1.5 LAURA'S LONG WINTER: PUTTING THE HARD WINTER OF 1880-81 INTO PERSPECTIVE

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1. INTRODUCTION

The winter of 1880-81 was strikingly difficult across much of the Plains and Midwest, so much so that it was featured in the Laura Ingalls Wilder historical fiction account, *The Long Winter* (Wilder 1940; Fig. 1), as well as in several town histories across the region. The Long Winter takes place in DeSmet, South Dakota, which is 60 km west of Brookings and 53 km east of Huron, South Dakota. While the book, as with the rest of the *Little House* series by Laura Ingalls Wilder, was a fictionalized account of her childhood experiences, much of the book strongly parallels the experience of the Ingalls family. Both meteorological records and non-meteorological accounts indicate that the winter was particularly long, snowy, and cold.

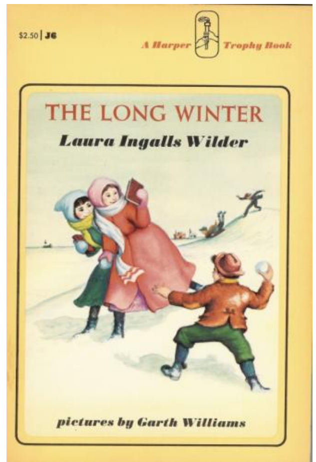

Figure 1. Cover of *The Long Winter*, second Harper Trophy edition.

This study will investigate the winter of 1880-81 in detail, including global weather patterns, teleconnections, and regional and local impacts. Specifically, the study seeks to answer several questions about *The Long Winter*:

- What data are available for the winter of 1880-81?
- How bad was the Long Winter, and did Wilder describe it accurately?
- Were the experiences of the Ingalls family and the town of DeSmet typical?
- Has there been a comparable winter since then? Was this the worst winter on record in the area?

Attribution of weather patterns in general to broader climate forcing and teleconnection is a more widely researched topic, and would provide a resource for placing the events of the Little House series in context. Because the books are historical fiction, the veracity of events must be confirmed with historical data, which are sparse in the late 19th century and must be supplemented with non-meteorological records. Specifically, regarding the Long Winter of 1880-81, the study will characterize the winter both local to Laura's experiences as well as with a global perspective, including the presence of teleconnection patterns or other climatic features that may have contributed to an extreme winter season.

Books about historical weather events are pervasive in popular literature, focusing on topics that include the Dust Bowl (Egan 2006), major hurricanes (Mykle 2002; Scotti 2003), tornadoes (Mathis 2007), floods (McCullough 1968; Barry 1997), and blizzards (Laskin 2004). These books enjoy wide circulation and appeal to an audience well beyond experts in meteorology and climatology. While historical weather and climate events are pervasive in popular literature, the events are less commonly analyzed in peer-reviewed and technical literature. Major historical weather and climate events hold the interest of the public, as is indicated by the success of books similar to the ones listed above, "soft literature" such as the magazine *Weatherwise*, and anecdotal interest in descriptions of events in news and internet features. Historical high-impact events do appear in some peer-reviewed literature, often in the form of a case study and occasionally in placing events in context of broader meteorological or climatological patterns (e.g. Kocin 1983, Myers and Jordan 1956, Frye et al. 2004). Placing weather events that were detailed in popular literature into a climatological context is unique, particularly for events occurring in the 19th century.

Historians and literary scholars have conducted extensive research on biographical information about Laura Ingalls Wilder (Zochert 1976; Anderson 1992; Miller 1998; Hill 2007; Fellman 2008), and have published books in popular literature. The research has focused on historical facts that support the information presented in the book, as well as missing and incorrect information; the life of Laura Ingalls Wilder and her family through her adulthood; the writing of the *Little House* series, including her strong collaboration with her daughter, author Rose Wilder Lane; and even some information about the town of DeSmet, South Dakota (Miller 1994), site of four books in the series as well as one book published posthumously. None of the books, however, has consulted with or been written with information specific about the weather and climate in the series.

It is beneficial to find a topic that can serve as a vehicle to convey weather and climate information. Such a

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vehicle allows non-meteorologists and non-climatologists to gain understanding about weather and climate as it applies to the topic. One such common topic is Laura Ingalls Wilder. Many people, especially in the Midwest and Plains areas, are familiar with the series of children's books written by Laura Ingalls Wilder, sometimes referred to collectively as the Little House books, or the television show based loosely on those books, "Little House on the Prairie" (1974-82). The books, which are historical fiction based strongly on the life of the author, thus provide a common ground from which lessons in weather and climate can be drawn. Weather events and climate extremes are featured prominently throughout the series, though nowhere as strongly as in *The Long Winter*. Other extreme weather and climate events throughout the books include tornadoes, prolonged drought, grasshopper plagues, cold snaps, and blizzard events outside of the Long Winter. The books thus provide a vehicle for discussing numerous weather and climate events to which a population could be vulnerable.

The Laura Ingalls Wilder books are engrained in the culture of the United States, and particularly the Plains and Midwest regions featured in the books; thus, adults and children alike recognize and respond to the stories. A narrative can be constructed, through the characters, plot, and setting of the Little House series, that enables the communication of weather and climate concepts that range from interesting tidbits like documenting individual storms to complicated concepts like localizing impacts of climate change. The practice of bridging between science and the community would benefit from a methodology, an example, and an investigation of how to apply the concept in practice. Thus, there is a need to see the process through from beginning, as a scientific investigation, to end, as a tool for education and communication. This study will serve as that end-to-end demonstration and will delineate practices to apply in future studies, using the Laura Ingalls Wilder books as a vehicle that can cross the bridge between meteorology/climatology and communication to a wide audience of non-specialists.

Figure 2. Locations of long-term and historical weather stations in the region surrounding DeSmet, South Dakota.

2. DATA

Meteorological data in the Central Plains region in the early 1880s was sparse in coverage, especially when seeking stations with long-term records that pre-date the Long Winter and continue through the present. As with many investigations of historical weather events, the few official and routine observations must be supplemented with historical and anecdotal information to create a description of the winter of 1880-81. The disparate data sets and qualitative information must be combined in a meaningful way to both create an accurate description of the weather and climate events while also retaining an element of interest that contributes to the narrative.

2.1 Meteorological data

Temperature and precipitation data were collected through the Applied Climate Information System (ACIS; Hubbard et al. 2004), a combined data system utilized by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center, NOAA National Weather Service (NWS), and the Regional Climate Centers. Just four sites within 500 km of DeSmet have records that pre-date 1880: Des Moines, Iowa (DSM), 446 km from DeSmet; Minneapolis/St. Paul, Minnesota (MSP), 344 km; Omaha, Nebraska (OMA), 370 km, and Bismark, North Dakota (BIS), 365 km. Data from BIS have not yet been analyzed and included. All of the sites are considered "threaded" records, with station moves across the metropolitan areas collected into one continuous data record. Thus, an important caveat with the data is that each station may include multiple, though related, sites, with variations in site location and instrumentation through the period of record. While some conclusions may be drawn about the long-term record at these stations, they should be made with caution and supported by analysis of a homogenized data set.

Historical weather observations provided by the Climate Database Modernization Project (CDMP) yielded data in closer proximity to DeSmet. Observations were taken at three military forts in the eastern half of South Dakota during the winter of 1880-81: Fort Bennett (now under present Lake Oahe in central South Dakota, 249 km west of DeSmet), Fort Randall (near Pickstown in southeast South Dakota, 167 km south of DeSmet), and Fort Sisseton (between Sisseton and Britton in northeast South Dakota, 143 km north of DeSmet). In addition, observations were available for Yankton, South Dakota (167 km south of DeSmet), a site that later established a long-term climate record. Figure 2 illustrates the location of DeSmet and all of the noted data points. The historical data included not only temperature and precipitation information, but also often included observations of precipitation type, wind description, and other meteorological and astronomical phenomena. Locations of both long-term and historical weather observing sites, in relation to DeSmet, South Dakota, are in figure 2.

Neither the long-term climate records nor the historical data included direct measurements of snowfall or snow depth during the winter of 1880-81, which is typical of the period. Occurrences of snow must be derived from a combined interpretation of temperature and precipitation data. Fisk (2008) produced a methodology to derive snowfall estimates from temperature and precipitation data, even using MSP data for the winter of 1880-81 as a demonstration of the technique. Further work is needed to determine if the method is robust enough to apply to this study, and quantifying an estimate of snowfall based on available observations remains a future task. As an initial estimate, precipitation in this study was interpreted to have fallen as snow if the high temperature was 0 °C or less.

2.2 Non-meteorological data

Though meteorological data were scarce for the Long Winter, evidence exists in documents including historical archives, journals, town histories, and newspapers. Such anecdotal data are subjective and could be prone to exaggeration, as well as lack of historical context or comparative value. That said, consensus of multiple voices from multiple sources about the nature of the winter provide confidence in conclusions about it. *The Long Winter* itself is a form of non-meteorological documentation of the winter, but confidence increases in its description of the winter of 1880-81 when matched to other documentary data.

2.3 ENSO and NAO data

Analysis of the global teleconnection patterns during the winter of 1880-81, including the El Niño/Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO), provides context for the synoptic scale patterns and resulting sensible weather experienced in the central United States. The Oceanic Niño Index (ONI) data set available from NOAA Climate Prediction Center (CPC) spans the period from 1950 to present. ONI is widely used in NOAA applications of ENSO studies, as well as in the operational definition of El Niño and La Niña utilized by CPC, which defines an El Niño (La Niña) episode by the presence of a sea surface temperature (SST) anomaly greater (less) than 0.5 °C (-0.5 °C) in the Niño3.4 region (Figure 1) for five consecutive three-month-average periods (Kousky and Higgins 2004). CPC experts are developing monthly SST anomaly data for the Niño3.4 region based on Extended Reconstruction SST version 3b (ERSST.v3b) data (Smith et al. 2008), generating monthly anomaly data from 1871 through 2010; this data set has been provided via personal communication (M. LeHeureux). During the winter of 1880-81, a weak to moderate El Niño was in place, an analysis that is corroborated by Allen et al (1991).

NAO influences temperature strongly in the central Plains, and also precipitation to some extent (Mayes 2011). As with ENSO, there is no single data set that defines NAO, and many analyses exist (Hurrell and Deser 2009). This study utilized data from the Climate Analysis Section of the National Center for Atmospheric Research (NCAR; available online at http://www.cgd.ucar.edu/cas/jhurrell/indices.html), spanning 1864 to the present (Figure 3). In this data set, the NAO index is based on the difference in normalized sea level pressure (SLP) between Lisbon, Portugal, and Stykkisholmur/Reykjavik, Iceland. Hurrell normalized the SLP anomalies at each station by dividing the seasonal mean pressure by the standard deviation of the long-term mean (1864-1983). Normalization is used by Hurrell to avoid the series being dominated by the greater variability of the northern station. During the winter of 1880-81, one of the strongest negative NAO episodes since 1871 was in place, an analysis that is corroborated by Marsh (1998).

3. RESULTS AND DISCUSSION

Lacking direct weather observations at DeSmet, it is still possible to construct a regional description of the winter of 1880-81 based on the available data, evaluating the season as a whole (from 15 October 1880 through 15 April 1881) as well as individual events noted in *The Long Winter*.

3.1 Data interpretation

Many sites in the region did rank among the coldest and wettest on record during the winter of 1880-81. The sites with complete records that pre-date 1880 – DSM, MSP, and OMA – demonstrate the widespread nature of the harsh winter conditions (Table 1). The winter was the coldest on record for both DSM and OMA and the eleventh coldest on record at MSP. Also, the winter was the second wettest on record at MSP and the 15th wettest at DSM, though in OMA it was a middle-of-the-pack 63rd wettest. Among the three sites, 1880-81 is the only winter on record in which all three sites experienced a winter ranking among the coldest 25 on record and at least two of the three sites also experienced a winter ranking among the wettest 25 on record.

Yankton and the fort sites lack a complete record from 1880 through the present. Each of the sites, though, is in reasonable proximity (within about 40 km) to a long-term station that has been established since the cessation of historical data. In the case of Yankton, the sites are within the same town. For these sites, the records from 1880-81 are compared to the nearest present site to at least create a rough, qualitative comparison of the Long Winter to a longer climatology. Additionally, the month of February 1881 is missing from the Fort Bennett data, and thus that site cannot be used to evaluate the full winter season. The modern observation sites nearest to each historical site are specified in Table 2. Among the remaining historical sites, the winter of 1880-81 would be colder than any other winters observed by modern observations. Two of the three sites also would be among the top 10 wettest, with the remaining site among the top 25 wettest. The sites support the wider-ranging regional observations in depicting a winter that was anomalously cold and wet, though the specific quantification is still to be determined.

3.2 Specific events from The Long Winter

Several specific events are noted through *The Long Winter*, raising interest in documenting the specific events within the book. To some extent, this is indeed meteorologically feasible, and the succession of the events follows.

Near the beginning of the book, a blizzard strikes in October, while the Ingalls family still resides in their flimsy claim shanty. Indeed, the daily observations from the historical sites as well as the long-term stations indicate a drop to temperatures below freezing, combined with precipitation, progressing through the region around 15-18 October 1880. The October blizzard appears in multiple anecdotal accounts, as well.

A few chapters later, similar to stories like those in *The Children's Blizzard* (Laskin 2004), a blizzard strikes while Laura and her sister Carrie are at school. The school was on the edge of town, but the journey home was perilous nonetheless, as the students and teacher nearly miss the town. By counting back time from Christmas in the book, with a literal interpretation, the school blizzard would appear to have occurred around 6 December. Weather observations around the region indicate widespread cold temperatures and precipitation around 2-4 December. Other snow events occurred in late November, as well, and thus the precise date of the school blizzard is not certain. It is, however, plausible.

Several blizzards occur in the book between the school blizzard and Christmas. Likewise, weather observations indicate several instances of precipitation and cold temperatures, and even higher winds, during this period. Also, a blizzard begins on Christmas evening in the book, and this is also corroborated by observational data, with snow beginning to be reported late in the day or the following morning. The blizzard on Christmas evening is a significant event in the story, with a Christmas of deprivation ending on a frustrating note for Laura.

In late December, the book notes that the trains stop running. DeSmet was established in 1880, built on the Chicago & Northwestern (C&NW) railroad line as it expanded westward to Huron. It was a new town dependent on the railroad for supplies, with few settlers who were established well enough to have ample food stores. Thus, the cessation of rail service cut off a vital link to incoming food and fuel supplies – the only link other than foot or wagon transportation, which also was made nearly impossible through the winter. C&NW archives confirm that the rail service ceased along the track between Minneapolis and Huron between late December and early January, with more westerly points cut off earlier. Train service returned from east to west in late April and early May; thus, the most westerly locations were cut off as long as 4.5 months. Figure 3, obtained by Stennett 2007 from the C&NW archives, illustrates the depth of the accumulated snow over a railroad cut in western Minnesota in March 1881.

After Christmas, a cold but relatively clear spell allows DeSmet townsmen to conduct an unsuccessful antelope hunt. The book notes that temperatures were as low as "40 below" and that clear weather lasted long enough to allow confidence in venturing out of town. Observations from none of the sites in the study indicate minimum temperatures reaching 40 below, but they do indicate a cold and clear spell from 6-14 January 1881, with temperatures as low as -29 to -34 °C. It is feasible that wind chills could have been as low as -40 °C, and it is also feasible that temperatures so cold could seem like "40 below" even if actual readings were a few degrees higher.

From around mid-January through February, Wilder loses track of individual blizzard events. Records indicate numerous episodes of cold weather and precipitation, indicating snow; most of these were short-lived, but they were frequent at any one location, and almost all days during that period had snow falling in at least one location. It is also reasonable that after being a few months into the winter, the events became indistinguishable in her memory not only because of their frequency but also because of the length of the winter.

A climactic event occurs near the end of the book, as the memory of individual blizzards becomes fuzzy. Laura's future husband, Almanzo Wilder, and his friend Cap Garland make a risky trip south of DeSmet to acquire a homesteader's seed wheat, to be shared out

Figure 3. Kelly's Cut, 0.5 mi west of Sleepy Eye, Minnesota, in March 1881 (Stennett 2007).

to the town and prevent starvation of many families, including the Ingalls family. A study by high school physics teacher Jim Hicks, presented at LauraPalooza 2010 (http://beyondlittlehouse.com/laurapalooza/), confirmed the veracity of the trip based on how far horses can travel with a loaded sled. The trip depended on one clear day, timed with a full moon, and the book notes that day being very cold. Such a cold, clear day with a nearly full moon occurred on 16 February, making this the most likely date of the seed wheat trip. The winter would last for two more months.

Snow events continued through March and up until mid-April. Abruptly, warmer weather arrived at the observational sites in the region on 13-15 April, with a distinct regime change apparent as temperatures rarely fell below freezing at any site for the rest of the month. The book marks the transition with a chapter describing the arrival of the Chinook, a warm downsloping wind known to melt snow in the region.

3.3 Related event: Flood of 1881

As many residents in the northern Plains and upper Midwest can attest, a snowy winter in the region often is followed by a spring marked by flooding, especially if the snow pack melts abruptly. Indeed, the spring of 1881 produced massive flooding in the Missouri and Mississippi River basins and their tributaries, with some locations still noting 1881 as the flood of record or as only recently exceeded. Flooding early in the season was caused by ice jams as significant meltwater flowed into ice-covered rivers. Figure 4, for example, shows the flooding in Omaha, Nebraska. An ice jam flood was responsible for major damage in Vermillion, South Dakota, causing damage to two-third of the town and leading to its relocation on higher ground. Subsequent flooding through the spring and early summer continued as rain and melting runoff continued to feed the rivers. The major flood in Omaha changed the course of the Missouri River, cutting off a segment of the river that was later named Crescent Lake. Many towns and cities endured significant flooding, with some towns (such as Green Island, Nebraska) never rebuilt.

3.4 Constructing a narrative

It is no mystery that a well-crafted story will capture the attention of its audience more than a list of facts. Jones and McBeth (2010) added credibility to the relationship between narrative communication and its impact on the attitudes of its audience. A narrative, as described by Jones and McBeth (2010), is a story with a sequence of events, including the elements of setting or context, plot, characters (including a hero and a villain), and a moral of the story. While it has been noted in many studies that people are inclined to respond to information that most closely matches their own expectations, it is possible to move people beyond those expectations. A story that exhibits congruence, or similarity to the life experiences of the listener, is more likely to be received. A break with expectations about the way things should

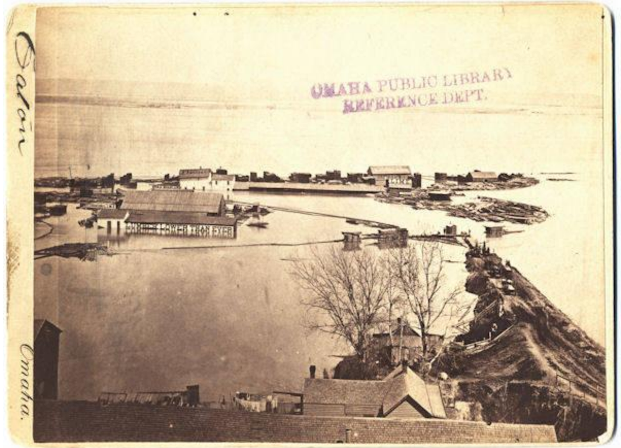

Figure 4. Flooding in Omaha during the spring of 1881. Photo courtesy of the Omaha Public Library, available online at http://digital.omahapubliclibrary.org/earlyomaha/floods/1881_flood_1.html

be, referred to as a “breach”, is hypothesized to be a positive to persuading the listener. Likewise, the ability of the story teller to transport listeners so that they become involved with the characters is also key to persuasion. Finally, listeners are more likely to be persuaded by a story if they trust the storyteller. In particular, Jones notes that the depiction of the hero is critical (Pitzer 2010); if listeners like and relate to the hero, then they are more willing to believe other facets of the story. In an interview related to the publication (Vergano 2010), Jones noted that scientists are reluctant to accept storytelling as a valid means of communicating information. He specifically cited an instance in which he presented the research to National Weather Service meteorologists, who resisted the idea of telling a story over listing facts. Meteorologists are notoriously conservative and reluctant to stray outside their science, besides being among the most reluctant of physical scientists to view climate change as a concern (Doran and Kendall Zimmerman, 2009), and this reaction is not surprising.

The Long Winter lends itself well to narrative construction. It includes a hero, Laura Ingalls Wilder, who is well known and even beloved by multiple audiences. The stories are familiar to their readers, and adding information about weather and climate to build on those stories allows a credible breach from a story that otherwise meets expectations. Thus, the only element remaining is credibility in the storyteller, an element that the author is pursuing via both education and academic credibility as well as exposure to and comfort with audiences. The story about weather and climate in Laura’s time can be shaped to the audience and time allowed, expanded as needed, and delivered via different media.

4. CONCLUSIONS AND FUTURE WORK

While precise quantification of the parameters of the winter of 1880-81 in east central South Dakota remains an item of future work, less precise qualitative and quantitative analysis indicates that the winter indeed was historical across much of the central Plains into the upper Midwest and western Great Lakes regions. Significant and possibly record-setting snowfall did occur, with a prolonged winter season that extended from mid-October through mid-April and included frequent snowfall events across the region. Temperatures were among the coldest on record across the region, as well.

The combination of negative NAO and positive ENSO phases is not unprecedented, having occurred 17 times since 1879 (Mayes 2011). The coupling of a very strong NAO (NAO index of -3.0 or less) with a positive ENSO event has occurred 3 times: 1880-81, 1968-69, and 2009-10. While more investigation is needed to quantify the temperature and precipitation anomalies of all of those winters for comparison to 1880-81, at least a couple of those winters are also among the coldest and wettest on record in the region, the most recent of which is 2009-10. The global teleconnection patterns therefore appear to have played a role in the extent and severity of the Long Winter. One question for future research is whether climate change has influenced the intensity of winters in the region, either by influencing the resulting weather patterns associated with global teleconnections or by changing the likelihood of extreme temperatures or precipitation. The changes may be of either sign and may be opposing; for example, it is a reasonable hypothesis that wintertime extreme cold outbreaks are becoming less frequent while precipitation increases, which may or may not combine to influence the amount of snow in the region.

The connection to The Long Winter does open the door to communication about weather and climate phenomena, providing a narrative foundation from which related narratives may be spun. Audiences from students to teachers to Laura Ingalls Wilder scholars have requested speaking engagements or information about the connection between *The Long Winter* (or other Laura Ingalls Wilder books) and actual weather and climate events, providing an open door to connect new information to a beloved and well-studied existing story. While the impact of connecting weather and climate information to the Long Winter narrative has not yet been quantified, the information already has connected to a broad audience.

Much future work remains with this study. Foremost among the work yet to be completed includes creating an objective classification or indexing system for winter seasons. The index should be functional both with and without available snowfall and snow depth data, so that it can be applied to historical data prior to routine observations of snow. The index should provide an objective measure of the intensity of a winter season, so that more subjective measures such as human and societal impacts and costs can be compared to that objective classification.

Additionally, more available data will be included in the analysis of the Long Winter. BIS, and possibly observations from Duluth, Minnesota, and LaCrosse, Wisconsin, should be evaluated. Historical data are available in western and northern Iowa, and these sites also will be used to fill in the regional picture of weather patterns and impacts. Other sources of anecdotal data also are available and can be incorporated, including several newspapers and likely other sources residing at museum and archive sites that are yet to be uncovered.

Finally, completion of this study does not end with the scientific analysis; rather, it will end with effective communication of the study results to non-technical audiences, as well as incorporation of lessons into educational materials. While development of such materials is underway, their completion is among the future challenges of this project.

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