Determining Regional Weather Patterns from a Historical Diary

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ABSTRACT

Prior to the twentieth century, there was a dearth of official local weather and climate observations for much of the United States outside of major cities. Useful information can be gleaned, however, from primary accounts, such as historical diaries kept by farmers and others whose interests were tied to the land. Herman Smith, a farmer in west-central New York State, kept a detailed record of daily life, including weather characteristics such as temperature, precipitation, and wind, for his farm near Covert. Two full years of his diary, 1884 and 1886, were recently published and selected for study. Although typically not numeric data, the lexicon used in the diary to describe relative heat and cold allow Smith’s observations to be analyzed semi-quantitatively in order to determine the weather experienced that year including factors affecting the growing season, as well as significant weather and climatic events. The analysis demonstrates that for Covert—located in an area of topographic variability and proximal to the Finger Lakes—microclimatic effects occasionally dominated over the synoptic circulation. This finding was further reinforced by comparison of Smith’s 1886 records with those of a nearby farmer. Meanwhile, Smith’s accounts also establish an inextricable link between his agricultural practices and the weather and climate patterns he observed. These findings underscore the value of acquiring climatic data from nonconventional sources for places and times when reliable data may be nonexistent in order to better understand how climate, and its impacts on the environment, have varied over time, across multiple scales.

1. Introduction

Since the Neolithic revolution, and to the present day, short-term weather and longer-term climate have been ubiquitous in their impacts on human well-being, in no small part due to the sensitivity of agriculture to seasonal weather and climate trends (Butzer and Endfield 2012). Drought and resultant famine have impacted agricultural output and human civilizations throughout recorded history, from ancient Egypt (Bernhardt et al. 2012) to more recent times (Ladurie 1988). It is no surprise then that farmers, and others who directly subsist off the land or sea, often provide detailed accounts of day-to-day weather conditions, and longer-term climate trends, in their diaries and journals (Joly 2011). Surviving records from past centuries highlight the utility of such accounts, especially during times and/or in locations where other data are sparse or nonexistent. Ship logs are a particularly good source of climatic data for the presatellite era. Catchpole and Faurer (1983) analyzed logs from Hudson’s Bay Company ships in order to track summer sea ice severity in the Hudson Bay during the eighteenth and nineteenth centuries, and Landsea et al. (2004) utilized ship reports published in newspapers, among other sources, to determine hurricane tracks in the Atlantic Ocean between 1851 and 1910. Moreover, on land, the accounts of French peasants were used by Baker (2012) to investigate the damage caused by hail to crops in France prior to World War I. The diary of Myra Inman, a young Confederate woman living in Tennessee during the Civil War, also provided insight into how weather impacted both daily life on the farm and the progression of the war (Snell 2000). Last, Hubka (2004) utilized the diaries of New England farmers to construct the yearly rhythm of farming activity, something strongly influenced by the annual progression of seasons. All of these direct human observations of the weather stand in contrast to the current dominance of automated record-keeping of environmental conditions. Reading a vivid human description of a weather event can contribute special insight into...
learning how society was impacted by (and interpreted) the environment (Brázdil et al. 2005). Although more quantitative data are available now, this understanding of the interactions between nature and society can be lost when there are only numbers to go by.

Despite these various examples, only a few studies (e.g., Sparks and Carey 1995; Kington 1974; Nicholson 2001; Pillatt 2012) have analyzed the relationship between humans and their environment, specifically that of a farmer and his agricultural endeavors, through the lens of microscale climatic variations. Weather and climate can vary greatly over small geographic distances, especially in areas of complex terrain and/or near bodies of water. These nuances can be lost, however, when there are limited data over a given region with conditions favorable for small-scale variation. Such was the case during the nineteenth century in the United States, when official surface weather observations were almost exclusively limited to cities or other large settlements (Fiebrich 2009). Hence, alternative sources of data, such as a farmer’s diary, must be used in order to determine the nature of the microscale variations of the time. Even if the diary contains primarily qualitative data, it can still be analyzed semiquantitatively, especially in the context of quantitative data from the nearest available weather stations. This methodology is known as “content analysis,” described by Baron (1980) and Baron and Gordon (1985), and has been used in numerous studies (e.g., Catchpole 2003; McNally et al. 2008; McNally 2004, 2005, 2007). The present study follows this model by investigating a diary written by a farmer in rural upstate New York during the 1880s and comparing its observations with those from regional weather stations, along with those of another farmer in his own diary. Special attention is paid to the impact of daily weather conditions and seasonal climate trends on farm chores and the growing season length.

2. Data and methodology

a. The diary

The inspiration for this study was a diary kept by Herman Smith, a young man working and living on the family farm in Covert, New York, during the 1880s. Smith wrote in his diary on a nearly daily basis, including at least a comment on the weather in each entry (Fig. 1). When interesting or notable weather events or climatic trends were occurring, Smith often provided additional details. An excerpt of the diary, covering the year 1884, was transcribed and published by his granddaughter, Marsha Smith, in 1993 (Smith 1993) and forms the basis of this research, as it was analyzed using content analysis. Smith was 18 and 19 at the time of writing, and was responsible for various chores around the farmstead, which he recorded daily, such as plowing fields, planting crops, and assisting with the harvest and storage of foodstuffs. The diary also contains recollections of Smith’s other activities, including trips to local towns and villages, visits with friends and relatives, and somewhat regular church attendance.

b. Local physical geography

The activities Smith recounted in his diary typically took place on the family farm in the town of Covert in west-central New York. Covert is located in the south-eastern corner of Seneca County, on the west bank of
Cayuga Lake, one of the largest of the Finger Lakes, a group of 11 long, narrow lakes formed after the Last Glacial Maximum.

The Smith family farm was located in the western reaches of Covert, putting it on a plateau and relative high point between Cayuga Lake to the east and Seneca Lake to the west (Fig. 2). The farm was located at an elevation of about 390 m, in contrast to the lakes, which sit at about 100 m. Of important note was the presence of limy soils at the site of the Smith farm and over much of the Finger Lakes region due to the past glaciation. That soil type is not the most ideal for farming (Gregory and Nortcliff 2013), which meant that local agriculture was especially sensitive to the seasonal weather and climate. The soil type also dictated that during Smith’s time, wheat was the primary local cash crop, although oats, barley, corn, and rye were also grown.

c. The comparisons

Smith’s qualitative descriptions of daily temperature could be ranked in a more quantitative sense, using an approach similar to a Likert scale, which is frequently utilized for ranking and grouping qualitative survey data (Allen and Seaman 2007). There are some drawbacks to this approach, however, such as reduced power or nonapplicability of some quantitative statistical tests.
Moreover, two nearby weather stations could also be used as a quantitative comparison to Smith’s mostly qualitative data. One station was located adjacent to Cornell University in Ithaca, New York, 25 km southeast (as the crow flies) of the Smith farm. The other observation site was located on the grounds of the New York State Agricultural Experimentation Station in Geneva, some 50 km northwest of the farm. Despite the relative proximity of these two weather stations to where Smith was taking his observations, local microclimates likely dictated that Smith experienced different conditions at his farm, on both short- and long-term scales. For example, the weather stations were located at a lower elevation, and much closer to the Finger Lakes, than the Covert farm. Further, Orlanski (1975) defined the smallest scale of atmospheric processes, the microscale, as having phenomena occurring at a horizontal scale of 2 km or less. As shown in Fig. 3, Ithaca and Geneva were each situated well outside the range of any microclimatic features that impacted Herman Smith on his farm. Meanwhile, Orlanski also indicated that important mesoscale features such as thunderstorms occur at horizontal scales of 20 km or less. Thus, many of these important events also would have affected Smith, but not necessarily Ithaca or Geneva (Fig. 4).

Further, to broaden the array of textual data used and extend the analysis, a transcribed version of Smith’s 1886 diary was obtained from Marsha Smith. The year 1886 was utilized because the 1885 diary had not been typed, and thus was not readily available for analysis. In addition, the 1886 diary of a regional farmer, Henry Cadmus Olney, published electronically by his relatives on a blog in order to provide greater exposure for his original written material (Olney 1886), was analyzed along with Smith’s diary from that year, also using content analysis. Olney’s diary was written on his farm in Naples, New York, located approximately 60 km to the west of Herman Smith (Fig. 5).

3. Results and discussion

a. 1884 weather and microclimate highlights

Herman Smith highlighted numerous weather and climate events that occurred during the year of 1884. Several of these occurrences had a profound impact on Smith’s daily life (Table 1). During 8–9 January, an East
Coast winter storm (ECWS) moved through the mid-Atlantic and northeast United States (Fig. 6). This storm brought heavy rain to coastal locations and heavy snowfall to interior portions, such as Covert. By the conclusion of the snow on 10 January, Smith measured a snow level of about one foot, while he heard that in Rochester, New York, there were three feet of snow. This account can be corroborated by Gelber (2002), who noted that the 8–9 January storm brought heavy snow as far south as Atlanta, Georgia, with the highest snowfall observation being 36 inches in Lockport, New York—not too far from Rochester. Last, the snowstorm’s impact on Smith’s livelihood is readily apparent, as he mentioned being confined to his home on both the 8th and 9th and skipping church on the 9th, a Sunday.

Near the end of February, a late-winter extreme cold snap struck and once again forced Smith to stay indoors. The combination of cold air temperatures and strong winds caused him to exclaim “An exceedingly cold day. We had all that we could do to keep warm. Wind blows hard from the west... This is the coldest night of the winter. This morning it was 10 degrees below zero [Fahrenheit] and tonight must be 20 degrees below zero.”

By March of 1884, the cold weather had passed, giving way to periods of heavy rainfall. A significant rain event occurred on 23 March and, according to Smith, led to very muddy roads. The importance of this event was demonstrated in the *Ovid Independent*, a nearby weekly newspaper, which reported that “The mud is the deepest we’ve had in years” in its 26 March issue (*Ovid Independent* 1884a).

In June, an early-summer heatwave took place during the latter stages of the month. This high heat episode—and its subsequent end after the passage of a cold front—reinforced the importance of the diary for understanding microclimatic occurrences. On 24 June, Smith wrote that it was “another hot day.” The *Ovid Independent* mentioned a temperature of 95°F in town (about 10 km north of Smith’s location) in the following day’s issue (*Ovid Independent* 1884b). However, in Geneva, closer to Seneca Lake, the maximum temperature that day was only 89°F, likely reflecting the moderating effect of that body of water. Then, on 25 June, a cold front crossed through, ending the hot stretch. Herman noted heavy afternoon rain in his diary, although Geneva only recorded one-tenth of an inch of rainfall. Despite the June...
heat, the rest of the summer was generally cool and rainy.

The final extreme temperature event of 1884 occurred in December, when an area of high pressure moved directly over upstate New York (Fig. 7). Under these clear and calm conditions, temperature once again fell well below 0°F (observed as −14°F by Smith on 20 December), and for the first time since the previous winter he was forced to stay inside the entire day, keeping warm by the stove.

These events were often recorded, and found to have similar impacts, at the nearby observation sites, especially during situations when larger-scale features (e.g., low pressure system) dominated the local weather. When Smith's observations did not agree with those from nearby locations, microclimatic variation served as a logical explanation, especially in cases where there were no larger-scale features controlling the weather. For example, Herman noting a heavy thunderstorm in June while Geneva only received a tenth of inch of rain that day is sensible, given the aforementioned limited spatial extent of thunderstorms. Further, these storms were far too small to be detected on the weather maps of the time, which were drawn on the synoptic scale (e.g., Figs. 6 and 7).

b. Analysis of weather and the 1884 growing season and farming activities

Perhaps the most salient reason for Herman Smith to closely follow and record the daily weather and seasonal climate was the connection between those factors and the growing season (Baron 1982). The typical growing

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**TABLE 1. 1884 weather and climate highlights.**

<table>
<thead>
<tr>
<th>Month</th>
<th>Date(s)</th>
<th>Event type</th>
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<tr>
<td>January</td>
<td>7–9</td>
<td>Nor’easter</td>
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<tr>
<td>February</td>
<td>28–29</td>
<td>Cold wave</td>
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<tr>
<td>March</td>
<td>23</td>
<td>Heavy rainfall event</td>
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<td>June</td>
<td>15–17</td>
<td>Heat wave</td>
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<tr>
<td>September</td>
<td>3–9</td>
<td>Cold, windy, snow squalls</td>
</tr>
<tr>
<td>October</td>
<td>23</td>
<td>Rain and windstorm</td>
</tr>
<tr>
<td>November</td>
<td>23</td>
<td>Cold wave</td>
</tr>
<tr>
<td>December</td>
<td>16–20</td>
<td>Cold wave</td>
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(frost free) season in Covert only lasts a modest 143 to 163 days (Fig. 8), so taking full advantage of that period with timely planting and harvesting was critical. Smith began preparations for the growing season in mid-March. On 14 March, the snowpack melted after a period of rain and above-freezing conditions. The next day, he began laying manure on the fields he intended to plant on. Smith also prepared for the growing season during that time by performing outdoor maintenance such as splitting rails for fences to be placed around crop fields.

As the temperatures rose, Herman Smith accelerated his activity. On 15 April, he commenced plowing fields, and also began digging ditches around the fields on 17 April, while continuing his other outdoor activities such as laying down manure and splitting rails for fences. However, actual planting did not begin until 13 May. This relatively late start to planting is likely to have occurred because the months of March, April, and May all featured well below normal temperatures in Ithaca, with frosts likely persisting into the first week of May. Moreover, although Geneva recorded its last frost on 22 April (a minimum temperature of 27°F), the Smith farm would be expected to have experienced cooler nights due to its location and higher elevation, farther from the moderating lakes. This explains why Herman did not express his zeal to begin planting until 7 May, when he wrote “hurry up or you will get nothing in the ground to germinate and bring forth an increase when it does get dry enough the grain will fly and you don’t forget it.” However, this entry coincided with a shift into a stretch of rainy weather, hence why the planting activities were further delayed until the 13th. Once Smith started planting, he continued nearly every day for the rest of May, and into early June, on account of the favorable weather conditions.

During the summer months of 1884, Smith continued to plow and maintain the fields, along with executing a second round of planting during July. He also began initial harvest of wheat, hay, and fruit during that time. In early August, Smith began working on planting of potatoes, and then harvesting barley and wheat in the second half of the month. Despite the conditions over the summer, Smith reported no ill effects of the weather on his farming endeavors.

The fall harvest began in earnest in mid-September with falling temperatures, as Smith rolled wheat and cut corn. Harvesting activities were hastened in early October, coinciding with the average date of first fall frost. Smith began picking apples on 7 October and digging

Fig. 6. Surface synoptic weather map from 9 Jan 1884. Data source: NOAA Central Library.
out potatoes on 9 October, and it was likely that the first frost of the season occurred during this time. In Geneva, the first freezing temperatures did not occur until 15 October, although the Smith farm would be expected to have had the earlier freeze, due to the same factors allowing for colder nights. These freezing temperatures marked the end of the outdoor season and marked the beginning of a time of more indoor activities, such as husking corn, cleaning up barley, making cider, and grinding meat, which persisted into November. Last, by December, with cold conditions and snowfall abounding, Smith’s activities further shifted into winter mode, as he cut wood to heat the home, prepared the barn for the winter, and threshed wheat. Meanwhile, with the end of December being the least demanding time of year for upstate New York farmers, thanks to the inhospitable climate, Smith took a week and a half to travel to Washington, D.C., for leisure over the Christmas holiday.

Finally, although not directly related to his farming, the other important aspect of Smith’s life, as seen through the lens of his diary, was also modulated by the weather. Herman and others in the Smith family regularly attended church on Sundays, although this required a ride on a horse-drawn vehicle into a nearby town. This journey was sensitive to weather conditions, as extreme events, such as very low temperatures, could cause going to church to become an unbearable hardship on a particular Sunday. Moreover, church attendance could also be affected by short-term weather. During periods of constant rainfall, such as the spring, or heavy snowfall in the winter, the dirt roads into town could become impassable due to excessive muddiness or high snow cover. Herman Smith mentioned skipping church because of environmental factors six times in his 1884 diary. Three of those instances were due to weather conditions (wind and rain), and the other three were due to bad roads caused by persistent rainfall or snow cover. An example of the former occurred on 7 December, when a strong storm system tracked northeast from the Midwest United States into southeastern Canada. This area of low pressure brought gusty winds to much of the northeast United States (e.g., Philadelphia Inquirer 1884), and Smith recounted: “We do not attend church this evening on account of the wind blowing a perfect hurricane.”

\[c. \text{1886 weather and climate highlights}\]

Herman Smith’s observations from the year 1884 were also compared to his records from 1886. As in 1884, the 1886 diary featured daily observations of the weather, along with accounts of farming tasks and other activities. Much like 1884, the year 1886 was cooler than normal according to climate records from Ithaca (Tables 2 and 3), especially during the winter and summer months. Precipitation and snowfall totals were each below normal as well.

Despite having the same average annual temperature, there were some key differences in the weather between
1884 and 1886, resulting in a contrasting pattern of agricultural work on the Smith farm. Specifically, the spring of 1886 was warmer than its counterpart, resulting in an accelerated start to the growing season. A striking example of the difference between the two years was the fact that Smith tapped and then boiled maple syrup from trees in 1886, an activity not mentioned in the 1884 diary, likely due to the unfavorable early spring conditions then. He decided to tap trees on 26 March, and commenced doing so the next day, with the process of procuring and boiling sap lasting until 9 April. Following the syrup production, a warm stretch of weather ensued, hastening the spring planting. Smith initially sowed seeds (for wheat) on 15 April, a full four weeks earlier than he began in 1884. Planting continued on and off during the remainder of April, and for much of May, as the fields were plowed and weeded before being planted with oats, wheat, and corn. The early start to the growing season came as a courtesy of a lack of frosts after around 12 April, as temperatures never fell below 38°F at Geneva after that time, unlike 1884 when the temperature fell to 32°F as late as 3 May in Geneva and was likely cooler on the Smith farm at that time, delaying planting. Likewise, the warmer than normal April (recorded at both Ithaca and Geneva) was also noticed by Smith because of the blossoming of cherry trees on 22 April, a phenomenon he had never seen before during the month of April. The caveat in 1886 was that the warm

![Fig. 8. Average annual freeze-free season, New York State. Data source: Cornell University Cooperative Extension.](image)

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<tbody>
<tr>
<td>Jan</td>
<td>Feb</td>
<td>Mar</td>
<td>Apr</td>
<td>May</td>
<td>Jun</td>
<td>Jul</td>
<td>Aug</td>
<td>Sep</td>
<td>Oct</td>
<td>Nov</td>
<td>Dec</td>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>Avg temperature (°F)</td>
<td>17.2</td>
<td>26.3</td>
<td>26.7</td>
<td>38.1</td>
<td>49.6</td>
<td>65.9</td>
<td>62.9</td>
<td>65.6</td>
<td>63.0</td>
<td>49.4</td>
<td>35.5</td>
<td>27.5</td>
<td>44.0</td>
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<tr>
<td>Precipitation (in.)</td>
<td>3.13</td>
<td>2.64</td>
<td>3.41</td>
<td>1.88</td>
<td>4.36</td>
<td>1.35</td>
<td>4.87</td>
<td>3.75</td>
<td>1.72</td>
<td>2.90</td>
<td>1.74</td>
<td>2.42</td>
<td>34.17</td>
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<tr>
<td>Snowfall (in.)</td>
<td>29.3</td>
<td>5.0</td>
<td>8.5</td>
<td>3.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>6.8</td>
<td>14.3</td>
<td>67.8</td>
</tr>
<tr>
<td>Temperature departure</td>
<td>−6.5</td>
<td>2.5</td>
<td>−6.0</td>
<td>−6.7</td>
<td>−6.2</td>
<td>0.9</td>
<td>−6.8</td>
<td>−2.2</td>
<td>2.0</td>
<td>−0.6</td>
<td>−3.9</td>
<td>−0.7</td>
<td>−2.9</td>
</tr>
<tr>
<td>Precipitation departure</td>
<td>1.11</td>
<td>0.66</td>
<td>0.09</td>
<td>−1.02</td>
<td>1.04</td>
<td>−2.31</td>
<td>1.26</td>
<td>0.27</td>
<td>−1.67</td>
<td>−0.21</td>
<td>−0.91</td>
<td>−0.01</td>
<td>−1.70</td>
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<tr>
<td>Snowfall departure</td>
<td>13.9</td>
<td>−9.4</td>
<td>−3.5</td>
<td>0.1</td>
<td>−0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>−0.4</td>
<td>1.9</td>
<td>0.8</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>
April and May temperatures were accompanied by increasingly dry conditions. After a rainy stretch in mid-May, Smith did not record any rain in his diary from 28 May through 15 June. He lamented these dry conditions multiple times, noting that it prevented much of the corn he had planted from growing. Fortunately for Herman Smith, a considerably wetter, and relatively cool, weather pattern developed for the remainder of June and majority of July. He mentioned this pattern shift on 17 July, stating “We are now having quite frequent showers while four weeks ago we were suffering for rain.”

Much like 1884, 1886 featured a cool summer, despite the warm spring. For June, July, and August of 1886 in Ithaca, temperatures averaged 3.3°F below normal. Smith wrote off the summer by early August after low temperatures reached the 40s early in the month, stating on 3 August that “This weather reminds me of fall which is so near at hand.” His predictions were not quite accurate, however, as the warmest stretch of the summer actually occurred over the end of August and first week of September, akin to a similarly timed hot spell in 1884. Also like 1884, temperatures quickly decreased as September wore on, and Smith began cutting corn on 17 September, an activity which he continued through 28 September—an almost identical timeline to 1884, when he commenced cutting corn on 20 September. Interestingly, the fall of 1886 increasingly became cooler than that of two years prior, as Herman started picking cider apples on 29 September, the day after finishing cutting corn, and nine days earlier than in 1884. Through October, Smith continued the normal fall harvest activities, much like 1884, including cider preparation from apples, husking corn, grinding oats, and digging potatoes. These activities, though, were interrupted on 17 October, as an early season snowfall struck, at a date earlier than 1884, and a few weeks before normal for the first snow.

Herman Smith’s harvesting activities in 1886 concluded on 3 November, as he picked pumpkins on that date. Soon after, winter began early, as a low pressure system moved along the northeast coast on 12–13 November, bringing heavy rain to the coast and snow to interior regions, including Covert. Herman Smith reported snow two feet deep on 13 November, accompanied by strong northwest winds on the backside of the storm system. Despite a few warm days, this snow cover generally remained for the rest of the calendar year, according to Smith, hampering travel.

Although the seasonal cycle of farming activities differed between the two years, Smith’s church attendance was similarly impacted by the weather in both 1884 and 1886. He skipped church a total of six times directly because of weather conditions in 1884, and did so eight times in 1886. In 1886, poor roads were also the primary culprit, such as in the wake of the aforementioned November snowstorm, as well as during March with excessive mud after heavy rainfall. In both years, there was a clear seasonality of church skips, as conditions were always favorable for church attendance during the warm season months of June through October. 

d. Conversion between qualitative and quantitative data in Smith diary

Although Smith’s observations were almost exclusively qualitative, they were still able to be used effectively (by means of content analysis) to assess the daily weather conditions, owing to the variety of descriptive words utilized in the diary. This was especially true of extreme temperatures. Although the summer was cooler than normal, there were some hot days, particularly during June and September. When describing these oppressive days, Smith used strong language, labeling those days as “extremely hot,” “more hot,” or “O! Hot.” Additionally, a day that was uncomfortable but not quite as extreme could be termed as “hot,” and more typical summer days were noted as being “quite warm” or “very warm.” Last, more comfortably summer days, or warmer days that had a moderating breeze, were seen as “warm,” “fine,” “splendid,” or “pleasant” by Smith.

The more moderate summer temperature descriptors employed by Herman Smith were also found during
other parts of the year in his diary, such as the winter and spring. Quite clearly, a “warm” December day was far cooler than a “warm” July day, but the descriptions are sensible when taken in context with observations from other winter days. Analogous to the summer, the winter months in 1884 were rather cold, with numerous outbreaks of Arctic air from the north. Smith referred to the extreme days as “frigid,” “extremely cold,” and, in the case of the December cold snap, the “coldest yet.” Slightly more tolerable days were described as “cold,” “cool,” or “semi-cold.” Despite the generally below normal temperatures, there were some thaws and warmer periods during the cold-season months (January, February, and December) of 1884. Smith demarcated those days as “pleasant,” “mild,” or even “warm.” The fact that he used the same adjectives in both summer and winter days underscores both the importance of context when analyzing qualitative observations of weather, as well the shifting human feel for temperatures throughout the year, especially in a location with highly variable conditions such as upstate New York.

These qualitative descriptions were also compared to numerical data in order to be put into context. Table 4 indicates the temperature observations at Geneva, New York (the closest site with daily temperature observations), accompanying some of the common descriptors used by Smith during the year 1884. As might be expected, “hot” and “very hot” days (per Smith) only occurred during warm season months (June–September) and had an average maximum temperature of 85.86°F. Conversely, “frigid” days were limited to the winter months (December–February) and had average minimum temperatures of −0.99°F. As previously mentioned, “warm,” “cool,” and “cold” days, however, could occur at almost any time of the year, and thus had highly variable associated temperatures, as evidenced by their higher standard deviations than the most extreme types of days, “very hot,” “hot,” and “frigid.”

e. Forecasting practices

Although farmers of the late 1800s like Herman Smith had a fundamental understanding of basic weather mechanics, they had limited knowledge of forecasting these phenomena. This resulted in a reliance on traditional ecological knowledge/local environmental knowledge (TEK/LEK) to project future conditions, as was common practice during the time, and a feature of almanacs published at the time. One such case was Smith’s entry during the vernal equinox (20 March) in 1886. Because the wind was coming from the southeast that day, it portended a warm summer, according to Smith. Although this prediction was not realized, Henry Cadmus Olney did have a correct forecast—the day before the November 1886 snowstorm, he saw wild geese flying overhead, and he correctly interpreted this as a sign of snow to come. Despite the overwhelming technological advancements made in terms of forecasting, the use of TEK/LEK data in forecasting seasonal climate patterns is still pervasive, as evidenced by numerous studies (e.g., Zuma-Netshiukhwi et al. 2013; Aryal et al. 2014; Ifejika Speranza et al. 2010; Shaffer 2014) and the continued popularity of the Old Farmer’s Almanac and similar publications.

f. Insight into microclimatic variability and annual variations in weather

A diary written by a nearby farmer, also during 1886, can be used to corroborate Herman Smith’s accounts from 1886. Henry Cadmus Olney, a middle-aged farmer in Naples, New York, kept a diary similar in spirit to Herman Smith, with daily references to weather conditions and farming tasks completed. Olney’s location in Naples was close enough to Smith’s in terms of distance and elevation, although there were some microclimatic differences between the two observers. For example, the Olney farm was located in a valley, and the Smith farm was on a plateau.

Given their same general location in the Finger Lakes region of New York, Herman Smith and Henry Cadmus Olney’s environmental observations, and resultant farming endeavors, followed each other closely. During the early months of 1886, both missed church on multiple occasions for similar reasons: low temperatures, and snow cover resulting in poor road conditions. Both

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Frequency</th>
<th>Average temperature (°F)</th>
<th>Standard deviation (°F)</th>
<th>Months represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very hot</td>
<td>7</td>
<td>80.43</td>
<td>3.05</td>
<td>June–September</td>
</tr>
<tr>
<td>Hot</td>
<td>13</td>
<td>86.37</td>
<td>7.65</td>
<td>June–September</td>
</tr>
<tr>
<td>Warm</td>
<td>53</td>
<td>67.56</td>
<td>22.31</td>
<td>January–April, June–December</td>
</tr>
<tr>
<td>Cool</td>
<td>81</td>
<td>40.96</td>
<td>25.43</td>
<td>January–December</td>
</tr>
<tr>
<td>Cold</td>
<td>74</td>
<td>16.55</td>
<td>15.10</td>
<td>October–May</td>
</tr>
<tr>
<td>Frigid</td>
<td>13</td>
<td>−0.99</td>
<td>10.02</td>
<td>December–March</td>
</tr>
</tbody>
</table>

Table 4. Frequency and associated temperatures (Geneva, New York data) of common descriptors of weather conditions used in Herman Smith’s 1884 and 1886 diaries. Source for temperature data: New York State Agricultural Experiment Station.
diaries typically were in agreement on the conditions experienced during those months, namely cold conditions, with occasional thaws, and times of snow. Snowfall, however, could occasionally be localized in scale. On 3 March, Olney reported strong winds and snow squalls, but Smith noted fair and warming conditions. This difference can likely be attributed to a lake-effect snowband (which is often limited in size, as a mesoscale phenomenon) striking Naples, but not Covert. In addition, as the spring planting season began, the two diaries presented similar descriptions of activity. Smith concluded boiling sap on 9 April, and interestingly, Olney attended a maple sugar party on that same day. Later than month, Herman Smith began sowing seeds on 15 April, and Henry Cadmus Olney followed soon after on 22 April. Each farmer continued preparing and planting his fields over the remainder of April and into early May, with occasional interruption. One such incidence was 27 April, when both mentioned that their planting for the day was curtailed by rain, of which 0.27 in. was recorded at the weather station in Geneva. During the harvest season, important similarities between the two accounts also persisted. On 17 October, Herman Smith mentioned the first snow of the season, while Olney also observed snow, as well as the first hard frost of the fall, with a minimum temperature of 26°F—a bit cooler than the more moderate Geneva weather station, which recorded 28°F. The storm occurred on a Sunday, preventing both men from attending church. The cold conditions marked the conclusion of the growing season, as Smith finished digging potatoes on 23 October and Olney concluded on 21 October. Last, both diaries made mention of the major winter storm on 13 November, including a foot of snow in Naples and up to two feet near Covert. The storm caused both farmers to hasten their winter preparations, such as cutting wood for fuel, and also resulted in missing church the following day.

Annual conditions in the present day might not be recognizable to a late-nineteenth-century farmer such as Herman Smith, given his observations and the available numerical data. Both years of data analyzed in this paper featured considerably cooler than normal conditions, as per observations in nearby Ithaca and Geneva. Yet Herman Smith, while occasionally commenting on the cold conditions, generally seemed nonplussed by the progression of the seasons and growing conditions each year. This notion is confirmed by the climatic variability seen at the Ithaca weather station, the closest station to the diary with a long period of record. On average, in 1884 and 1886, a day referred to as frigid by Smith had a minimum temperature of −1°F. There has been no significant trend, though, in the number of winter season days (October–April) with temperatures at or below that threshold in Ithaca. In fact, during the most recent 30 years with full data (1984–2014), there were an average of 8.7 days annually with minimum temperatures of −1°F or less, while during the oldest 30 years with full data (1893–1931), there were only 6.2 such days. Days with a minimum temperature below zero are an important metric, as they are included in U.S. climate normal data provided by the National Climatic Data Center (Arguez et al. 2012). Further, while the persistent snow cover mentioned by Smith as early as November might seem notable to the casual observer in the northeast United States, snow cover days (number of winter season days with at least 1 in. of snow on the ground) also show no significant trend at Ithaca since 1928, when snow depth became an official measurement. Snow cover climatology is also a part of U.S. climate normal data (Durre et al. 2013), as the presence or lack of snow on the ground can have important implications for local and regional climate. These results indicate that despite myriad changes to global atmospheric patterns and conditions (e.g., greenhouse gas concentration), as well as changes at smaller scales (e.g., land use–land cover change), some regions, such as this area of upstate New York, may not be seeing significant changes to all aspects of local climate, especially at the microscale, as suggested by the lack of trends in cold nights and snow cover days.

4. Conclusions

An analysis of Herman Smith’s 1884 and 1886 diaries—as well as their comparison to nearby observations in the Finger Lakes region of New York—provides valuable insight into the role environmental conditions played in the agricultural pursuits of the time, as well as small-scale climatic variations across the area. These differences reflect that influences on the weather occur at various scales, as microscale climatic variations between the Smith diaries, Olney diary, and observing stations in Ithaca and Geneva could be augmented or overridden by the larger-scale synoptic pattern. The results of this study indicate that the Geneva station, located closest to a large body of water, typically had the most moderate conditions, while the farmers, at higher elevations and further from the lake, experienced harsher weather and climate conditions. This knowledge dictated that Herman Smith pay careful attention to the environmental conditions in order to maximize his agricultural production during the modest (in length) growing season.

Given that the main thrust of research into climatology and climate change seems to be moving toward future predictions, it is easy to overlook the past. Although
Proxy data from ice cores and other sources have been utilized to gain insight into how climate has changed on large spatial scales, less work has been done to assess changes at the local to regional level, partially due to a lack of data. Given the importance of microclimates to various stakeholders—for example, grape growers in the Finger Lakes area—it is critical to understand how these small-scale variations have changed over time in order to better predict how they may continue to shift in the future. Using nontraditional sources such as historic diaries should continue to be seen as one method for doing so.

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APPENDIX

Local Geography

The local topography of the study region and observation sites is presented in Figure A1.

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