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Issue(s):	Weather Normals
Witness:	Allen L. Dutcher
Sponsoring Party:	Union Electric Company
Type of Exhibit:	Surrebuttal Testimony
Case No.:	ER-2012-0166
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MISSOURI PUBLIC SERVICE COMMISSION

Case No. ER-2012-0166

SURREBUTTAL TESTIMONY

OF

ALLEN L. DUTCHER

ON

BEHALF OF

UNION ELECTRIC COMPANY
d/b/a Ameren Missouri

St. Louis, Missouri
September, 2012

SURREBUTTAL TESTIMONY

OF

ALLEN L. DUTCHER

CASE NO. ER-2012-0166

Q. Please state your name and business address.

A. My name is Allen L. Dutcher. My business address is 724 Hardin Hall, 3310 Holdredge Street, Lincoln, Nebraska.

Q. By whom are you employed?

A. I am employed by the University of Nebraska Lincoln.

Q. Are you the same Allen L. Dutcher who filed rebuttal testimony in this case?

A. Yes, I am.

Q. What is the purpose of your surrebuttal testimony?

A. The purpose of my surrebuttal testimony is to address several issues that Missouri Public Service Commission Staff ("Staff") witness Dr. Seoung Joun Won listed in his rebuttal testimony in regard to Ameren Missouri witness Steven Wills' testimony on weather normalization. Dr. Won set forth several erroneous conclusions in his testimony that require clarification.

Q. Dr. Won stated that Double Mass analysis is a subjective methodology that can introduce bias. Do you agree?

A. I do not. Double Mass analysis is a mathematical process. It analyzes the accumulation of temperature unit differences between two locations, identifies slope change

points, determines which location is responsible for the slope change, and then quantifies the degree of change when required. It is not subjective.

Additionally, the source (Menne) cited by Dr. Won referred to a 1986 study in the Journal of Climate,[1] which discussed the Pairwise Homogeneity methodology. The article discusses a process that is another form of the analysis the Company and Staff had previously used and which I advocate continuing to use. The Menne article states that Jones conducted an arduous station-by-station homogenization by manually determining the cause of the change points in paired difference series. The foundation of NCDC's methodology used laborious station-to-station temperature comparisons to identify discontinuities in temperature records at individual station locations. This aspect of NCDC's analysis is not the problem and is not subjective - to that extent the article cited by Dr. Won is supportive. However, while NCDC's methodology has a foundation based on the laborious inspection of data, it applies computational software to identify suspected discontinuity points. This is where the Missouri Public Service Commission ("Commission") should be concerned. No one, including Dr. Won, has been able to explain the computational process used by NCDC. The cited article provides no support for this process, which is the context in that Dr. Won attempted (improperly) to use it.

Q. Dr. Won also states that Mr. Wills implicitly assumes a bias in the St. Louis data series based upon a Double Mass analysis adjustment using a reference station data series with no documented change. Dr. Won continues to cite several reasons he claims show that this assumption is incorrect. Is Mr. Wills' assumption incorrect?

[1] Menne, M.J., and C.N. Williams, Jr., (2009) Homogenization of Temperature Series via Pairwise Comparisons, J. Climate, 22, p. 1701.

A. It is not. The Commission should remember that the adjustments used by Mr. Wills were agreed upon by Staff and Ameren Missouri as part of a compromise. I am told those adjustments have been consistently used since that agreement.

If Dr. Won is implying this concern impacts the discontinuities addressed in the 1999 Double Mass analysis study, then I take serious issue with his overall conclusion. Whether discontinuities are documented or undocumented, the Double Mass process I used will properly identify and address them. The source relied upon by Dr. Won (the Menne journal article) that raises undocumented changes as an issue is specifically concerned with this issue as it pertains to *an automated algorithm* for detecting and quantifying discontinuities for mass application to thousands of weather stations. The first sentence of the abstract of the Menne journal article states, "An **automated** homogenization **algorithm** based on the pairwise comparison of monthly temperature series is described."[2] (Emphasis added). I agree that undocumented changes would prevent an **automated process** from producing a valid result. However, we don't need an automated process, because we aren't calculating adjustments for every weather station in the nation. Because it is a focused review for one target station, the process I used overcomes this potential flaw. I **specifically review** every slope change and attribute it to the station (reference or target station) causing it. An automated algorithm cannot provide that level of review. These two processes are designed for different purposes and those different purposes have caused Dr. Won confusion.

Q. Are you saying that you review more than just the target and a comparison station?

[2] Id. at p. 1700.

A. Exactly. I would never run a Double Mass analysis only on the target station and one comparison station. This analysis must be run between all comparison stations, and it was.

Q. Please provide an example of how the process you used works.

A. For example, let's discuss how I came up with the values associated with the 1996 station move and ASOS installation at St Louis Lambert. The 1996 event is documented and appears on each comparison plot submitted in my rebuttal testimony. To describe the process of determining which station caused the discontinuity, I am going to call the 1996 event "Point A." From this discontinuity point, you follow the accumulation plot forward and backward to the first obvious slope change.[3]

As I compared the Double Mass plot of Lambert Field and St Charles maximum temperatures, there are obvious slope changes near points 4000 (Point B) and 5000 (Point C). A regression analysis is computed using the data found between Point B to Point A and between Point A to Point C. This will determine the slope change, which gives the resultant temperature adjustment, which should be applied to the Lambert temperature records.

If it is necessary to continue this analysis further back or forward in time so that there is enough data to make a reliable calculation, then the process repeats itself to determine whether Points B and C are the result of a change at Lambert Field or at the comparison station. If there is not a slope change identified, the discontinuity is likely the result of a change at the comparison station and can be verified by making sure that the suspected comparison station shows a discontinuity against the other comparison sites for the date in question.

[3] An automated algorithm could not conduct this type of comparison and thus can't achieve this level of accuracy.

If the discontinuity is the result of a change at the comparison station, the discontinuity point becomes the beginning point of the new relationship between Lambert Field and the comparison station. The analyst then looks at the accumulated difference data prior to Point B (meaning it looks backward) and beyond Point C (meaning it looks forward) to the next obvious pivot points until it identifies the location of the next discontinuity point. If it is Lambert Field, the slope change is calculated by determining the slope from Point B and/or Point C to the new discontinuity point and the slope change from the new discontinuity point to the next discontinuity point. If it is the result of the comparison station, the new pivot point once again becomes the beginning point of the next new relationship between St Louis Lambert and the comparison station. The process is repeated until all discontinuity points have been examined.

Q. Is there a difference in the data used in the analysis presented by Dr. Won and yourself versus the original analysis in Case No. EM-96-149?

A. Yes. The analysis in Case No. EM-96-149 was based upon raw, unaltered data. This is one of the most basic of premises for analyzing the impacts of discontinuities; that is, never trust that the data has been properly corrected. It is important to remember that the accumulated plots from the analysis for my rebuttal testimony in this case use the same data sets (called Final Data by NCDC) that Staff acquired from the Midwestern Regional Climate Center ("MRCC"). Final Data is not the raw, uncorrected weather data that was used in the analysis in Case No. EM-96-149. Final Data from MRCC is the raw weather data as modified during their Quality Control process to identify periods when missing data occurs, etc. I prefer to work with the raw, uncorrected weather data, but for this case I also used data acquired from MRCC for my analysis of the 2002 discontinuity.

Q. Does this difference in source data contribute to the parties' inability to recreate the 1996 analysis?

A. It is only logical that one would not be able to reproduce exact results when starting with different source data. As Mr. Wills testifies in his surrebuttal testimony, Staff does replicate a level of adjustment that is supportive of the agreed upon 1996 adjustments.

Q. Dr. Won next asserts a fundamental problem is the dependence of Double Mass analysis on the length of time series used. Do you agree the selection of time period can be a problem?

A. No. The analysis that I used is based upon objective criteria for determining the time scale for the regression calculation. As explained previously, Double Mass analysis is conducted from discontinuity point to discontinuity point. This may result in different time series, but because it is based upon the specific characteristics of each station (when the documented or undocumented change occurred), it identifies the appropriate time series for each discontinuity. It is also important to have a minimum amount of data available between discontinuity points to ensure that all seasons are represented in the data to avoid seasonality bias.

Contrary to Dr. Won's assertion, the time series is not randomly selected. I agree that to do so would interject bias. But the analysis is not run in that manner. It is the timing of the occurrence of discontinuity points that determines the length of the period for which the regression analysis must solve. By definition, that means there will be differing length of time series used. That does not interject bias.

Q. Dr. Won cites a communication with Richard Voytas of Ameren Missouri regarding which weather stations were chosen for the Double Mass analysis in Case No. EM-96-149. Why were those weather stations chosen?

A. The second basic premise of the Double Mass analysis is that two stations in close proximity will measure the environment in a similar fashion and that, over time, this relationship can be described by a linear function. Both Staff's and my Double Mass analysis output plots show these relationships throughout the study period. With that premise in mind, the six stations were selected because they all lie within the greater St. Louis area. The farther away a weather station is from Lambert Field, the more likely that weather events recorded at that station would not have occurred at Lambert Field. In simple layman's terms, a station in northern Illinois is not representative of stations in close proximity to Lambert Field. The stations selected for the 1996 analysis had correlations in the upper 0.9 range, which indicates a tight fit between stations. The lower correlated sites were discarded because they increased the standard deviation of the mean slope change average obtained from the comparison sites. As the variance increases, the confidence of the estimate decreases.

Q. Didn't Dr. Won testify that it is only an assumption that there is spatial correlation between Lambert Field and surrounding stations?

A. Yes, he did testify to that, but this testimony contradicts NCDC's own methodology of finding the highest correlated sites in proximity to Lambert Field. NCDC identifies the highest correlated sites for use in their determination of the adjustments that should be assigned to discontinuity events in 1988, 1996, and 2002. The highest correlated stations will provide the best estimate of the measurement change associated with any

discontinuity event. Highly correlated data reduces the potential spread of slope change estimates from comparison station plots.

Q. Dr. Won believes that NCDC's homogenization process is an improvement over the methodology previously used by Staff and Ameren Missouri. Do you agree?

A. No. This is a very broad statement that lacks any scientific credibility or support. NCDC's pairwise technique and subsequent derivation of the new normals was used for the first time and the results were not made available until last fall. We cannot know how reliable NCDC's technique is because there hasn't even been time for researchers to run a simulation of the technique, submit the research for publication, and have the results published. It has only been 12 months since the 1981-2010 normals were released. Second, as Dr. Won stated in his deposition, he did not replicate NCDC's pairwise technique to validate the output generated by computer modeling, so he cannot state that it is a superior technique. With all due respect, reading journal articles and looking at NCDC's output is not sufficient to validate the accuracy of NCDC's calculations.

Q. Dr. Won indicates that the pairwise technique avoids the problem of undetected discontinuities in reference stations. Do you agree?

A. In part. I disagree with the underlying assumption that the Double Mass analysis cannot detect discontinuities in the reference stations. To reiterate, Double Mass analysis looks at target stations relationship with reference stations **and** also looks at the relationship of reference stations to each other to determine what station is causing the Double Mass analysis accumulation plot to change slopes. The pairwise technique has to "overcome" the problem of undetected discontinuities that is experienced by automated

algorithms. It is not necessary to "overcome" this concern with the Double Mass technique, because there is a focused review of each station to identify all discontinuities, meaning there are no undetected discontinuities.

Q. Dr. Won points out that Ameren Missouri did not offer an adjustment for the 2002 evaluation change. Is this correct?

A. While it is true that the 2002 evaluation change was not addressed in Ameren Missouri's initial filing, it was addressed in my rebuttal testimony. At that time, I provided an estimated impact of the 2002 event.

Q. Since filing your rebuttal testimony, have you confirmed the level of movement for this change?

A. Yes, I have. My analysis indicates a minimum temperature change of .195 degrees and a maximum temperature change of .13 degrees. Mr. Wills will quantify the impact of these changes as part of his weather normalization surrebuttal testimony.

Q. Did you use the same process described in your rebuttal testimony when you developed these results?

A. Yes, I did. In order to determine the minimum temperature change, I ran the Double Mass analysis using Lambert Field and two reference weather stations; each of which had a correlation of over 95%.[4] When determining the maximum temperature change, I also used Lambert Field and two reference weather stations; however, the correlation for one station was a bit lower, at 91.8%.[5]

[4] I ran the analysis on a third station but the results indicated that there was a problem with the data from one of the reference weather stations, so I did not include the third station in my final analysis.
[5] I ran the analysis on three reference weather stations, but the correlation level for one of the reference weather stations did not support inclusion in my final analysis.

Q. Why did you use a reference station with a correlation below 95%?

A. My preference is to use a station with a correlation of 95% or higher. However, I would be more concerned about potential bias if I only used one reference station, so I determined it appropriate to use the second reference station with the lower correlation. Additionally, 91.8% is still a high correlation, and indicates a strong enough relationship to allow me to use it as part of the basis for my analysis.

Q. Does this conclude your surrebuttal testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Increase Its Annual Revenues for Electric Service.	)))	File No. ER-2012-0166

AFFIDAVIT OF ALLEN L. DUTCHER

STATE OF NEBRASKA

COUNTY OF LANCASTER

Allen L. Dutcher, being first duly sworn on his oath, states:

1. My name is Allen L. Dutcher and my office is located in Lincoln, Nebraska and I am State Climatologist for the School of Natural Resources at the University of Nebraska Lincoln.

2. Attached hereto and made a part hereof for all purposes is my surrebuttal testimony on behalf of Union Electric Company, d/b/a Ameren Missouri, consisting of 10 pages and Schedule(s) N/A, all of which have been prepared in written form for introduction into evidence in the above-referenced docket.

3. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded are true and correct.

Allen L. Dutcher

Subscribed and sworn to before me this 7th day of September, 2012.

Shellie J. Hanneman
Notary Public

My commission expires:

GENERAL NOTARY - State of Nebraska
SHELLIE J. HANNEMAN
My Comm. Exp. April 1, 2016