.³⁵ It soon became popular to perform "thermometric observations" and such measurements were widely conducted by amateur and professional scientists.³⁶ At first, however, the temperature measurements tended to be carried out unsystematically and over short periods, and yielded data of only limited, or even confusing, climatological value.

The earliest lengthy and reasonably standardized set of temperature records was collected at Salem, Massachusetts, by a physician named Edward A. Holyoke (1728-1829) and covered the period 1786 to 1829. The data were assembled in stages, the first seven years in 1793, the next 26 years, in 1818, and the full 36 years in 1833.³⁷ Although flawed in various ways (for example, no observations were made at the coldest period of the day) the "meteorological journal" of Dr Holyoke represents the earliest substantial American attempt to compile temperature records. Compiling the record was one thing; interpreting was another. Holyoke seems to have approached the subject with his conclusions already drawn; he had early in his career attributed what he considered to be the coldness of America (compared with Europe) to the abundance of forest in the New World. Holyoke himself believed that his journal showed that the climate of Massachusetts (and, by extension, the United States in general) was moderating in terms of temperature.³⁸

Acknowledging the importance of the much cited Holyoke journal, and the subject itself, Enoch Hale (1790-1848), on behalf of the American Academy of Arts and Sciences, analyzed the entire data series and published all the raw data in 1833. As Hale wistfully noted "If this opinion (*that climate was changing as a result of land use changes*) be well founded it may be expected that some decisive evidence of it will be furnished by a journal kept with so much care, in the same situation, and by the same individual, for nearly 40 years, of a period when these changes in the face and condition of the country have been extensively made."³⁹

Hale, the interpreter and compiler of Holyoke's data, was clearly disposed in favor of the idea of climate change and expressed the belief that deforestation, drainage, and cultivation significantly affected temperature and precipitation.⁴⁰ However, despite the fact that both Holyoke and Hale espoused the climate change thesis, the journal provided only inconclusive support for the view that the American climate was moderating in temperature. A slight tendency in this direction is suggested by the early years, but is not sustained in the later ones. Another of Holyoke's beliefs, and shared by many others, was

that a diminution of the severity and frequency of storms was part of the ameliorating climatic trend. Again, Hale's scrutiny of the journal (which also contained information on storms) revealed even less to support the idea that this aspect of climate was changing.

Holyoke nevertheless continued to be cited in support of the idea of climate change, even though his own data were problematical in their interpretation and provided weak support for the proposition. However, Holyoke's journal did represent a first step toward the collection of long term weather records.

More extensive and systematic compilations of weather records were begun in 1819 by the United States Army Medical Corps at various military posts. These Army Medical Corps data provided the basis of a book published in 1842, *The Climate of the United States and its Endemic Influences*, by a medical doctor named Samuel Forry (1811-44)⁴¹. As the title suggests, the book gave much attention to the supposed relationships between local climates and disease – a common pre-germ theory focus of interest – but it also addressed the matter of climate change in the light of the Army data. Forry asked the question “Does the climate of a locality, in a series of years, undergo any permanent changes?” In the same vein, this writer also wondered if the climate of the “north-western frontier resembled that of the Eastern States on their first settlement?”⁴²

In attempting to find answers to these questions, Forry followed first the path taken by Noah Webster, tracing the climate change idea back to its European origins and weighing the evidence from Classical and other sources that Webster had earlier discounted. Like Webster, Forry concluded that these historical records did not support the idea of a major climate change in Europe over the past two millenia, either on evidentiary or theoretical grounds.

However, Europe was not Forry's main interest, he was more concerned with the New World climate changes that “also are alleged to have supervened.”⁴³ In the consideration of this question, Forry had the advantage of having at his disposal an expanding store of Army weather records. His study was thus actual climatic data, with no recourse to impressionistic evidence such as the recollections of long-time residents. Forry concluded that the climate records did not support belief in the idea of an evolving, changing climate. The conclusion was reached cautiously, however, because Forry was aware of the limitations of his data. Forry summarized his position on climatic stability as follows:

No accurate thermometrical observations yet made in any part of the world, warrant the conclusion that the temperature of a locality undergoes changes in any ratio of progression; but conversely, as all facts tend to establish the position that climates are stable, we are led to believe that the changes or perturbations of temperature to which a locality is subject, are produced by some regular oscillations, the periods of which are to us unknown.⁴⁴

Forry's rejection of the older notion of changing climates may be considered flawed by his apparent acceptance of “regular oscillations” of climate.⁴⁵ Forry's arguments in favor of the stability of the American climate were endorsed and repeated by the renowned Alexander von Humboldt (1769-1859). Forry's book was described by Humboldt as an “admirable treatise” and the famous German scientist observed that the “statements so frequently advanced, although unsupported by measurements, that since the first European

settlements in New England, Pennsylvania, and Virginia, the destruction of many forests on both sides of the Alleghany has rendered the climate more equable, — making the winters milder and the summers cooler — are now generally discredited.”⁴⁸

The debate was far from being finished. In 1857 Lorin Blodget (1823-1901) published the first comprehensive study of the American climate. This monumental work drew together for the first time meteorological information from many sources, including the nearly 600 weather stations that had been established by the 1850’s in the United States. Blodget also incorporated the various early records that existed, including the earliest for Charleston, S.C., from 1738-40, and 1742.⁴⁷

Blodget’s *Climatology of the United States* was mostly devoted to summarizing the characteristics of American regional climates, but an entire chapter was devoted to the subject of climatic change. This chapter, entitled “Permanence of the Principal Conditions of Climate”, suggests that, Humboldt’s comments notwithstanding, the idea of climate change was far from discredited. However, Blodget’s purpose in devoting a chapter to the climate change topic was essentially one of rebuttal. The task was not easy for, as Blodget acknowledged, the variability of climate elements “attached ideas of change to the whole subject which it is difficult to remove.”⁴⁸

In arguing for “Permanence of the Principal Conditions of Climate”, Blodget marshalled the scanty arguments available from physics and astronomy to suggest constancy of earth-sun relationships, and then followed the historical evidentiary review along the line taken by Noah Webster. Considering first the Classical and other sources that purported to corroborate the climate change position, Blodget also examined the case of the Northmen in the New World whose history was alleged to support the climate change arguments. He concluded that all the literary evidence for climatic change lacked scientific worth and provided at best only ambiguous support for events that could be explained in other than climatic terms.

Since Blodget denied that the “more common ideas” invoked to account for climatic change (forest removal, drainage, and cultivation) had the influence claimed for them, and since this writer had compiled the most extensive collection of American climate records to date, a definitive judgement on the climate change matter might have been expected. However, Blodget took only a cautiously negative position on the issue since he was aware that statistical data on climate available at the time were inadequate to settle the matter finally. Despite their limitations, Blodget’s United States climate statistics suggested that the United States’ climate was indeed “permanent”. Cognate data, such as the 63 years of records of the opening and closing of the Hudson River at Albany supported this author’s view of climatic stability.⁴⁹

Blodget’s opposition to climate-change ideas certainly cast doubt on them, but did not close the debate. Another general volume on New World climates appeared, written by J. Disturnell (1801-77) titled *Influence of Climate in North and South America*, which took a firmly pro-climate-change position appeared in 1867.⁵⁰ This writer noted that when New England was first settled, winters “set in regularly, and continued for three or four months, without interruption, and broke up at nearly the same time, as is now the case in Canada. The snow is diminished, and the period of sleighing is less.” Weather was

reported by Disturnell to be less predictable than hitherto, and wind directions changed from formerly. These climate changes were attributed mainly to forest clearing but the possibility of other unidentified large-scale climatic influences is suggested.⁵¹

Disturnell, writing in 1867, expressed views scarcely amplified since colonial times and little supported with data. The conviction was, however, clear that climate was undergoing a change in the United States, and perhaps all North America, and that the moderation of the New World climate had been going on since "European settlements began". Apparently oblivious to Blodget's data compilations, Disturnell argued that the records of freezing of the Delaware and Hudson rivers suggest an amelioration of winter temperatures.⁵²

Also reviving ideas from Colonial times was Disturnell's repetition of Williamson's 1770 views of Pennsylvania's changing climate. In support of Williamson's views, Disturnell adduced some new data, consisting of temperature records from 1800 to 1859, which show a slight warming trend, with the coolest decade average (1800-09) being 51.8 °F and the warmest (1850-59) averaging 53.0 °F. As the major data offered support of the claim that the American climate changed significantly since the early colonial period, this was not very impressive quantification. Equally unimpressive is Disturnell's recourse to part of the famous "Meteorological Journal" of Holyoke. Temperature records were taken for Salem, Massachusetts, from 1786 to 1821, and supplemented with data for Boston from 1821 to 1856. As Disturnell rather wanly acknowledged, this relatively lengthy series of data support belief in only minor climatic fluctuations.⁵³

A Treatise on Meteorology by Elias Loomis (1811-89), a physicist, mathematician, and climatologist at Yale College, appeared in 1868. This widely read and authoritative volume (it appeared in 13 American editions between 1868 and 1899) firmly maintained that climates were unchanging over long periods of time. The author examined climatic records for both the United States and Europe and concluded that no significant climatic variations had occurred over either the long or short term. Loomis further conjectured that the climate in both continents had not changed appreciably in the past two millenia and summarized his position by declaring that "The climate of a country remains permanently the same from age to age."⁵⁴

Belief that the American climate was undergoing relatively rapid change was based on scanty real evidence; impressionistically formed views weighed heavily. For such views of climate in the United States to be confirmed or revised, it was, of course, necessary for the study of climates to be put on a scientific basis. Scientific climatology is obviously not a matter of individual or group impression but is a matter of measurement. It necessarily involves collecting and processing large quantities of data from many widely separated places. It is also a fairly new field. The first steps towards systematic climate data collection in the United States were taken in 1812 when military doctors were directed to keep regular weather diaries.⁵⁵ The interest originally was primarily epidemiological and the data collected were incomplete and inconsistent. Even so, it marked an important climatological beginning in this country. The results were published in a series of "Meteorological Registers."⁵⁶

Besides the U.S. Army, the Smithsonian Institution early took an interest in the collection of climate data and in 1848 began assembling a system of weather observers, using

standardized methods and equipment. By the end of 1849 there were 150 regular observers and by 1861 there were 616. In 1874 the Army Signal Corps took over the meteorological work of the Army Medical Corps and the Smithsonian Institution, and in 1891 the United States Weather Bureau was established. Through the efforts of these agencies, the store of reasonably accurate climatic data was continually being enlarged, thereby preparing the way for eventual non-impressionistic analyses of American climatic records.

The first compilation of the expanding store of meteorological data at the Smithsonian was made by Arnold H. Guyot (1807-84) in 1852.⁵⁷ More comprehensive, and significant, were the substantial compilations and interpretations of the burgeoning mass of climate data that were prepared by Charles A. Schott (1826-1901) of the United States Coast Survey for the Smithsonian Institution. The first of Schott's important publications appeared in 1872 and presented a tabulation of all precipitation records from the entire United States, and elsewhere in the New World, from early settlement down to the end of 1866, "so far as they could be obtained."⁵⁸

The masses of precipitation records were presented mainly for the purpose of providing a data base, as well as for characterizing American climates. But Schott also examined the records with a view to determining if a secular change in precipitation receipts had been occurring. As Schott put it, "The question whether the annual rain-fall is gradually increasing or diminishing, stationary, of a periodic character, or apparently irregular, is one of great interest, scientifically as well as practically."⁵⁹ He concluded that the records revealed no clear trends in precipitation receipts and that "no sensible change has taken place in the law of the annual distribution within the period of observation."⁶⁰ In order to avoid the effects of "accidental irregularities," Schott grouped the precipitation records into nine categories of weather stations "where the annual rain-fall appears subject to the same laws." Again, no significant trends over time in precipitation receipts were revealed.⁶¹

Charles Schott was thus the first student of American climatology equipped with extensive data and in a position to controvert the claim that a climatic element — precipitation — was changing at a significant rate.⁶² Schott admitted that the detail and duration of the records on which he based his case for stability provided something short of complete proof but he confidently averred that "it can be shown that the secular change, if any, in the annual distribution (*of precipitation*), must be very small."⁶³

In 1876 Schott published the second part of his compilation of climate data, this time dealing with temperature — traditionally the most important strand of the climate-change discussion.⁶⁴ Again, data were presented from throughout the United States, and elsewhere in the New World, from the earliest to the latest available (1870). Again, on the basis of an unprecedented array of data, Schott denied the existence of any discernable trends. Opposing the conviction of generations that significant warming or cooling trends had occurred over the years, Charles Schott declared that there was nothing "to countenance the idea of any permanent change in the climate having taken place, or being about to take place, in the last 90 years of thermometric records, the mean temperatures showing no indication whatever of a sustained rise or fall."⁶⁵ Schott emphasized his point further by adding "The same conclusion was reached in the discussion of the secular change in

the Rain-Fall, which appears also to have remained permanent in amount as well as in annual distribution.”⁶⁶

Thus ended effectively the climate-change debate in America. Or at least, given the modern revival of the debate in a new version, what has turned out to be its early phase. Schott’s breadth and depth of data, their sources and sponsoring agencies, brooked no rebuttals. Blodget’s views on the “permanence of climate,” and the similar views held by Loomis and most other late nineteenth century climatologists, seemed confirmed by the data Schott presented. Thus, belief in climatic stability increasingly became part of late nineteenth century climatological conventional wisdom. It was, of course, also recognized that climates had drastically changed over long periods of time,⁶⁷ but the standard credo was that in historic times climates had become essentially stabilized, subject only to relatively short-term cyclical variations.

The hard-won struggle for the acceptance of the idea of climate as stabilized or “permanent” yielded only a brief triumph. Further research, more abundant and detailed data, combined with a distinct warming trend experienced by most parts of the world after 1900, eventually led to a revision of thinking on the subject of climatic stability. Before the end of the nineteenth century, the doctrine of climatic stability as enunciated by Loomis and others was being questioned. For example, in 1899, the American meteorologist F. Waldo (1857-1920) was reporting the investigations of the Austrian, E. Brückner (1862-1927) on “climatic oscillations during long periods.”⁶⁸ Brückner, in his *Klima-Schwankungen seit 1700* published in 1890, reviewed a wide range of evidence and concluded that climates were far from stable and that significant fluctuations had indeed occurred in precipitation, temperature, water levels, atmospheric pressure, glaciation, and other factors.⁶⁹

The “permanence of climate” in historic times that nineteenth century scientists strove to establish as a climatological precept has been repeatedly confirmed to be wrong, although there may have been a long period with little or no significant change in the late eighteenth and nineteenth centuries. The study of climatic history and meteorology has revealed that the earth’s climate has undergone a series of complex changes in the past. Most of these changes have resulted from entirely natural causes and have been attributed to many factors, including fluctuations in the energy output of the sun, changes in the earth’s position relative to the sun, “wandering” of the earth’s poles, and changes in atmospheric transparency involving volcanic dust or carbon dioxide. In addition, it now seems possible that human activities may have contributed to recent climatic changes. These human-induced changes are thought to involve land use effects on albedo, additions of particulate matter to the atmosphere, and production of carbon dioxide resulting from deforestation and the burning of fossil fuels since the industrial revolution.

There is now complete agreement that both long and short term climate changes have taken place. Ironically, the period of extended debate on the climate-change issue, when opinion was essentially polarized on either climatic amelioration or climatic stability was actually a period of distinct climatic deterioration for the western world. Climate was indeed changing but not in the way generally perceived. Rather than experiencing a warming trend, it appears probable that the years from about 1770 to 1850 constituted

a particularly cold period of the "Little Ice Age"⁷⁰ that affected most of the Northern Hemisphere.⁷¹

Notes

¹ Theophrastus, *History of Plants* III, 10.

² Pliny the Elder, *Natural History*, Book XVI, 15.

³ Columella, *De Re Rustica* I, 5.

⁴ For a review of these writers' ideas see C. F. Glacken, 1967, *Traces on the Rhodian Shore*, University of California, Berkeley, *passim*.

⁵ William Wood, 1634, *New Englands Prospect*, John Bellamie, London, 1634, pp. 7-8.

⁶ Peter Kalm, 1772, *Travels into North America*, trans. by J. R. Forster, The Imprint Society, Barre, Massachusetts, p. 264.

⁷ *Ibid.*, p. 469.

⁸ H. Williamson, 1771, 'An Attempt to Account for the Change of Climate, which has Been Observed in the Middle Colonies of North-America', *Transactions of the American Philosophical Society* Vol. I, Philadelphia, pp. 272-278.

Another early commentator on the American climate of this period was Richard Brooke, an English physician who made his observations in Maryland from 1753 to 1757. Brooke's comments include no reference to climatic change. Richard Brooke, 'A Thermometrical Account of the Weather, for One Year, Beginning September 1753': 'A Thermometrical Account of the weather, for Three Years, Beginning September 1754', 1759, *Philosophical Transactions of the Royal Society of London* 51, 58.

⁹ Kalm, *op cit.*, p. xvi.

¹⁰ For a discussion of early ideas concerning climatic change and deforestation see Kenneth Thompson, 1980, 'Forests and Climate Change in America: Some Early Views', *Climatic Change* 3, 47.

¹¹ Glacken, *op cit.*, p. 524 and p. 669.

¹² *The Writings of Thomas Jefferson*, 1907, A. E. Bergh, (ed.), The Thomas Jefferson Memorial Association, Washington D.C., Vol. II, p. 114.

¹³ *Ibid.*, p. 114.

¹⁴ Benjamin Rush, 1789, 'Account of the Climate of Pennsylvania, and its Influence upon the Human Body', *The American Museum*, Philadelphia, Vol. VI, p. 26.

¹⁵ Samuel Williams, 1794, *The Natural and Civil History of Vermont*, Walpole, N. H., Isaiah Thomas, and David Carlisle.

¹⁶ The title page of Williams' book indicated that the author was a member of the "Meteorological Society in Germany". This would be the 'Societas Meteorologica Palatina', the world's first meteorological society. It was established in 1780 at Mannheim, in the Rhenish Palatinate. The Societas Meteorologica Palatina was the first organization of its type to attempt the international collection of weather observations.

¹⁷ Williams, *op. cit.*, p. 57.

¹⁸ *Ibid.*, p. 380.

¹⁹ *Ibid.*, p. 65.

²⁰ The Duke (sic) de la Rochefoucault Liancourt, 1799, *Travels through the United States of North America, the Country of the Iroquois, and Upper Canada, in the years 1795, 1796, and 1797; with an authentic account of Lower Canada*, trans. by H. Neuman, R. Phillips, London, Vol. I, p. 320.

²¹ Gilbert Imlay, 1797, *A Topographical Description of the Western Territory of North America* etc., J. Debrett, London, p. 137.

²² William Dunbar, 1809, 'Meteorological Observations', *Transactions of the American Philosophical Society*, Vol. VI, Philadelphia, p. 48.

²³ *Ibid.*, p. 49.

²⁴ C. F. Volney, 1968, *A View of the Soil and Climate of the United States of America*. trans. by C. B. Brown, Facsimile of the Philadelphia 1804 edition. Introduction by G. W. White, Hafner Publishing Company, Inc., New York.

²⁵ *Ibid.*, p. 213.

²⁶ *Ibid.*, p. 215-216.

- ²⁷ *Ibid.*, p. 221.
- ²⁸ *Ibid.*, p. 219.
- ²⁹ *Ibid.*, p. 219.;
- ³⁰ Noah Webster, 1968, 'On the Supposed Change in the Temperature of Winter', in *A Collection of Papers on Political, Literary and Moral Subjects*, Facsimile of the New York 1843 edition, Burt Franklin, New York, pp. 119-162.
- ³¹ *Ibid.*, p. 144.
- ³² *Ibid.*, p. 147.
- ³³ *Ibid.*, p. 162.
- ³⁴ Thomas Hamilton, 1968, *Men and Manners in America*. Reprinted from the Edinburgh 1833 edition, two volumes in one, Augustus M. Kelley, New York, Vol. II, p. 372.
- ³⁵ It is beyond doubt that in 1714 Fahrenheit constructed the first mercury thermometer with reliable scales. H. H. Frisinger, 1977, *The History of Meteorology: to 1800*, Science History Publications, New York, p. 61. According to Volney, the first thermometer in America was introduced "About 1740". Volney, *op. cit.*, p. 220. Blodget, however, noted that a Dr Lining began measurements with Fahrenheit's thermometer at Charleston, S.C. in 1738. Lorin Blodget, *Climatology of the United States, and of the Temperate Latitudes of the North American Continent*, 1857, J. B. Lippincot and Co., Philadelphia, p. 31.
- ³⁶ Thomas Jefferson, John Winthrop (1714-79), Benjamin Franklin (1706-90) and George Washington (1732-99), were among the most famous early "thermometric observers".
- ³⁷ Edward A. Holyoke, 1833, 'A Meteorological Journal for the Year 1786 to the Year 1829, inclusive', with a Prefatory Memoir by Enoch Hale, *Memoirs of the American Academy of Arts and Sciences*, new series, Vol. I, Cambridge, pp. 107-216.
- ³⁸ See an earlier paper by Dr Holyoke. Edward A. Holyoke, 1793, 'An Estimate of the excess of the Heat and Cold of the American Atmosphere beyond the European, in the same parallel of Latitude', *Memoirs of the American Academy of Arts and Sciences*, Vol. II, Part I, Boston, pp. 65-92.
- ³⁹ Hale, *op. cit.*, p. 114.
- ⁴⁰ An aspect of the climate change debate involved public health. Associated with the view that cultivation, drainage, and settlement modified climate was the belief that these developments also improved health conditions in the area. The belief was based on the notion that deforestation, cultivation, and drainage tended to diminish the formation of atmospheric toxins that were supposed to cause a number of serious diseases, including malaria. For a discussion of this subject see Kenneth Thompson, 1978, 'Trees as a Theme in Medical Geography and Public Health', *Bulletin of the New York Academy of Medicine*, Vol. 54, No. 5, pp. 517-531.
- ⁴¹ Samuel Forry, 1842, *The Climate of the United States and its Endemic Influences*, J. & H. G. Langley, New York.
- ⁴² No observations had then been made west of the Mississippi and those used by Forry only to 1831.
- ⁴³ *Ibid.*, p. 97.
- ⁴⁴ *Ibid.*, p. 108.
- ⁴⁵ Numerous casual observers as well as students of climate at different times and places have seized on the notion of climatic cycles, providing another example of a climatological presumption that has never been validated. For some extreme examples of supposed climatic cycles see Emmanuel le Roy Ladurie, 1971, *Times of Feast, Times of Famine*, trans. by Barbara Bray, Doubleday and Co., Garden City, New York, p. 11. A bizarre example of a cycle interpretation of the American climate is provided by a contemporary of Forry's who wrote that "It is said by many that the winters of America are observed to alternate after periods of ten years; that there are ten years, for instance, during which they are severe, and go on getting more and more severe from the first of these decades to the last; and they are then succeeded by a series of ten mild winters, growing milder and milder as they proceed, till the return of the severe period again." J. S. Buckingham, 1841, *America, Historical, Statistic, and Descriptive*, Harper and Brothers, New York, Vol. 1, p. 165.
- ⁴⁶ Alexander von Humboldt, 1850, *Views of Nature or contemplations on the Sublime Phenomena of Creation; with Scientific Illustrations*, trans. by E. C. Otté, and H. G. Bohn, Henry G. Bohn, London, p. 103. This is a translation from the German of the third edition, 1849.
- ⁴⁷ Blodget, *op. cit.*

⁴⁸ *Ibid.*, p. 481-492.

⁴⁹ *Ibid.*, p. 40.

⁵⁰ J. Disturnell, 1867, *Influences of Climate in North and South America*, D. von Nostrand, New York.

⁵¹ *Ibid.*, p. 129.

⁵² *Ibid.*, p. 129.

⁵³ *Ibid.*, pp. 130-131.

⁵⁴ E. Loomis, 1868, *A Treatise on Meteorology*, Harper and Brothers, New York, pp. 157-158. The study of this volume formed the basis of instruction for trainees enlisted in the meteorological branch in the early years of the Signal Service.

⁵⁵ D. T. Whitnah, 1961, *A History of the United States Weather Bureau*, University of Illinois, Urbana, p. 10.

⁵⁶ In 1855 the U.S. Surgeon-general's office published a report presenting the climatic data collected at military posts. U.S. Surgeon-general's office, *Army Meteorological Register, for twelve years, from 1842 to 1854, inclusive, compiled from observations made by the offices of the Medical department of the Army, at the military posts of the United States*, 1855, A. O. P. Nichol森, Washington.

⁵⁷ A. H. Guyot, 1852, *A Collection of Meteorological Tables, with other tables useful in practical meteorology*, Smithsonian Institution, Washington.

⁵⁸ Charles A. Schott, 1872, *Tables and Results of the Precipitation, in Rain and Snow, in the United States: and at some Stations in Adjacent Parts of North America, and Central and South America*, *Smithsonian Contributions to Knowledge* 222, Smithsonian Institution, Washington City, pp. 1-175. This 1872 monograph was expanded and re-issued in 1881 as *Smithsonian Contributions to Knowledge* 353.

⁵⁹ *Ibid.*, p. 142.

⁶⁰ *Ibid.*, p. 136.

⁶¹ *Ibid.*, p. 153.

⁶² While Schott's and other compilations of climate data were devastating at the time to the proponents of climate-change ideas, at least one writer managed to accept these compilations and still adhere to belief that the climate was changing. Thus Dr J. R. Ham, in an 1874 medical journal, acknowledged that the traditional elements of climate change – temperature and precipitation – had been shown by Schott and others to be essentially static, however this writer believed that the *humidity of the air* had been reduced in America since settlement began and that this had beneficial effects on public health. If nothing else, the article attests to the persistence of belief in climate change. J. R. Ham, 1874, 'The Changes in Our Climate and their Effects upon Disease', *New Hampshire Medical Society Transactions*, pp. 70-85.

⁶³ Schott, *op. cit.*, p. 136.

⁶⁴ Charles A. Schott, 1876, *Tables, Distribution, and Variations of the Atmospheric Temperature in the United States, and some adjacent parts of America*, *Smithsonian Contributions to Knowledge* 227, Smithsonian Institution, Washington City, pp. 1-345.

⁶⁵ *Ibid.*, p. 311.

⁶⁶ *Ibid.*, p. 311.

⁶⁷ For example Robert Hooke, (1635-1703), the famous English physicist and mathematician, deduced from fossils that the climate of southern England had long ago been tropical. In the seventeenth century the Swiss had observed evidence that indicated that glaciers had formerly been more extensive. The evidence was first published in the 1830's and made widely known by Louis Agassiz (1807-73) between 1837 and 1847. See H. H. Lamb, 1972, *Climate: Present, Past and Future*, Methuen and Co., Ltd., London, Vol. I. p. xxvi.

⁶⁸ F. Waldo, 1899, *Modern Meteorology*, Walter Scott, Ltd., London, pp. 406-421.

⁶⁹ E. Brückner, 1890, *Klima-Swankungen der Diluvialzeit*, E. Holzels, Vienna.

⁷⁰ The "Little Ice Age" occurred from about 1200 to 1900 AD. Some believe it began in the fourteenth century and others mark its beginning as late as 1750.

⁷¹ H. H. Lamb, 1977, *Climate: Present, Past and Future*, Vol. 2, Methuen and Co., Ltd., London, pp. 577-578.