6.7 EVALUATION AND VERIFICATION OF STATEWIDE CLIMATE EXTREMES RECORDS

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1. Introduction

Extreme outliers of meteorological elements are an important component of the statistical characterization of the climate of a location or geographic region. Beyond obvious public interest, such values aid in establishing the practical upper and lower bounds of the distribution for a particular variable, and can play an important role in decision making at many levels – from individuals deciding where to retire to civil engineers determining storm drain requirements. Extreme values also aid in evaluating the validity of other meteorological observations, with values exceeding those thresholds being identified for closer scrutiny.

Furthermore, to adequately incorporate climate into planning and decision making at a local or regional scale, the substantial spatial variability in Earth's climate necessitates the identification of climate extremes at those finer scales. Unfortunately, while global and national climate extremes have historically been given ample attention and review by teams of expert climatologists, the vetting of extremes at finer spatial scales has largely been relegated to automated quality control processes that may or may not adequately establish their validity.

2. State Climate Extremes Committee

In the summer of 2006, a NOAA National Weather Service (NWS) Cooperative Weather Observation station observed a maximum diurnal temperature that potentially exceeded the existing all-time maximum temperature for the corresponding state and a new record was declared. Subsequently however, questions arose as to the validity of the observation. In addition, a review of the existing statewide climate extremes tables revealed that they had not been kept up to date for several years. In response, the National Data Stewardship Team (NDST; comprised of representatives from NOAA and its climate partners) established a climate extremes committee that recommended a twofold solution. First, the committee recommended the establishment of a State Climate Extremes Committee (SCEC) that would be responsible for the objective review of any meteorological observation that potentially established a new record for a particular state.

Draft guidelines for the operation of the SCEC were established, based loosely on the guidelines set forth for the National Climate Extremes Committee, and were included in NWS Instruction 10-1004 Appendix E (NWS, 2008). These instructions direct a local NWS office (WFO), when a potential challenge to a statewide record is observed, to convene an *ad hoc* SCEC comprised of representatives from the WFO, the State Climatologist office, the NWS regional headquarters, the Regional Climate Center (RCC), and the National Climatic Data Center (NCDC). This committee is tasked to review the validity of the observation in light of all relevant evidence surrounding the observation. Such evidence may include, but is not limited to instrument siting and maintenance, operational parameters, associated radar or synoptic information, historical observational quality, storm reports, and observations from neighboring locations.

Observations need not come from instruments operated or maintained by NOAA or the Federal Government. However, in order to be considered as a legitimate observation, the SCEC requires that certain criteria be met. These requirements include adherence to accepted minimum

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instrument and observation standards, public access to archived data, and that the station has, or has the potential to generate an observational record sufficient to establish a representative long-term climatology of the location.

The SCEC is tasked with actively tracking and evaluating a set of core parameters for all states (*e.g.,* maximum and minimum all time temperature, greatest 24-hour precipitation and snow fall, greatest all time snow depth). A comprehensive list may be found in NWS Instruction 10-1004 (NWS, 2008). In addition, a state may request tracking of extremes for additional elements (*e.g.,* greatest hail stone size).

When a committee adjudicates a value, that recommendation is reviewed by NCDC, which ensures that the value is flagged with the appropriate quality control (QC) flags in its archives. Since its inception in 2006, these *ad hoc* committees have convened several times to review potential statewide extremes. These meetings have resulted in the establishment of several new statewide record extremes, as well as preventing some questionable observations from being erroneously regarded as legitimate records.

3. Review of historical extremes tables

The second recommendation of the NDST climate extremes committee was to review existing historical climate extremes tables and update them as necessary. Statewide tables of maximum and minimum temperature and greatest precipitation are maintained by NCDC, but are static and have not been updated in several years. The table for greatest 24-hr precipitation has not been updated since 1998. More up to date values are accessible from the U.S. Monthly Extremes data available via NCDC's Climate Data Online (CDO) system (CDO, 2009). However, these data are derived from the summary of the month data and may not include the full period of record for some stations. Snow fall and snow depth statewide extremes are also maintained by NCDC as part of an automated United States Snow Climatology (USSC) system. However, these data are subject to a rigorous and conservative automated QC process that has significant potential to reject values in the upper tail of the snow fall or snow depth distribution. Thus, a manual review and update of the existing statewide climate extremes was warranted.

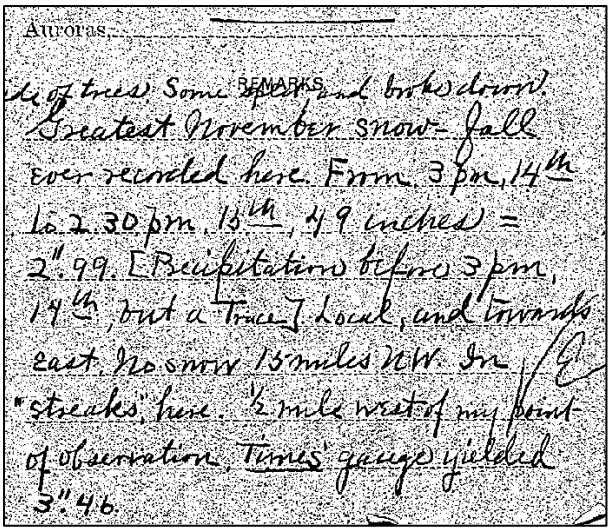
A review of the all-time maximum and minimum temperature, 24-hr precipitation, 24-hr snow fall, and greatest snow depth for each state (including Puerto Rico and the U.S. Virgin Islands) was conducted between late 2006 and 2009. In reviewing and reevaluating these records, the following procedure was employed. Initially, the top (bottom in the case of minimum temperature) 100 observations were extracted from all daily observations archived at NCDC. The flagged validity of these observations was ignored as associated quality assurance methods have not been consistent across all data. Data not residing in NCDC archives was not considered unless it was previously established as a statewide record.

Using the extracted data, values that were undoubtedly in error (*e.g.,* meteorological improbabilities, obvious transcription errors) were removed from consideration. Each state's existing historical record was then used as a starting point for evaluation. First, the validity of the existing record was evaluated against the extracted digital data, and against original observation forms and ancillary documentation (*e.g.,* Climatological Data publication, Meteorological Diaries, special reports). In most instances, the comprehensive evaluation work conducted by predecessors at NCDC, NWS, and State Climate offices to originally validate and track these established records proved well grounded and the records were deemed valid. In just a few instances, investigation revealed transcription or reporting errors that invalidated the established record. In another few instances, the established record was based on an observation for which either no primary-level historical evidence exists, the data were not archived, or the value was deemed predominantly biased by non-climatological influences. In those instances, the established value was also removed from consideration. Finally, in a few cases the existing record was either an estimated value or a value

based upon measurement from a non-standard source (*e.g.,* oil drum). In such instances, unless the accuracy of the estimate or non-standard source could be established via official documentation (*e.g.,* bench tests, etc), it was not considered valid. On the whole, only ten of the existing records were invalidated for any of the aforementioned reasons.

Once the existing records were evaluated, the data were examined for values that exceeded the established record and were meteorologically plausible. These were each investigated by the same criteria as the established records. Evaluation of these data without regard for automated QC flags proved fruitful. In reviewing QC processes, it became evident that many QC errors stem from a need for the QC algorithm to reference simultaneous observations of other elements (e.g., precipitation as a check against snow fall). Unfortunately, historically, many observers did not report all required elements each day, and in the absence of a comparison, an otherwise legitimate observation might be invalidated by automatic processes. In some gross instances, most of the more extreme observations from historically significant severe weather events had been invalidated by inadequate QC methods. For example, most of the snow observations from a severe Nor'easter that impacted New England in March 1888 were deemed invalid by automated QC routines, but were supported by contemporary narrative from the New England Meteorological Society (NEMS, 1888).

In many cases, ancillary information that can either support or refute a particular observation can be found in the remarks on the original observation forms (*e.g.,* "Greatest November snow fall ever recorded here. From 3 PM 14th to 2:30 PM 15th, 49 inches …" [Watertown, NY, November, 1900]; see figure 1), in a preponderance of extreme values in the digital data for the same date, or in descriptive weather summaries (unfortunately discontinued in the 1960s) in the Climatological Data publication for the state (*e.g.,* "The great storm of 27th-28th probably gave … more snow than they have


Auroras.

REMARKS

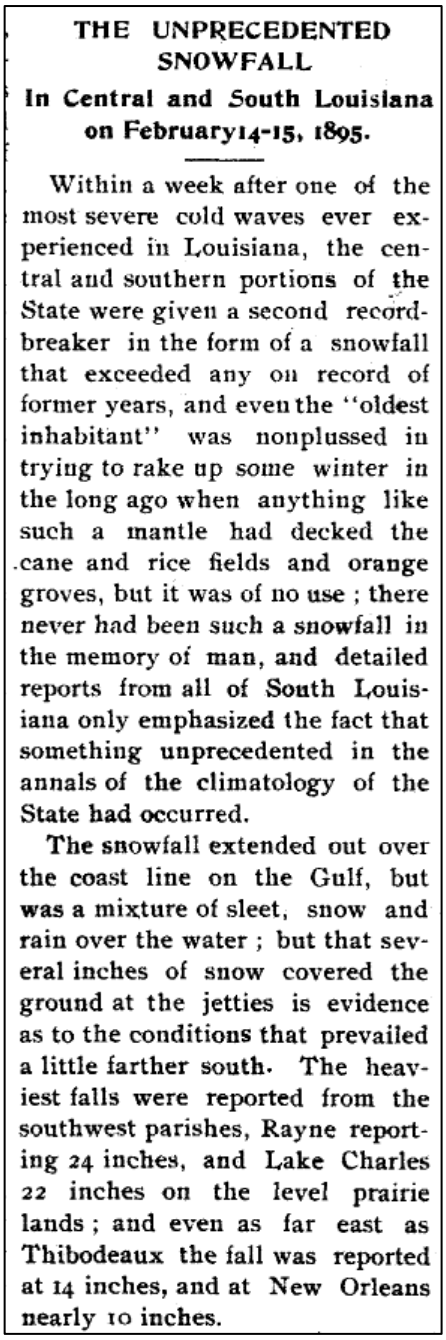
Greatest November snow-fall ever recorded here. From 3 pm, 14th to 2.30 pm. 15th, 49 inches = 2".99. Precipitation before 3 pm, 14th, but a Trace. Local, and towards east. No snow 15 miles NW. In "streaks" here. ½ mile west of my point of observation. Times gauge yielded 3".46.

Figure 1. Remarks from the official observation form from Watertown, NY for November, 1900.

measured in many years; old settlers state that no storm since the great snow of 1830-31 has exceeded it." [USDA, 1900]). Figures 1 and 2 illustrate some of these comments. Overall, since in most cases, too much time has transpired since the observation for any living memory to serve, unless there is compelling evidence that a particular historical observation is not accurate, this reevaluation has assumed that the observation is valid.

4. Summary

Following the completion of manual reevaluation of the statewide climate extremes tables at NCDC, the values were submitted to the NWS and the American Association of State Climatologists (AASC) for review. Upon completion of their review, the revised tables will be published and will be incorporated with NCDC's data systems to automatically compare newly received data against the records, such that a SCEC can be convened if a new observation challenges an existing record. In addition, the SCEC now provides a mechanism by which both new and existing records can be investigated in a rigorous and objective manner. As a result of these efforts, it is hoped that planners, decision makers and the public at large can have the utmost confidence that the record climate values for any given state are accurate and current.



THE UNPRECEDENTED SNOWFALL

In Central and South Louisiana on February14-15, 1895.

Within a week after one of the most severe cold waves ever experienced in Louisiana, the central and southern portions of the State were given a second record-breaker in the form of a snowfall that exceeded any on record of former years, and even the "oldest inhabitant" was nonplussed in trying to rake up some winter in the long ago when anything like such a mantle had decked the cane and rice fields and orange groves, but it was of no use ; there never had been such a snowfall in the memory of man, and detailed reports from all of South Louisiana only emphasized the fact that something unprecedented in the annals of the climatology of the State had occurred.

The snowfall extended out over the coast line on the Gulf, but was a mixture of sleet, snow and rain over the water ; but that several inches of snow covered the ground at the jetties is evidence as to the conditions that prevailed a little farther south. The heaviest falls were reported from the southwest parishes, Rayne reporting 24 inches, and Lake Charles 22 inches on the level prairie lands ; and even as far east as Thibodeaux the fall was reported at 14 inches, and at New Orleans nearly 10 inches.

Figure 2. Descriptive narrative from the Louisiana climate summary of February, 1895 regarding a record setting snow event in southern Louisiana (Louisiana Weather Service, 1895).

5. References

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