HOURLY WEATHER FORECAST ANALYSIS

by

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Presented to the Faculty of the Graduate School of

The University of Texas at Arlington in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

THE UNIVERSITY OF TEXAS AT ARLINGTON

August 2006

ACKNOWLEDGMENTS

I am indebted to a number of professors at the University of Texas at Arlington (UTA). I would like to express my deep thankfulness to Dr. Wei-Jen Lee for this guidance as a member of the author's graduate committee. Sincere appreciation is expressed to. Dr.Wei-Jen Lee for being my advisor and for giving me valuable advice. A great help from Mr. Kittipong Methaprayoon, one of Dr. Wei-Jen Lee's students, for his advice and continual encouragement throughout the thesis process is also truly appreciated.

A special thanks is extended to Energy Systems Research Center (ESRC) members for their suggestions to the author's thesis. Finally, I would like to express gratitude to my family members for their great support to my master's degree studies.

July 14, 2006

ABSTRACT

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Publication No._____

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The University of Texas at Arlington, 2006

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Today, internet becomes one of the most important resources for useful information. However, since the authentic of the information is difficult to verify, one also has to take precaution when getting information from the internet. Utility companies need to forecast their load for unit commitment scheduling and system planning. The traditional approach for neural network forecasting relies on the temperature forecasting information from a single source. The customer loads are closely correlated with the temperature. Therefore, the accuracy of the load forecasting is affected by the temperature forecasting errors. The objective of this thesis is to reduce the temperature forecasting errors by using artificial neural network (ANN) to preprocessing the temperature forecasting information from various resources. In this

thesis, temperature information from five (5) websites have been used fro this process. Each website provides hourly forecast temperature of 15 days. A JAVA program is designed to extract the useful temperature information from each individual web site and record them into the database (MySQL). Depends upon the available data, an ANN is then used to forecast hour ahead and day ahead temperatures up to seven days. Through this preprocessing, better weather information is obtained to have more accurate load forecasting results.

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CHAPTER 1

INTRODUCTION

Under decisive moment of the electric power system industry, the traditional operating environment of electric utility is unavoidably being changed. The power system operation will become more competitive in the open market environment. Thus, the basic operational functions such as generation resource planning and unit commitment scheduling should be effectively executed to maintain competitiveness in the market. The accuracy of load forecast is the primary. Load forecasting can be generally classified into many categories depending on forecast lead-time. In this study, we have paid attention to the accuracy of load forecasting within lead-time ranging from hours to days ahead. This is called short-term load forecasting (STLF), and it is an important factor to acquire optimal operation of generation control functions such as the hydro scheduling, unit commitment, hydrothermal coordination, as well as interchange transaction evaluation.

In the past, most energy firms were not concerned about minimizing their cost due to the guaranteed payback as a monopoly producer within their service area. This led to various issues such as inefficient production, irrational pricing policies, as well as overstaffing. As a result, open market concept was initialized to reduce the operational cost. In market environment, efficiency is the top priority for utility business which is

closely related to the demand forecasting. An underestimated or overestimated system demand can lead to profit loss. Therefore, an accurate model designed on closely evaluated demand values can be very helpful. Demand forecasting can provide operators with better estimation to economically dispatching the units. All this demand forecasting and efficient operation should be concurrently embedded with economy analysis to reduce the overall cost in both planning and real time operation.

To date, the artificial neural networks (ANN) has been receiving more attention over other algorithms to handle the load forecast. Determining the properties of the load is very difficult and it normally requires complex analysis. The main attraction of artificial neural network is that it simplifies this process through machine learning.

According to our previous experience, hour-ahead and day-ahead load forecasting are very sensitive to the forecast temperature. Currently, most of the neural network forecasting software depends on temperature forecasting information from a single source. Temperature forecasting errors become the major issues of load forecasting errors.

At present time, the Artificial Neural Network Short-term load forecast engine developed at Energy Systems Research Center (ESRC) employs the temperature forecast information from a single web site, www.accuweather.com, to perform load forecast. The engine has been installed and successfully operated in our sponsored utility in the State of Oklahoma. Artificial Neural Network has been proven to produce load forecast at superior quality to conventional regression based approach; however,

We have observed from time to time the significant error caused by large deviation of temperature forecast. Figure 1.1 illustrates two-day forecast from historical record with high temperature forecast error. The load forecast from actual temperature record is also provided as a comparison of the forecasting performance that would have obtained if better temperature forecast can be provided as input to the networks.

The main idea of this thesis is developing a front-end weather forecast to improve the accuracy of temperature forecasting. By integrating multiple weather forecast resources, with proper evaluation of individual forecasting performance, it is likely to improve the accuracy of temperature forecast. As the customer loads are closely correlated with the temperature; therefore, the accuracy of the load forecasting can be improved.

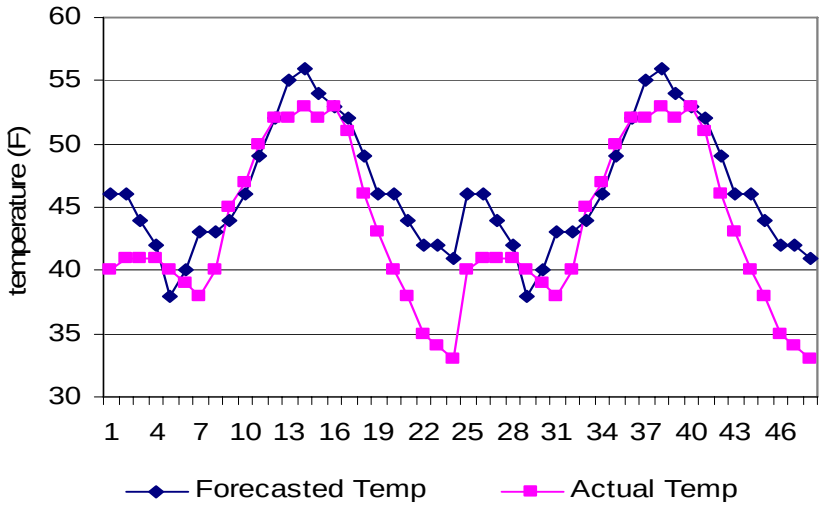


Figure 1.1 Two-day forecast from historical record with high temperature forecast error.

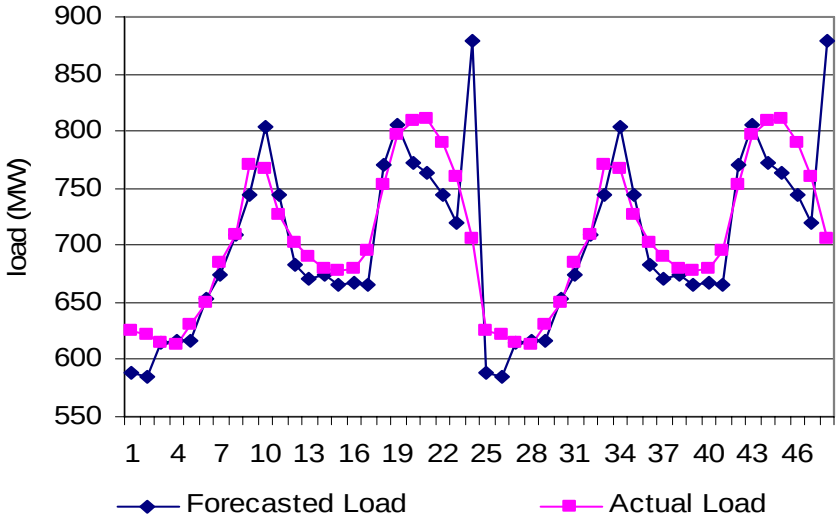


Figure 1.2 Two-day forecast from historical record with high load forecast error.

In this thesis, we have used up to five (5) websites www.accuweather.com, www.americaweather.com, www.findlocalweather.com, www.srh.noaa.gov, and www.weatherperhour.com to reduce the temperature forecasting errors by developing the front-end artificial neural network (ANN) module to preprocess the temperature forecasting information. The temperature forecast information is retrieved by JAVA programming for 5 service areas served by the sponsored utility. The data is recorded into and managed by MySQL database management system. The conceptually design is shown in the Figure 1.3.

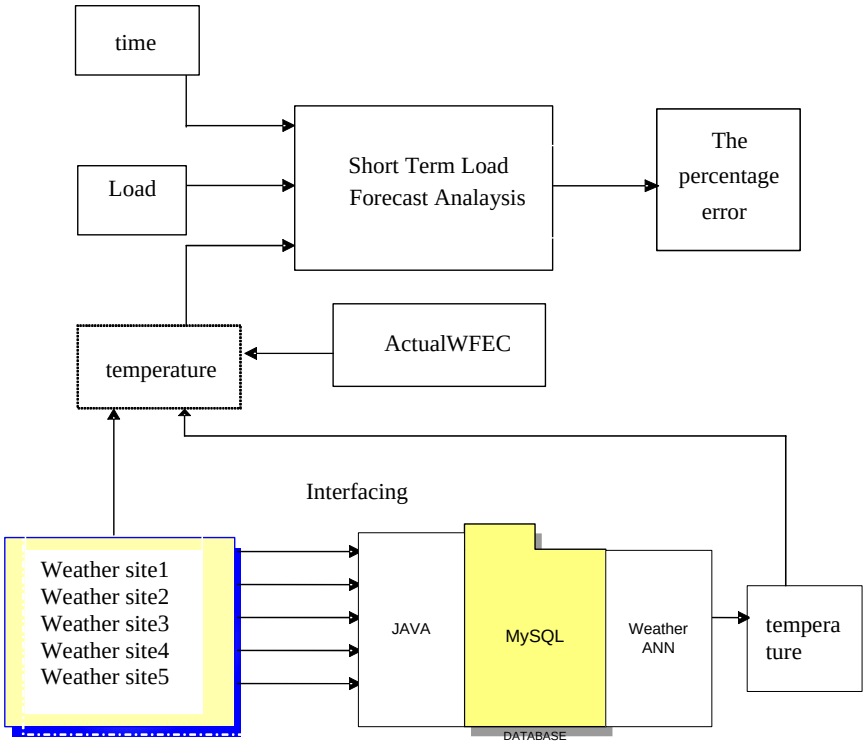


Figure 1.3 Weather Forecast System

The thesis structure is constructed as followed. Chapter 1 discusses the motivation of this thesis study. Chapter 2 deals with the fundamentals of programming. Chapter 3 describes designing temperature forecasting system. Chapter 4 addresses the short-term load forecast implementation. Finally, chapter 5 clarifies the conclusion and further studies of this thesis.

CHAPTER 2

THE PROGRAMMING FUNDAMENTAL

2.1 Artificial Neural Network

An artificial neural network (ANN) is a computing system that resembles the way biological nervous systems process information. The main characteristic of such a computing system is the number of highly interconnected processing elements (neurons) working together to solve specific problems without being programmed with step-by-step instructions. Instead, ANN's are capable of learning on their own or by example through a learning process that involves adjustments to the connections that exist between the neurons.

State of the art Neural Network research is inspired by the current understanding of the inter connectivity of biological Neural Networks within the human brain. Recent advances in computer technology (increased process speeds and so on) allows for the construction of Artificial Neural Networks (ANN) with similar features to the biological ones. An ANN is a model that emulates the biological neural network, where a very simple mathematical representation is employed to mimic the perceived biological neural activity.

Researchers have successfully developed a number of ANN architectures that have been shown capable of solving such problems as pattern recognition, classification, and forecasting, with pattern recognition and ultimately forecasting one of the biggest strength of many established ANN's. The term pattern recognition encompasses a wide range of information processing problems from speech recognition, the classification of hand-written characters, to fault detection in machinery and medical diagnosis. The most general framework in which to formulate a solution of pattern recognition problems is via a statistical model; with many statistical inspired ANN's having produced successful results. (Bishop, 1995)

The aim of a pattern recognition ANN is to categorize data in order to predict future events. Adaptive Resonance Theory (ART) NN and Radial Basis Functions (RBF) NN are two good examples of this type of ANNs, (Gail et al., 1987; Lowe and Webb, 1991). Several networks have been used to predict and monitor oceanographic time series. (Corchado and Fyfe, 1999; Corchado, 2000; Corchado et al., 2001) Attempting to predict the ocean structure encompasses both pattern recognition and forecasting techniques. Particularly good results have been obtained with the RBF in forecasting thermal oceanographic time series. (Corchado, 2000; Corchado et al., 2001) An RBF ANN has got the ability to learn fast (Lowe and Webb, 1991) – a critical requirement in dealing with real-time problems, and it's learning can be supervised by a simple rule based system which can control its dimensionality and the training time. (Fritzke, 1994) Nevertheless, as it is reported by (Corchado and Fyfe, 1999; Corchado,

2000; Corchado et al., 2001) that due to the heterocedasticity and multicolinearity of the oceanographic time series ANN's do not predict with the required accuracy by themselves.

2.2 The Background of Artificial Neural Network

The original inspiration for the technique was from examination of the central nervous system and the neurons (and their axons, dendrites and synapses) which constitute one of its most significant information processing elements. In a neural network model, simple nodes (called variously "neurons", "neurodes", "PEs" ("processing elements") or "units") are connected together to form a network of nodes hence the term neural network. While a neural network does not have to be adaptive per se, its practical use comes with algorithms designed to alter the strength (weights) of the connections in the network to produce a desired signal flow.

These networks are also similar to the biological neural networks in the sense that functions are performed collectively and in parallel by the units, rather than there being a clear delineation of sub-tasks to which various units are assigned (see also connectionism). Currently, the term ANN tends to refer mostly to neural network models employed in statistics and artificial intelligence. Neural network models designed with emulation of the central nervous system (CNS) in mind are a subject of theoretical neuroscience.

In modern software implementations of artificial neural networks the approach inspired by biology has more or less been abandoned for a more practical approach based on statistics and signal processing. In some of these systems neural networks or

parts of neural networks (such as artificial neurons) are used as components in larger systems that combine both adaptive and non-adaptive elements. While the more general approach of such adaptive systems is more suitable for real-world problem solving, it has far less to do with the traditional artificial intelligence connectionist models. What they do however have in common is the principle of non-linear, distributed, parallel and local processing and adaptation.

2.3 Artificial Neural Network architecture

Basic computing processing elements connected together in a form of layers which is composed to be ANN. This processing element, called neuron, is modeled as a multi-input and nonlinear processor.

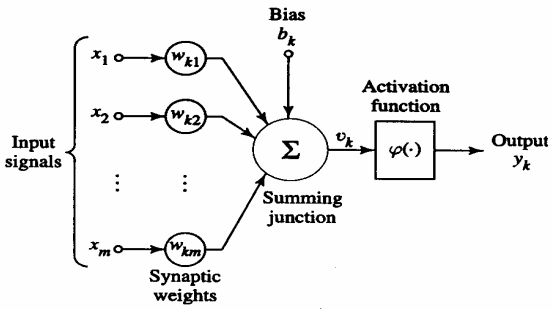


Figure 2.1 Nonlinear model of neuron

Each neuron receives all inputs and combines them with different weights. The combined input is passed through a so-called activation function to produce the output, which can be used as an input for other units. Equation below gives a mathematical expression of single neuron processing.

$$y_k = \varphi\left(\sum_{j=1}^{m} w_{kj} x_j + b_k\right)$$

Where x_j are the inputs; m is the number of inputs

y_k is the output of the neuron k

$\varphi(\cdot)$ is the activation function

w_{kj} are the synaptic weights

b_k is the bias of the neuron k

In the above equation, the synaptic weights are used to determine the strength of each transmitted input. These weights are adapted during training to establish appropriate mapping property of neural network. The bias also referred to as offset or threshold has an effect to the net summed input of the activation function. The level of transmitted signal between neurons is determined by activation function. The activation function is also referred to as a squashing function by that it squashes the summed input signal into the output within a certain range

2.4 Employing Artificial Neural Network

Perhaps the greatest advantage of ANN's is their ability to be used as an arbitrary function approximation mechanism which 'learns' from observed data. However, using them is not so straightforward and a relatively good understanding of the underlying theory is essential.

Choice of model: This will depend on the data representation and the application. Overly complex models tend to lead to problems with learning.

Learning algorithm: There are numerous tradeoffs between learning algorithms. Almost any algorithm will work well with the correct hyper parameters for training on a particular fixed dataset. However selecting and tuning an algorithm for training on unseen data requires a significant amount of experimentation.

Robustness: If the model, cost function and learning algorithm are selected appropriately the resulting ANN can be extremely robust.

With the correct implementation ANN's can be used naturally in online learning and large dataset applications. Their simple implementation and the existence of mostly local dependencies exhibited in the structure allows for fast, parallel implementations in hardware.

2.5 Application for weather forecast

One of the major problems in examining weather records for detecting changes in extremes is the lack of high-quality, long-term data (ground-based meteorological network does not operate over a common time period of adequate length). In general, the biggest drawback is that recorded data available must be gap-filled and quality controlled to provide a reliable continuous reference time series. It is important for time periods where no satisfactory reference series can be built due to an insufficient number of suitable nearby stations or large discontinuities in the time series. Good quality database like MYSQL undoubtedly provides a key source of historical meteorological information for detection and monitoring of climate variability. However, in general, the meteorological network was not designed to serve this function, and preliminary evaluations indicate that few weather stations meet the criteria necessary for inclusion

in a climatologically sub-network. The question of the adequacy of the meteorological network to meet this need for information on climatic variability has been widely addressed, through a systematic process of network evaluation and planning. This process is intended to lead to the evolution of an appropriate network of meteorological stations.

A common problem in numerical climate characterization is the spatiotemporal processing (integration or interpolation) of data from different types and different origins or accuracies (the space-time change of support problem).The basic idea is to import the entire posterior distribution from other locations allowing prediction of unsampled weather parameters using spatial related sampled information. The spatial distribution of rainfall is summarized by subjective descriptive four moment measures: mean variance, skewness and kurtosis, giving support to spatial pattern recognition (clusterization). As expected, this reliable and robust reconstruction method has good performance, since more information can be introduced in the decision-making system. In particular, they were able to capture the intrinsic dynamics of atmospheric activities, producing good long-term forecasting for periods of at least a complete cycle of ENSO/PDO. It seems that the dynamics is essentially non-chaotic in this time scale, but perturbed by a fairly large amount of noise. In addition, the knowledge of phenomena connected to the precipitation variability is very important, particularly where the cases of extreme precipitation events affect negatively the life of the populations provoking flooding and dislodgement of families or droughts that deprive them of essentials means of subsistence.

During last decade, numerous researchers have proposed diverse methods to forecast electricity load. A comprehensive review of methods based on ANN's is presented by Hippert (2001). W. Brockmann and S. Kuthe proposed several models to forecast electricity usage, from simple statistical models up to hybrid crisp-fuzzy, neuro-fuzzy models based on rules and learning. (Brockmann, and Kuthe, 2001) Their simplest model describes load as an average for the two years 1997 and 1998. This model is later improved by shifting the days of the week. However, it was still unable to account for holidays that do not occur on same date each year. Another model proposed by (Brockmann, and Kuthe, 2001) considers load as having a base value with oscillating variations superimposed. Additionally, an offset was included in the nominal load by means of a holiday indicator.

Fuzziness is introduced because the load and the oscillation of various holidays differ in amplitude and time. The effect of temperature on load variation was ignored as it was considered noise. Chang, Chen, and Lin (Chang, Chen, and Lin, 2001) used support vector machines to predict electricity load. In support vector regression, time series prediction is considered an optimization problem subjected to some constraints. In their experiments, Chang et al. used local modeling to generate predictions, finding segments in the time series that closely resembled the segment at the points immediately preceding the point to be predicted. Conversely, global modeling was also employed by training the model to predict the load of a particular day. Attributes such as maximum loads of past seven days, whether a day was a holiday or not, which day of the week was a particular day etc., were used in the global modeling. Temperature data

were discarded. Moreover, all days in January 1999 were treated as non-holidays to simplify the prediction.

Taylor and Buizza (Buizza 1999 and Taylor 2000) proposed a method to forecast electrical load using weather ensemble predictions. In their experiments they employed a feed-forward neural network with 10 nodes in the input layer, 10 nodes in the single hidden layer, and 1 node in the output layer. The input layer nodes were the 7 different days of a week and 3 weather variables. From the 7 nodes, 6 were used to represent different days in the week, and the last one was used for the second week of the industrial closure in the summer. The 3 weather variables employed were the effective temperature, cooling power of the wind, and effective illumination. Four different methods were modeled and tested to determine what influence the weather had on forecasting accuracy. The three methods based on neural networks, which used weather data showed better prediction results when compared to the one that did not use weather data. Moreover, the method that did the best forecast used actual weather data.

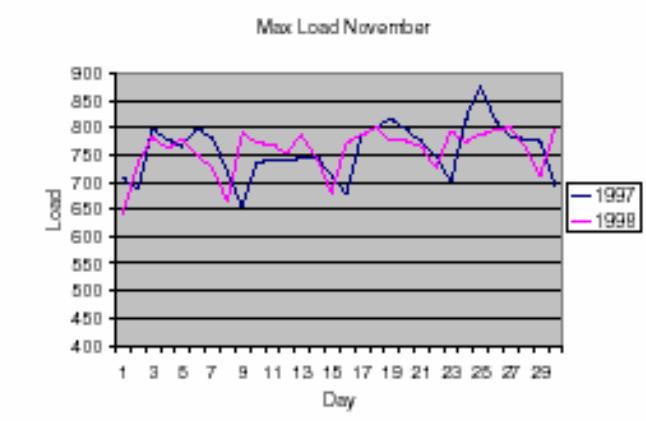


Figure 2.2 Load pattern

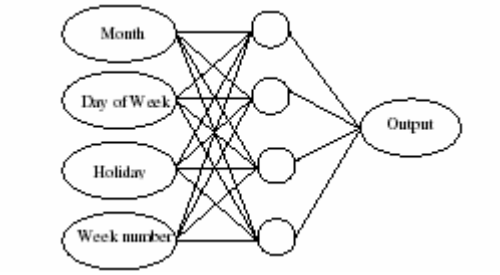


Figure 2.3 ANN in the final model

2.6 Why use JAVA programming to forecast?

In this thesis, attention have been mostly paid to JAVA programming part, since we would like to get the forecast information as accuracy as possible. More accuracy will be useful for utility companies in term of power system planning. Temperature is considered to be one of the most important variables in the short term load forecasting. If the forecast temperature is close to the actual temperature or with high accuracy, load forecasting will be also close to the actual load. From the load forecasting, we can estimate how much electricity utility should generate in each period to avoid overestimate and underestimate problems. Importing the forecasting information from various resources and perform front end temperature forecasting is the essential step that can improve the accuracy of the information to predict load. JAVA programming can deal with this mission.

2.7 Using MY SQL as database

Data storage and retrieval is a core element of most applications today. In the early days of software development, programmers wrote their own low-level code to

accomplish this. However, they quickly realized that in each application they were essentially reinventing the wheel. Through the usual cycle of trial, error, and subsequent refinement a solution was developed: the data storage and retrieval engine was abstracted into a stand-alone database server with the clients connecting to it and sending requests in a custom language called SQL (Structured Query Language).

Today, developers can choose from many data storage and retrieval products that use SQL. These products are usually referred to as SQL database servers, or sometimes relational database management systems (RDBMSs). Strictly speaking, an RDBMS system must comply with a set of formal requirements. It does not necessarily implement the SQL language, and vice versa an SQL server may comply only partially with a set of formal RDBMS requirements. However, for practical purposes, the terms are frequently used interchangeably; most RDBMS products implement the SQL standard, and an SQL server that complies only partially with the formal requirements of an RDMBS will still be regarded by many IT specialists to be in the RDBMS league. Products such as Oracle, DB2, Informix, and Microsoft SQL Server implement the SQL standard and are widely used in the industry. Even if you know nothing about SQL and relational databases, you have no doubt heard of these products they are the well-known giants in the world of SQL servers.

Unlike most database servers, MySQL is an open source product: its source code is freely available for download to anyone. Programmers can modify the source code to tailor MySQL to their needs. One of the values of open source products is that a wide range of professional developers and users contribute their experience to the

software, making it better. As a prominent open source project, MySQL has a large community of loyal supporters. MySQL has benefited in many ways from the contributions of the community, making it more than just a piece of software.

Decision makers in the IT industry are sometimes wary of open source products. The most common concern is that open source products do not have a commercial entity behind them that will take responsibility for supporting the software. In this respect, MySQL is different from most open source products. MySQL is a full-fledged company that, at the time of this writing, employs some 50 people all over the world who are responsible for development, support, sales, consulting, training, documentation, and other business functions.

MySQL has several million users, among them many corporate users. The most common uses of MySQL in a corporate environment are that many Web sites have to provide dynamic content such as a new site and/or collect some data from visitors , an online store. Thus, there arises the need to have some data storage and retrieval functionality in the Web application. As many Web developers have discovered, MySQL is a perfect tool for this kind of job. Free to obtain, easy to install and configure, and providing excellent performance and stability, MySQL has been a lifesaver for more than one CTO floundering in the perilous waters of the dot-com world. Some often hesitate to bypass a more expensive alternative, somehow thinking that if MySQL is free it cannot be good. Nevertheless, when they finally make the decision they are often surprised to discover that MySQL is not only able to handle the

load, but can often handle a load that none of the database “giants” they have tested has been able to.

Another common problem in the IT industry is logging events of various types for the purpose of subsequent statistical analysis or simply for record retrieval in the future. This could be, for example, a network traffic monitor, an ISP keeping track of dial-up users, a cell phone provider logging calls, or a Web usage counter. MySQL’s speed on insert and select queries makes it an attractive choice for this kind of application. And, of course, the other advantages of MySQL mentioned earlier make it only more attractive.

Various technologies today enable the accumulation of large collections of data. For example, a business could have a list of purchase records accumulated over the years, or a computer chip manufacturer could have collected a large dataset of test results. It could be very useful for various purposes to drill through the data and produce a number of statistical reports. MySQL’s speed on select queries makes it an excellent choice for many such problems. In fact, MySQL was originally written for the specific purpose of solving a particular data-warehousing problem more efficiently than what the market could offer at the time.

More and more often, software vendors are finding it necessary to integrate a database into their commercial products. For example, a desktop phone book application with various search capabilities will be much easier to write if a lightweight SQL server has been integrated into the system. The main considerations for a database server in this situation are the cost and the resource requirements. MySQL makes the

grade in both aspects. Although not free in this case, the license cost per copy could very well be below $10 if the volume is large enough. And, of course, MySQL is very frugal about the resource utilization, the binary itself being small in size and the server configuration options allowing it to use no more than a few kilobytes of system memory while still maintaining a decent performance.

Sometimes an application must process large amounts of data. A low-cost, lightweight database server is the ideal solution for an application programmer working under the restrictions of the embedded environment. In addition to the advantages mentioned in the previous section, all of which apply here, the portability of MySQL makes it an attractive choice. MySQL can already run on a large number of architectures. Even if it has not yet been ported to the target architecture, the high coding standards that diligently address potential portability issues make it very likely that the port could be done with minimal effort.

MySQL has earned a reputation for being able to run unattended for days even months—after initial setup. Here and there, of course, various issues arise and various bugs are discovered, just like in any other database server, but overall it is very uncommon for MySQL to go down—and when it does, it is usually able to recover gracefully from the crash. This reputation for reliability got MySQL noticed by a number of enterprise users, who decided it was a great product for their needs. The list includes Yahoo! Finance, Cisco, Texas Instruments, the United States Census Bureau, NASA, Novell, Blue World Communications, Motorola, and many others. The development team members are extremely focused on making MySQL reliable; they are

obsessed (at least by industry standards) with ridding betas of bugs. I have seen MySQL releases postponed in numerous instances just because a single and rather insignificant bug had not yet been resolved. The discovery of one serious bug is reason to build a whole new release and issue a public apology.

As this thesis, MySQL has been used to accumulate the importing data in every hour for almost a year. The large numbers of these data have never been problems for this database server in term of transferring the data, speed, righteousness of the transferred data and capacity. It still can work efficiency. There is no problem since we start installing and using it. until this time , it can prove how much the data base can do.

CHAPTER 3

HOURLY WEATHER FORECAST DESIGN

3.1 Introduction

In the original ANN based short term load forecasting (STLF) program for the target utility- Western Farmers Electric Cooperative (WFEC), the temperature forecasting information was obtained from a single resource. However, the quality of the STLF results was highly affected by the temperature errors. The temperature forecast accuracy has to be improved. Thus, attention has been given to increase the efficiency of the forecast which will affect the load for unit commitment scheduling and system planning by using additional resources. Load forecast problem is basically understood as a function-mapping problem; by a known characteristic of the problem, a specific model can be developed to extract the dependency among the independent variables and the target of interest. Due to its ability to provide good function mapping with robustness and fault tolerance, the model has been widely used for short-term load forecast (STLF).

This chapter aims to provide detailed descriptions of JAVA programming and the ANN-based model design to perform STLF of the target utility. The main effort was put in the reducing erroneous information by using more trustable resources. Other related issues to improve the forecast result as well as to aid network design are described.

3.2 Western Farmer Electric Cooperative (WFEC) Load Characteristics

WFEC is an electricity utility established in Oklahoma to meet the needs of Altus Air Force Base and various others establishments. 45% of its total electricity generation is utilized by the industrial load. WFEC has more than 10 generation facilities, one of them is a load based, six are gas fired and another 3 are combined cycle units all of which produce a total of 1300 MW units of electricity.

As shown in Fig. 3.1, WFEC has a large service area and may have significant temperature variation among distant regions. The temperature data are recorded separately in 5 different areas, namely ***Anadarko*** located at the center of the service area, ***Fort Supply*** in the north western area, ***Hugo*** in the south eastern, ***Pharaoh*** in the northeast, and ***Russell*** where Altus Air Force base is located.

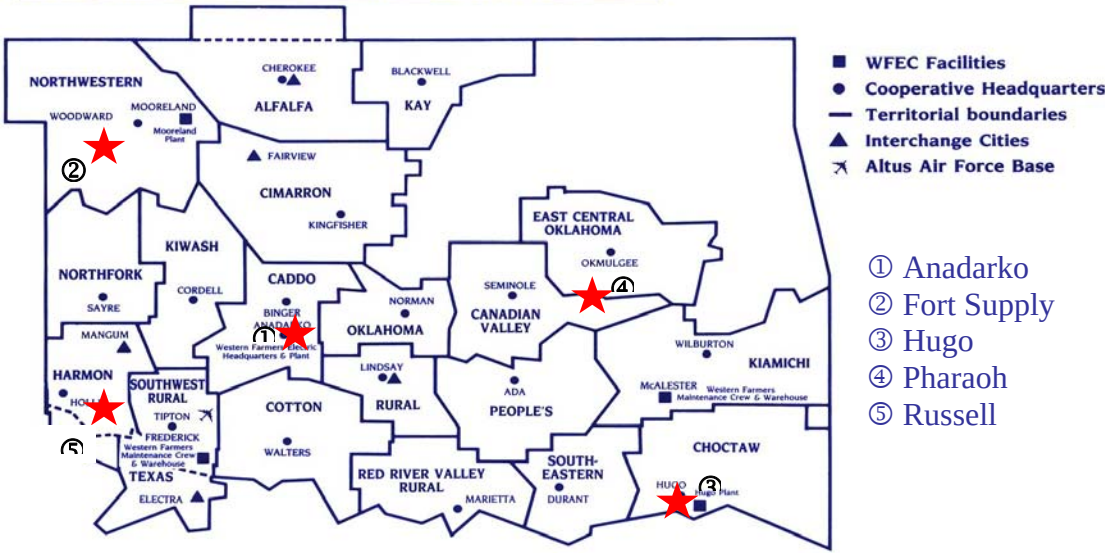


Figure 3.1 WFEC member systems' service areas and location of temperature stations.

As seen in the past, August has the maximum electricity requirement as compared to any other month in the year. 1181 MW and 1132 MW have been the recorded peaks for the year 2001 and 2002 respectively and both of them have happened in the August. The following four periods were set under the previous adaptive load forecast tool in their SCADA/EMS.

- Spring: March 03 to May 31
- Summer: June 01 to September 14
- Fall: September 15 to November 30
- Winter: December 01 to February 29

Models that have been generated to forecast the load continue to suffer from two major drawbacks. Firstly, load forecast is a complex model and it is difficult to define their variables in a perfectly accurate manner. The number of weather-related inputs is also limited. Second drawback is that all of these models are specific to change in the season. Hence any variation in the model parameters can greatly affect the local forecast.

Operational effectiveness can be achieved by improving the efficiency of STLF. ANN has proved to be an important tool in improving the performance of STLF.

A good trial run would be to have a forecast for only few days and compare the result with that of the previous year. Analysis over this period provides us with the accuracy details of the current model and helps in generating appropriate parameters.

The load patterns of WFEC are clearly diverse for different days; therefore, load forecast model has to be broken into several day types. Each daytype bears its own characteristic and separate ANNs are designed to capture those characteristics individually. Normally, Saturday and Sunday would have different load pattern compared to weekdays. Monday and Friday loads also have slightly distinct patterns from other working days due to their proximity to weekends. Four separate daytype categories are implemented in the program. Other special days (legal or religious holidays) are treated as weekends.

- Monday (daytype 0)
- Weekdays – Tuesday to Friday (daytype 1)
- Friday (daytype 2)
- Weekends – Saturday and Sunday (daytype 3)

As Daytype is an important factor in the load forecasting, we consider the hourly distribution of the days. Like in the early morning and evening, load from the residential unit constitutes a major part. However, in the afternoon commercial units consume a large part of the generated power. The design of ANN should also take into account the different trend of this change.

Period 1: 1 AM to 5 AM

Period 2: 6 AM to 8 AM

Period 3: 9 AM to 4 PM

Period 4: 5 PM to 9 PM

Period 5: 10 PM to 12 AM

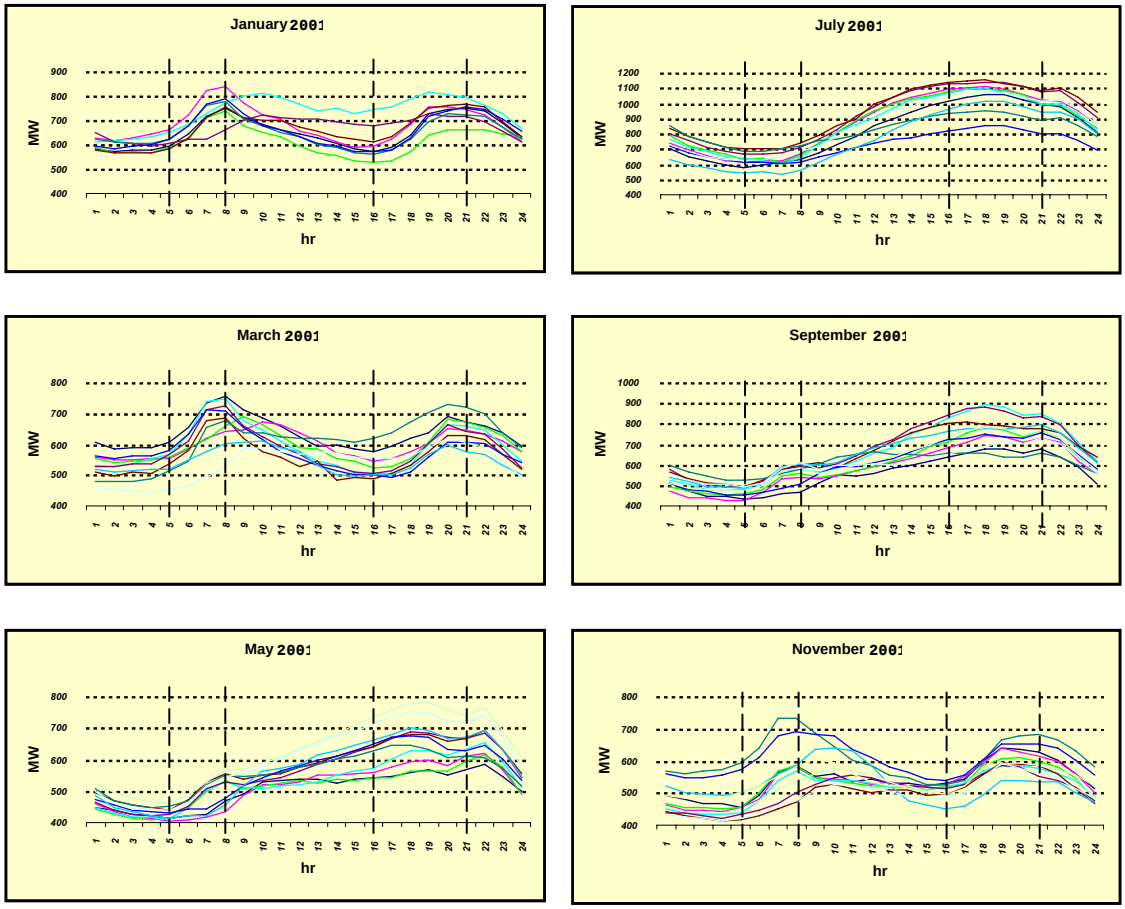


Figure 3.2 WFEC 2001 daily load patterns; sub-periods are divided by vertical dash line.

3.3 Effect of forecast temperature error on STLF performance

Minimizing the error of the forecast temperature plays an important part in determining the forecast performance, since in this program temperature is the only weather affecting variable being used. The error in forecast temperature is unavoidable when the program is put into effect. This section displays how the accuracy of temperature forecasting affects to load forecast results.

The error ranges of -5˚F through +5˚F of temperature forecast were used to simulate the load forecasting performance. The peak period was from August 2, 2005 to August 8, 2005. The MAPE of ANNSTLF hour-ahead load forecast and day-ahead load forecast at different temperature forecast error levels are shown in figure 3.3 and table 3.1.

Table 3.1 MAPE for different temperature forecast error range

Error Range	Day Ahead	Hour Ahead
-5	8.1649	3.6596
-4	7.6392	2.9915
-3	5.6332	2.3639
-2	4.5188	1.9298
-1	3.6454	1.8295
0	2.3642	0.9623
1	2.518	1.1758
2	2.8847	1.3362
3	3.5324	2.7893
4	4.3878	2.9384
5	6.2592	3.5223

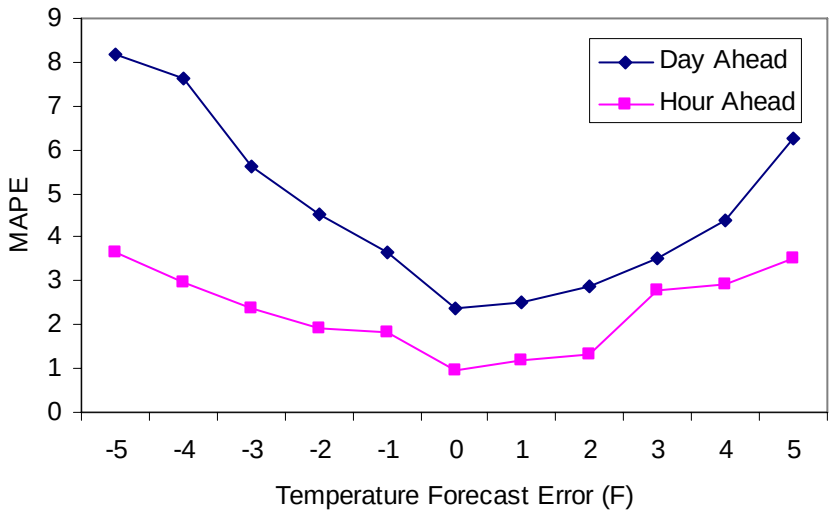


Figure 3.3 The average forecast error for different temperature forecast error from -5˚F to +5˚F.

That the values are plotted in figure 3.3 illustrate the load forecast is sensitive to the forecast weather information. When the absolute deviation of forecast temperature increases, the value of MAPE also increases rapidly. For the absolute temperature forecast within 3˚F, the MAPE of day-ahead forecast is within 5% and hour-ahead is within 2%. When the absolute temperature forecast reaches 5˚F, the MAPE of day-ahead forecast and hour-ahead forecast exceed 6% and 3%, respectively. It implies that if the erroneous information value is high, the value of MAPE tend to be high also.

When the forecast temperature happens to be overestimated or underestimated for a certain period of time, the effect of this temperature error will be accumulated and in turn significantly degrade the performance of ANN models. In this study, we

introduce integrating multiple weather forecast resources to improve accuracy of overall process in STLF performance.

3.4 Network Structure design

Currently, the load forecast performance relies on the accuracy of a single weather forecast source. To improve the efficiency of weather forecast as an input for load forecast, a multi-stage load forecast engine with front-end weather forecaster have been developed in this thesis. Its structure is shown in Figure 3.4. Two sets of neural network are connected together to perform the overall process. The first model gathers the raw weather forecast data from each website to estimate the results and calculates the proper temperature forecast as the output of the first stage, which will be used as an input to the second model to perform load forecast. The collection of temperature forecast information from various service websites automatically transfers the forecast information via web-based server by writing JavaScript and using MySQL as data storage.

For the second model, the load and weather information from local sensors are updated by EMS/SCADA on hourly basis and the raw temperature forecast from each individual web site are also updated. The load forecast simulation results using the proposed temperature forecaster, the actual temperature, and the raw temperature forecast are compared to verify the performance of the short-term load forecaster. The simulation replicates the process that actually takes place in the real-time operation of the program. Load forecast will be calculated for 168 hours, each iteration and the

simulation is moved onwards hour-by-hour until the whole simulation period is covered. The original day-ahead forecast result is updated at the beginning of the day. All simulation is performed on actual system load data. The load forecast using actual temperature case should have the lowest mean and standard deviation since the actual temperature is used to perform the forecast. The next best result is obtained from multi-stage STLF proposed model. For a raw temperature forecast taken directly into STLF program from each service website, it will have highest mean and standard deviation. The result of the simulation from August 24, 2005 to September 6, 2005, is as summarized in table 3.2.

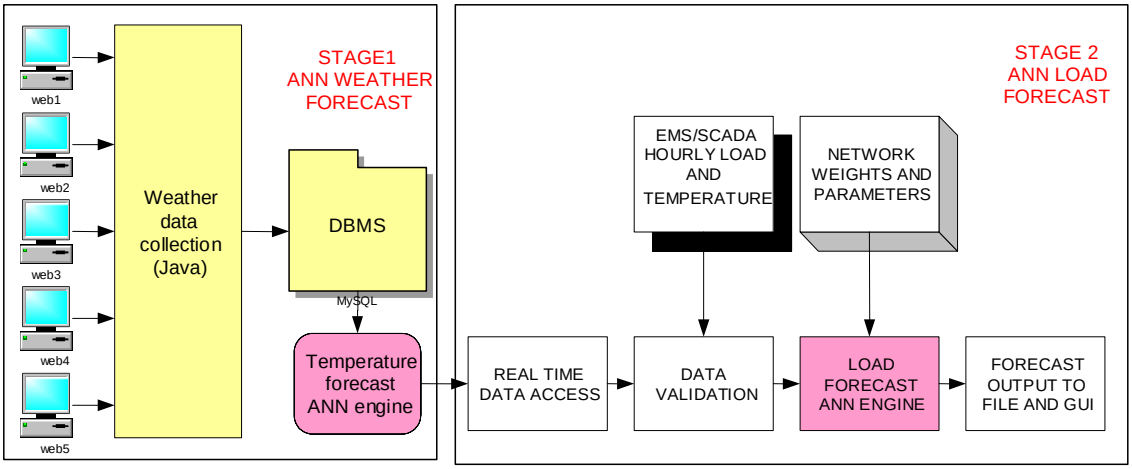


Figure 3.4 Structure of multi-stage STLF engine

3.5 Interfacing design

As mentioned, since temperature is the only weather affecting variable being used in the program, the accuracy of the forecast temperature plays a significant role in determining the forecast performance. This increasing accuracy is beneficial for the generation planning using results from load forecast program for unit commitment scheduling. The ANN STLF program is efficient in obtaining the hourly forecasting temperature information from various resources which helps the utility companies to get the less erroneous information as compared to using single resource as done in the past. The first thing that has to be done is to select the websites which provide the hourly forecast temperature for at least the next 2 weeks. In this work, there are 5 free websites to provide the required information.

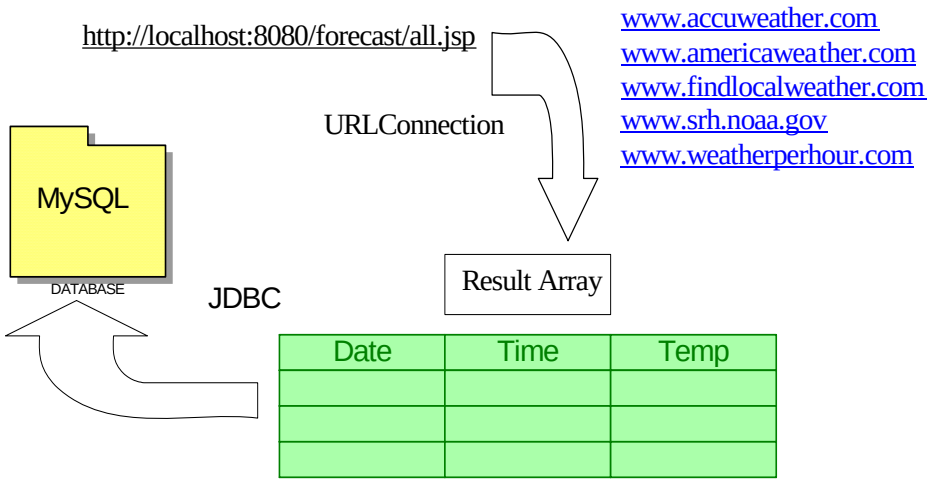


Figure 3.5 connecting between JAVA and The database

These resources are integrated by using JAVA (URL Connection Class). Even if the formats of data in the resources are tabular, there is something different in each website

such as the number of the data per page, or the arrangement of the data (vertical or horizontal). Result Array provides a way by which we can include the data from 5 different websites in a convenient and usable format, as seen in figure3.5. This further helps us in the forecast model by connecting it to the forecast database with the help of Java-Database Connection (JDBC). The forecasting temperature data will be automatically obtained from the database starting from 12 AM and continues till 11 PM every day. It will be updated automatically when new information appears on the websites.

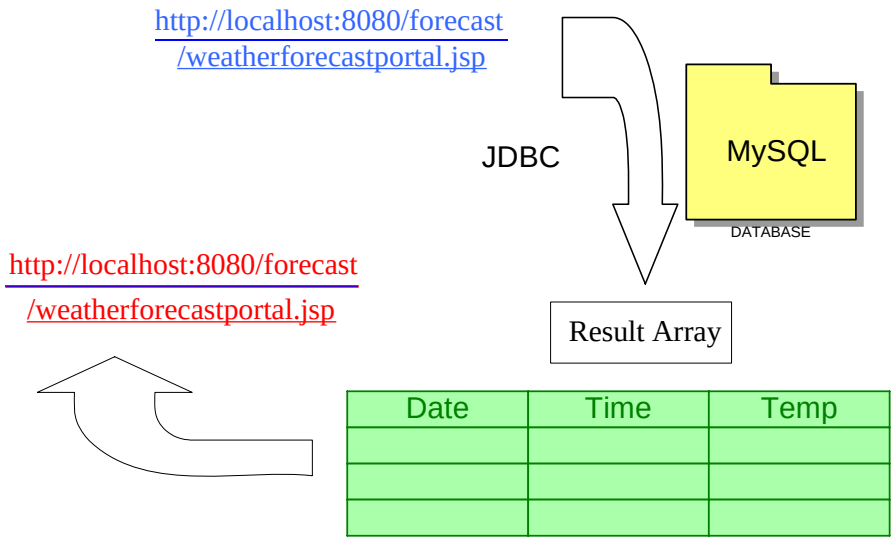


Figure 3.6 importing the data from the database to show on the java webpage

As shown in figure 3.6, users can go to http://localhost:8080/forecast/weatherforecastportal.jsp to obtain the forecast data from the database shown on this webpage.

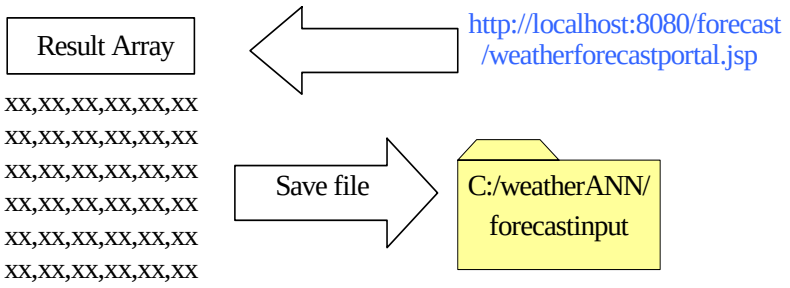


Figure 3.7 generating the output file

Because all the data that has been received previously from the resources is accumulated in the database, the past data can also be retrieved. As shown in figure 3.7, the data that are shown on the webpage will generate an output file under folder c:/weatherANN/forecastinput.

3.6 Temperature forecast error

The forecast accuracy is evaluated using the mean and standard deviation of percentage error and absolute percentage error. The forecasting accuracy is reported in terms of the maximum error and the mean absolute percentage error (MAPE) as defined by the following equation.

$$MAPE = \frac{1}{N}\sum_{i=1}^{N}\frac{\left|Actual_i - Forecast_i\right|}{Actual_i} \times 100 \qquad (3.1)$$

where N is the number of hours to perform the forecast

The peak load forecast is also important for effective resource planning of the utility. In practice, this information plays a vital role in performing the resource allocation and processing the energy transactions. For the target utility, if a very high peak load is expected on a certain day, they can call a ***peak load alert*** to notify their

members to prepare for load curtailment in those expected peak hours. It is important that this operation be done on the right day, as only a limited number of peak alert calls are allowed per year.

The accuracy of peak load forecast is measured by the MAPE of the peak load forecast. It is defined as the difference between the maximum predicted load and maximum actual load. For a given time period D days, the MAPE of peak load error is given by

$$\mathrm{MAPE_P} = \frac{1}{\mathrm{D}} \sum_{\mathrm{i}=1}^{\mathrm{D}} \frac{\left|\mathrm{Actual\,Peak_i} - \mathrm{Forecast\,Peak_i}\right|}{\mathrm{Actual\,Peak_i}} \times 100 \qquad (3.2)$$

Table 3.2 Absolute percentage error and percentage error between 8/24/05 to 9/6/05

Type	Max APE	Min APE	MAPE	Std APE	Max PE	Min PE	MPE	Std PE
Hour-Ahead Load Forecast								
actual	6.5891	0.0000	1.0932	1.0594	6.5891	-5.6539	-0.2848	1.4966
weatherANN	13.0275	0.0012	1.5753	1.8747	5.3368	-13.0275	-0.2085	2.4413
resource 1	19.8947	0.0042	1.9656	2.9637	6.7261	-19.8947	-0.8030	3.4594
resource 2	9.9396	0.0197	1.8235	1.8249	7.0229	9.9396	0.2787	2.5666
resource 3	12.2916	0.0028	1.9557	1.9974	8.7317	-12.2916	0.0632	2.7968
resource 4	13.2862	0.0112	1.7218	2.0718	6.0324	-13.2862	-0.4252	2.6616
resource 5	7.5195	0.0004	1.6031	1.4295	5.9093	-7.5195	0.3443	2.1218
Day-Ahead Load Forecast								
actual	16.9169	0.0094	2.8155	2.3951	16.9169	-8.7133	-0.8058	3.6105
weatherANN	13.4874	0.0336	4.3101	3.3194	13.4874	-13.1836	-1.1484	5.3224
resource 1	21.2302	0.0241	6.3938	5.1825	11.2538	-21.2302	-4.4750	6.9120
resource 2	32.0494	0.0080	5.1274	4.8612	32.0494	-12.4697	0.3323	7.0633
resource 3	29.5810	0.0566	4.9999	4.5969	29.5810	-13.6164	1.3455	6.6625
resource 4	17.8931	0.0475	6.0053	4.4047	17.4436	-17.8931	-3.5691	6.5418
resource 5	27.0421	0.0059	4.3197	3.9523	27.0421	-7.5591	1.3486	5.7020

MAPE = Mean absolutr percentage error
MPE = Mean percentage error
Std APE = Standard deviatiom of Absolute percentage error
Std PE = Standard deviation of Percentage error
APE = Absolute percentage error
PE = Percentage error

From the table 3.2, the average of MAPE for hour-ahead load forecast and day-ahead forecast from all 5 service resources is 1.8134, and 5.3692, respectively. As compared to the proposed model, the accuracy is increase by 15.1145% for hour-ahead forecast and 4.5725% for day-ahead forecast. The standard deviation also tends to improve the accuracy of forecasting result. This increasing accuracy supports the application of proposed model for actual load forecasting system.

3.7 Summary

This chapter describes the development of the STLF performance by using Java to integrate multiple service sources. Artificial Neural Network based Short-Term Load Forecasting program has been developed to implement load forecast in real time. The collection of temperature forecast information is stored in MySQL. Two types of forecasts were performed in the test (both of them are implemented in real time application). The dayahead forecast was generated for a whole day and forecast results were saved sometime in the morning. A load shape is calculated based on the previous day loads and weather information, and the forecast temperature of the particular day. The program calculates expected hourly load demand for a whole day at a time and the forecast results are frozen once they are recorded. Another type of forecast, the 1-hour ahead forecast, is updated hour-by-hour with the most current data obtained throughout the day to improve the forecast results of the following hours to be as accurate as possible. The errors for each type of forecast were analyzed. The raw temperature forecast from each website and the actual temperature have been used to compare the result with load forecast. The best result is obtained by comparing the load forecast

using actual temperature, the result from multi-stage STLF model, and a forecast data imported into STLF program directly from each service website.

CHAPTER 4

HOURLY WEATHER FORECAST IMPLEMENTATION

4.1 Weather Forecast Program Features

Since its accuracy directly affects the generation planning, this study aims to improve the results obtained from weather forecasts, from various resources, which will in turn be used by the sponsor utility's EMS. Under the scope of this study, the hourly weather forecast program will import data from 5 websites, record hourly forecast data of future hours and days, perform temperature forecasting from downloaded information, and display the results to the user via the java server webpage. The hourly weather forecast was developed using the JAVA programming language. The following features are included the overall package of the short term load forecasting program:

- The ANN STLF program uses the previous load and temperature information to calculate the hourly load forecasts. The program is capable of calculating load up to 168 hours ahead each iteration.
- Capable of obtaining the forecast information from the service websites free of charge.
- Automatically retrieve data from EMS/SCSDS system.
- Forecast results are available in tabular form. All archive forecast temperature data are saved in files which can be reloaded and displayed via the Graphical User Interface (GUI).
- Users are allowed to adjust the forecast temperature in the database. As system load is highly sensitive to the temperature change, large error in temperature

forecast which is taken directly from the online web source may induce a significant mismatch of load forecast results. The problem becomes obvious when the temperature deviation is consistent for a few hours, in which all errors are accumulated and affects the succeeding forecast. Thus this feature provides users an option to correct the temperature data and bring it closer to the actual weather conditions observed during the day.

- All archive temperature forecasts are stored in database that can be displayed via the developed Graphical User Interface (GUI).
- The java server webpage will display all the previous temperature data, hourly forecast temperature data, actual temperature from www.accuweather.com , and weatherANN.

4.2 Graphic User Interface

It is important to develop a Graphical User Interface (GUI) to view hourly weather forecast results, provide access to the forecast data in a sensible way. A GUI has been designed using Java server webpage for users to access the required information with minimum effort. The data can be presented in the form of table. Users can know the update forecast results for a particular day by just selecting the desired date. In addition, users can also observe regional forecast temperature from each weather station. Figure 4.1 depict some sample screens from developed GUI to display temperature forecast results.

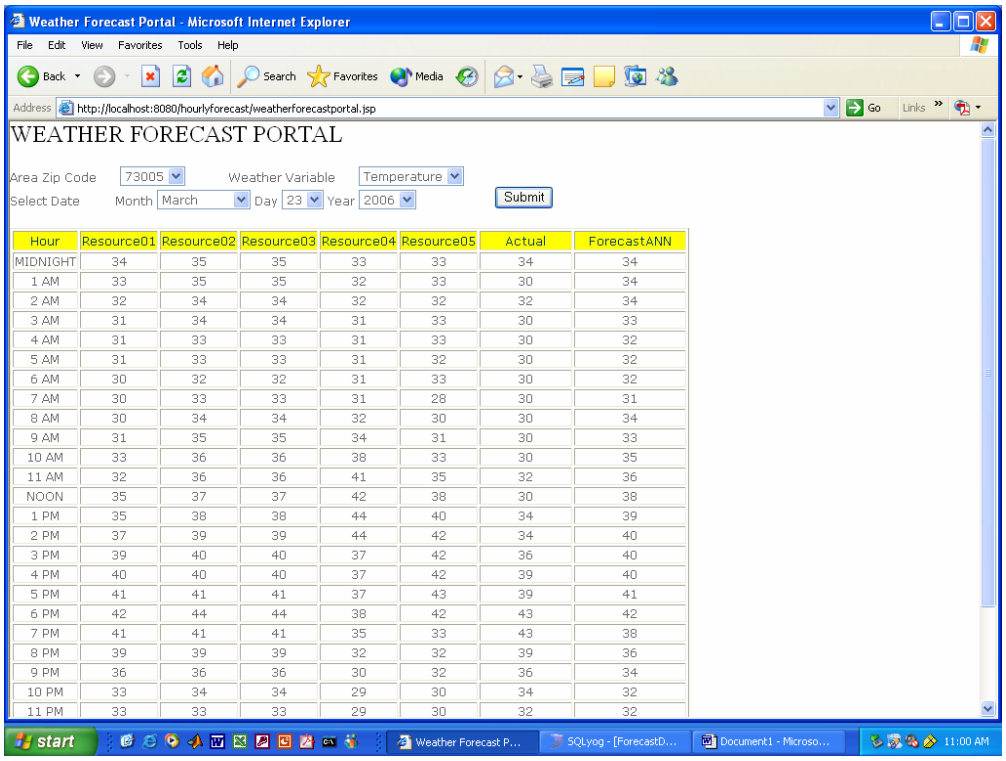


Figure 4.1 Java server page GUI; forecast result in tabular form.

To acquire the data from every interfaced website, one can choose the required date (past, present, and future), and place, from this webpage, http://localhost:8080/hourlyforecast/weatherforecastportal.jsp, and click the “submit” button. Once the required data is obtained for the particular date and place, it will be kept in “forecastinput” folder as show in the figure 4.2.

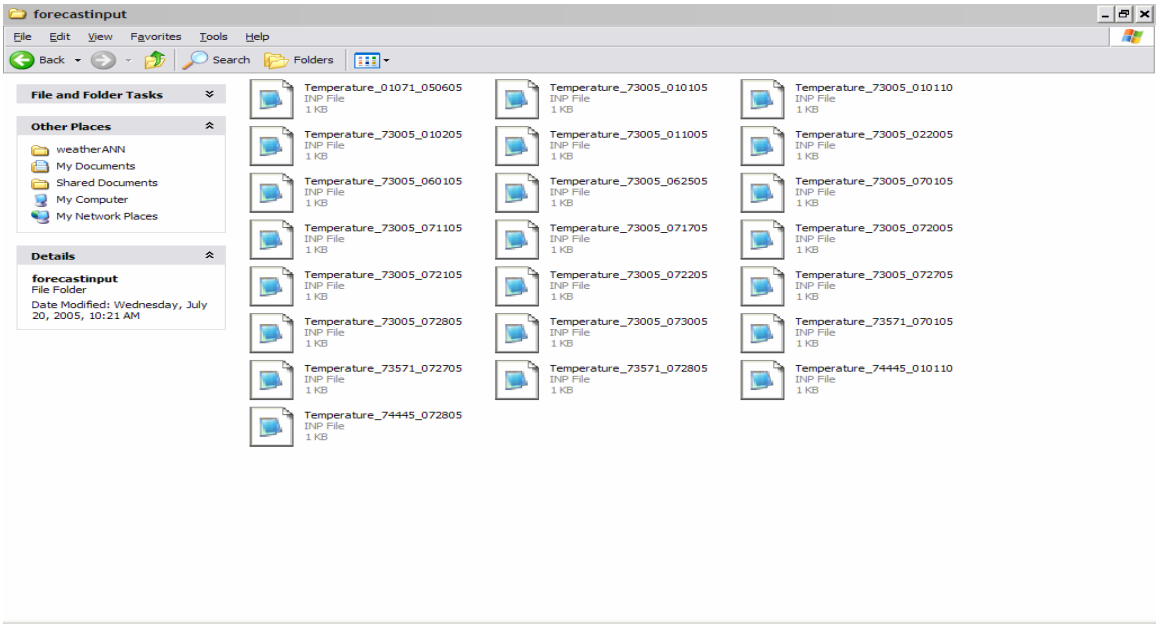


Figure 4.2 the “forecastinput” folder keeps all appeared data on the webpage

4.3 Implementation Results

The previous load and temperature data are updated by the STLF program which was evaluated in real time operation with the EMS system of WFEC, when the program starts working. The training process in Artificial Neural Network is then initialized to update network parameters (weights and biases) to capture load characteristics around the present time. The forecast temperature data is imported from various websites as weather input files for each weather station. Forecast time lead is determined by the availability of forecast weather information. Given the weather forecast information and previous load and temperature, to the STLF program automatically on an hourly basis,

the program will calculate the hourly forecast load. There are three types of output files used for storing the load forecast results.

The first output is the dayahead forecast file. The forecast load in this file can be used to analyze the performance of the program to perform the forecast for distant time lead, which is basically applied in the effective resource-planning functions such as unit commitment scheduling. The file also includes the hourly weighted temperature and the error associated with each hourly forecast.

The second output is the hour ahead forecast file. The structure of hour ahead forecast is almost the same as the dayahead forecast, except that the forecast loads will be updated hour by hour based upon recent load and temperature available throughout the day. The forecast results stored in these files also change when weather forecast is updated, either by weather forecast stations or by manual adjustment from the users. Thus, these output files provide the information of how well the program can track the changing load characteristics during the day. Normally, the output of forecast provides better results compared to dayahead forecast. Figure 4.3 shows the format of dayahead and hourly ahead forecast output.

The last output file is the temperature archive. These files have been created to collect regional weather information from different weather stations. The weather information from separate areas is recorded in temperature output files as a preparation for further development of regional load forecast model.

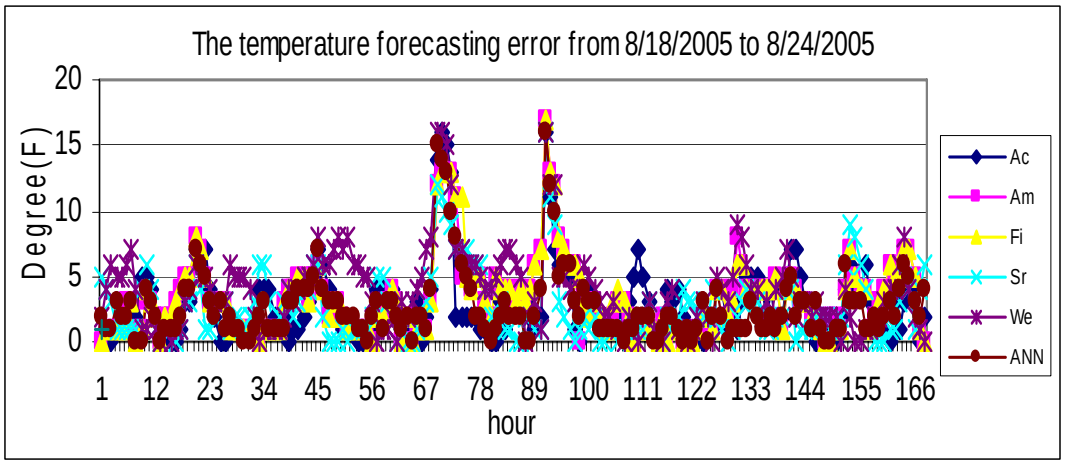
ForecastDay	Hour	Fcstload	ActLoad	%Fcst Err	WghFcstTemp	WghActTemp
7/14/2005	1	798	800	-0.21	77	75
7/14/2005	2	746	748	-0.32	76	74
7/14/2005	3	709	716	-0.97	74	73
7/14/2005	4	692	685	0.95	75	72
7/14/2005	5	673	671	0.24	72	71
7/14/2005	6	675	682	-1.03	74	71
7/14/2005	7	699	715	-2.27	73	71
7/14/2005	8	745	732	1.77	77	74
7/14/2005	9	768	763	0.66	80	77
7/14/2005	10	816	817	-0.18	84	79
7/14/2005	11	880	876	0.48	84	82
7/14/2005	12	945	943	0.25	89	87
7/14/2005	13	991	994	-0.25	88	90
7/14/2005	14	1036	1043	-0.63	89	90
7/14/2005	15	1079	1068	1.04	89	85
7/14/2005	16	1089	1088	0.09	89	90
7/14/2005	17	1087	1085	0.19	87	91
7/14/2005	18	1084	1106	-1.95	88	90
7/14/2005	19	1089	1095	-0.52	87	89
7/14/2005	20	1046	1063	-1.56	81	85
7/14/2005	21	1007	1020	-1.30	79	82
7/14/2005	22	999	1025	-2.49	76	79
7/14/2005	23	947	959	-1.20	76	77
7/14/2005	24	874	863	1.25	77	76

Figure 4.3 STLF dayahead and 1-hr ahead output format.

To evaluate the performance of the developed ANN STLF program to forecast WFEC's load by integrating multiple service websites, a comparison between forecast results from the STLF program and actual results is present from three distinct test weeks in three major different seasons. The first period is during summer 2005 - from August 18, 2005 to August 24, 2005. The errors of dayahead forecast and an hour-ahead forecast in this period are summarized in table 4.8. By averaging the entire test week, the developed ANN STLF program which uses various resources to provide the forecast result with 3.7407% MAPE for dayahead and 1.4639% for hour ahead. The average forecast MAPE from 5 resources in the same period is 4.5894% MAPE for dayahead and 1.6624% for hour ahead. Since we rely on the trend of temperature forecast from

various resources, the accuracy for dayahead forecast and hour ahead forecast is increased by 22.6877% and 13.5624%, respectively. The actual and forecast loads for all test weeks for dayahead forecast and hour ahead forecast are summarized in table 4.6 and 4.7.

It is apparent that STLF program provides a better forecast when it is used by the multiple resources to perform the load forecasting trend. This increasing accuracy encourages the generation planning.

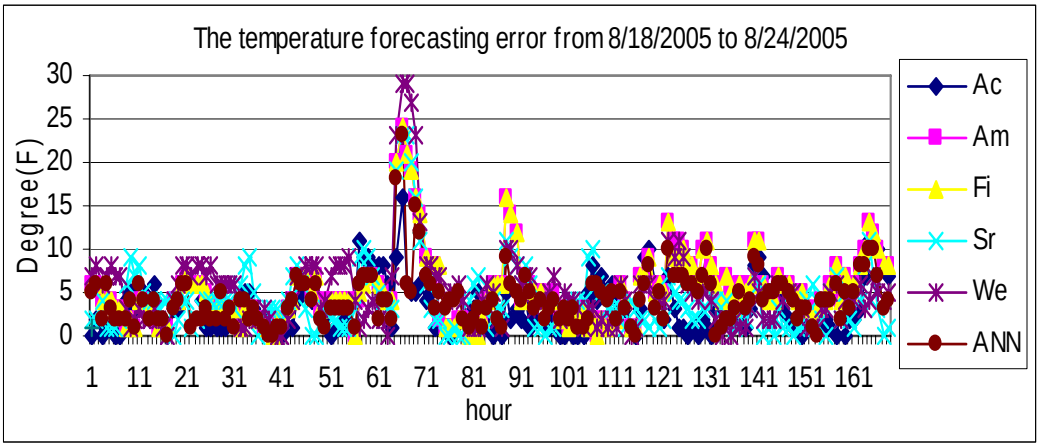


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.4 the temperature forecasting error at Anadarko during summer period.

Table 4.1 temperature forecast compare to actual temperature from multiple resoureces on the period 8/18/05 to 8/24/05 in Anardako.

Temperture Forecast (fahrenheit) on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	80	78	79	78	77	75	74	75	80	84	88	90	91	94	95	96	96	95	95	93	91	87	84
Americaweater	81	80	79	79	78	78	77	77	79	82	85	88	92	95	96	98	99	98	97	96	93	89	86	85
Findlocalweather	81	80	79	79	78	77	77	76	79	81	85	88	92	95	96	98	99	98	97	96	93	89	86	85
Srhnoaa	76	75	75	77	76	76	75	75	76	79	84	89	92	94	95	95	96	96	95	94	90	85	82	80
Weatherperhour	83	83	84	83	82	81	81	80	81	84	86	89	92	94	94	96	96	96	96	94	91	89	87	85
WeatherANN	83	80	77	81	79	77	77	76	80	81	85	88	92	94	95	96	97	97	96	95	92	89	86	84
Actual Temp.	81	79	78	78	77	75	74	76	80	85	88	90	92	93	94	95	95	93	92	88	86	84	83	82
Temperture Forecast (fahrenheit) on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	80	80	79	78	77	75	76	77	80	83	88	90	90	92	95	95	95	95	94	92	90	87	83
Americaweater	84	83	79	79	78	77	77	76	81	83	86	89	92	95	96	98	99	98	95	94	91	88	85	84
Findlocalweather	84	83	79	79	78	77	77	76	81	83	86	89	92	95	96	98	99	98	95	94	91	88	85	84
Srhnoaa	78	77	77	76	75	75	74	74	75	78	84	89	93	95	96	96	97	97	96	95	91	86	83	81
Weatherperhour	84	83	84	83	82	81	80	79	81	83	86	89	92	94	96	97	98	98	97	95	93	90	89	88
WeatherANN	78	79	80	79	76	76	76	76	79	81	86	89	92	91	95	97	98	97	96	94	92	88	86	84
Actual Temp.	81	80	78	78	77	76	76	77	81	84	87	90	91	92	92	94	94	93	92	89	85	84	83	81
Temperture Forecast (fahrenheit) on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	80	79	79	77	77	76	76	77	80	83	87	90	93	94	94	92	94	94	93	92	90	87	84
Americaweater	82	81	79	79	78	78	77	77	79	82	84	87	89	92	93	95	96	95	93	92	90	87	85	84
Findlocalweather	82	81	79	79	78	78	77	77	79	82	84	87	89	92	93	95	96	95	93	92	90	87	85	84
Srhnoaa	79	78	78	77	76	76	75	75	76	79	84	89	92	94	95	95	96	96	95	94	90	85	82	80
Weatherperhour	87	86	86	84	83	82	81	80	81	83	86	89	92	95	97	98	99	99	99	97	94	90	87	83
WeatherANN	82	81	80	80	78	78	76	75	78	83	84	88	90	93	93	95	93	96	93	93	93	88	85	81
Actual Temp.	79	79	78	78	77	77	76	77	81	84	87	91	92	92	95	95	95	94	92	89	78	74	72	71
Temperture Forecast (fahrenheit) on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	73	72	72	72	71	70	71	71	72	73	77	77	82	84	86	87	89	88	87	85	80	81	80	79
Americaweater	82	75	75	74	74	74	73	73	77	80	82	85	88	91	92	93	94	93	88	87	85	83	81	80
Findlocalweather	82	81	75	74	74	74	73	73	77	80	82	85	88	91	92	93	94	93	88	87	85	83	81	80
Srhnoaa	78	77	77	76	75	75	74	69	70	73	77	82	85	87	87	87	87	87	87	85	82	78	76	75
Weatherperhour	78	77	76	76	75	74	74	75	77	82	85	88	91	92	89	87	85	87	87	86	85	80	79	78
WeatherANN	79	76	75	74	71	71	71	71	73	74	81	83	87	89	89	89	90	90	87	86	83	80	80	80
Actual Temp.	71	70	70	70	69	69	70	71	72	76	78	81	85	87	89	89	88	86	71	74	73	75	74	74
Temperture Forecast (fahrenheit) on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	75	74	74	75	72	72	72	70	71	72	75	78	80	82	85	89	90	91	90	90	86	85	82	79
Americaweater	80	74	74	73	73	73	72	72	74	77	80	83	85	88	89	91	92	91	87	86	84	82	80	79
Findlocalweather	80	79	74	73	73	73	72	72	75	78	80	83	85	88	89	91	92	91	87	86	84	82	80	79
Srhnoaa	74	73	73	72	72	71	71	70	71	74	78	83	86	88	89	89	90	90	89	88	84	79	76	76
Weatherperhour	77	78	77	76	74	74	73	73	75	75	77	83	86	89	88	89	90	90	89	89	87	82	81	79
WeatherANN	77	76	75	74	73	72	72	72	73	75	77	80	84	87	88	90	91	91	88	88	85	82	80	78
Actual Temp.	74	74	71	71	70	71	71	71	72	74	77	81	85	89	90	92	91	91	89	86	83	81	80	79
Temperture Forecast (fahrenheit) on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	78	76	75	74	75	74	74	70	70	70	72	75	79	82	85	88	88	91	91	91	89	88	84	81
Americaweater	78	77	76	76	75	74	74	73	76	79	81	84	88	91	93	94	96	95	90	90	87	85	82	81
Findlocalweather	78	77	77	77	75	74	74	73	75	77	81	84	88	91	93	94	96	95	90	90	87	85	82	81
Srhnoaa	75	74	73	73	72	72	71	71	71	73	78	84	88	90	91	89	91	92	91	90	86	81	78	79
Weatherperhour	79	78	78	77	76	75	74	74	77	80	83	86	88	91	91	93	94	94	94	93	87	83	82	81
WeatherANN	78	77	78	75	74	74	72	71	73	72	76	79	81	85	88	91	90	91	91	90	87	83	82	81
Actual Temp.	78	76	75	75	76	70	70	71	72	71	75	80	84	87	89	90	92	90	89	86	82	81	79	78
Temperture Forecast (fahrenheit) on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	76	77	76	75	74	74	73	74	76	80	83	85	89	90	92	93	94	91	90	91	89	88	85	83
Americaweater	80	79	76	76	77	76	74	74	75	79	83	87	91	95	97	98	100	99	96	95	92	89	86	85
Findlocalweather	80	79	76	76	75	75	74	74	75	79	83	87	91	95	97	98	100	99	96	95	92	89	86	85
Srhnoaa	77	75	75	74	74	73	73	72	73	76	81	87	91	93	94	94	95	95	94	93	89	83	81	79
Weatherperhour	80	80	79	78	77	76	75	74	80	84	87	90	93	95	96	97	98	98	97	96	89	86	86	85
WeatherANN	79	80	76	76	75	75	74	72	79	81	84	90	91	91	95	96	97	96	95	94	90	87	83	81
Actual Temp.	78	77	77	76	75	74	75	78	82	84	87	91	92	93	94	94	94	94	91	88	85	84	85	85

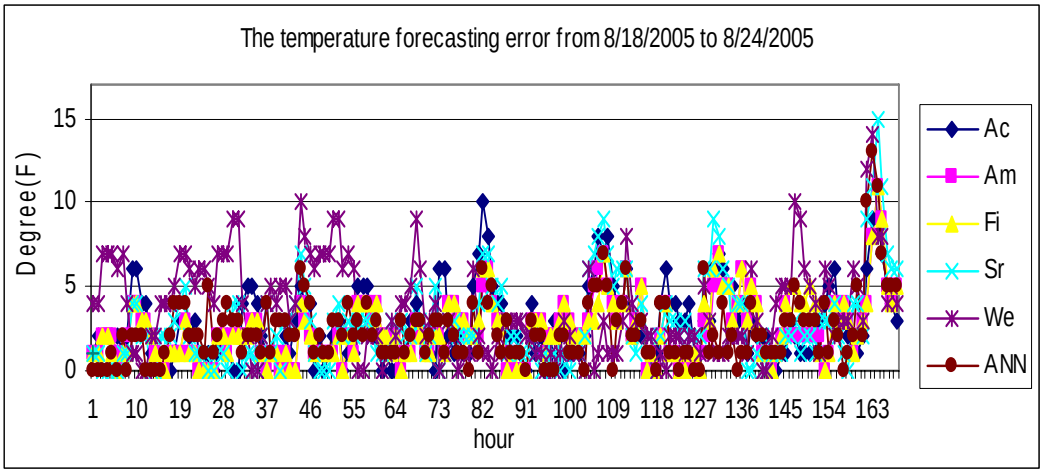


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.5 the temperature forecasting error at Fort supply during summer period.

Table 4.2 temperature forecast compare to actual temperature from multiple resoureces on the period 8/18/05 to 8/24/05 in Fort supply.

Temperture Forecast (fahrenheit) on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	76	77	76	76	75	74	74	73	76	80	86	88	92	93	97	98	100	99	97	96	92	91	88	85
Americaweater	82	81	80	79	78	77	77	76	79	82	86	89	93	96	98	99	101	100	98	96	93	91	88	87
Findlocalweather	82	81	80	79	78	77	77	76	79	82	86	89	93	96	98	99	101	100	98	96	93	91	88	87
Srhnoaa	74	73	72	74	73	73	72	71	72	76	82	88	92	95	96	96	96	96	96	94	90	84	80	78
Weatherperhour	83	83	82	82	82	81	81	80	80	85	87	91	94	96	97	99	100	100	100	98	94	92	90	89
WeatherANN	81	81	78	81	77	76	76	75	77	84	84	89	94	95	97	98	100	99	98	96	92	86	84	83
Actual Temp.	76	75	76	75	74	74	74	77	81	83	90	93	96	99	99	100	100	96	94	90	86	85	82	81
Temperture Forecast (fahrenheit) on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	80	79	78	78	78	77	76	77	81	86	89	92	94	96	97	98	97	94	93	91	89	86	83
Americaweater	85	82	81	81	80	79	78	77	79	83	86	89	93	96	97	99	100	99	97	96	93	90	87	86
Findlocalweather	85	82	81	81	80	79	78	77	79	83	86	89	93	96	97	99	100	99	97	96	93	90	87	86
Srhnoaa	76	75	74	73	73	72	72	72	74	77	84	91	95	98	100	100	100	100	100	97	92	86	82	79
Weatherperhour	87	87	84	83	83	82	81	79	81	84	86	89	91	93	96	97	98	98	97	96	93	91	90	87
WeatherANN	83	81	80	82	79	79	76	74	78	84	86	89	93	95	97	98	99	99	97	96	92	89	86	85
Actual Temp.	80	79	78	77	77	76	75	78	82	86	89	91	94	95	97	97	98	96	93	89	86	83	82	79
Temperture Forecast (fahrenheit) on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	77	77	77	75	74	72	71	71	71	77	80	84	85	87	89	90	83	85	75	75	75	75	75	76
Americaweater	84	83	81	80	79	78	76	75	78	80	82	85	87	90	91	93	94	93	90	89	86	83	80	79
Findlocalweather	84	82	81	80	79	78	76	75	77	80	82	85	87	90	91	93	94	93	90	89	86	83	80	79
Srhnoaa	78	76	75	74	74	73	73	72	73	76	80	85	88	91	92	92	93	92	92	90	86	80	77	74
Weatherperhour	84	83	84	84	83	82	81	79	81	84	86	88	91	93	95	96	97	98	98	97	93	82	79	79
WeatherANN	83	80	80	79	78	77	75	74	76	79	82	85	91	91	91	91	92	92	75	75	85	81	78	77
Actual Temp.	81	79	77	76	75	74	72	75	82	86	89	92	93	95	95	89	74	69	69	70	70	69	71	71
Temperture Forecast (fahrenheit) on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	71	70	70	71	71	71	70	71	72	75	76	77	78	80	77	77	79	79	78	74	75	75	73
Americaweater	79	72	72	71	71	71	71	71	74	77	79	81	83	85	86	88	89	88	81	81	79	78	76	75
Findlocalweather	79	78	72	71	71	71	71	71	74	77	79	81	83	85	86	88	89	88	81	81	79	78	76	75
Srhnoaa	73	72	71	70	69	69	69	67	68	70	74	78	81	82	83	83	84	84	83	82	79	74	72	71
Weatherperhour	78	77	75	75	75	75	73	72	73	78	81	83	82	81	79	82	85	84	83	81	80	76	75	75
WeatherANN	74	75	74	74	74	74	71	70	72	74	78	80	81	81	81	81	81	81	81	81	78	76	75	73
Actual Temp.	71	70	71	70	70	69	69	71	74	77	77	77	77	79	80	72	75	76	77	74	73	73	71	71
Temperture Forecast (fahrenheit) on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	71	71	71	70	70	70	70	69	70	71	75	76	79	81	84	86	88	89	88	85	88	85	82	79
Americaweater	74	74	73	73	72	72	72	72	74	77	79	81	83	85	86	88	89	89	89	89	86	84	81	80
Findlocalweather	74	73	73	73	72	72	72	72	74	77	79	81	83	85	86	88	89	89	89	89	86	84	81	80
Srhnoaa	69	68	68	67	67	66	66	65	66	69	73	78	81	84	85	85	86	86	85	84	81	76	74	73
Weatherperhour	75	76	73	75	75	74	73	70	72	76	78	81	83	85	87	88	89	90	89	88	85	81	80	78
WeatherANN	73	73	73	73	73	73	71	70	73	73	73	78	80	82	86	87	88	89	88	86	85	83	79	79
Actual Temp.	70	69	71	70	71	70	70	69	75	79	79	83	84	87	88	82	85	90	88	82	79	75	76	74
Temperture Forecast (fahrenheit) on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	72	69	67	67	67	68	67	68	69	72	74	78	80	82	85	88	88	88	88	86	85	82	81
Americaweater	79	78	77	77	76	75	75	74	76	79	80	83	86	89	90	91	92	92	91	91	88	84	81	80
Findlocalweather	79	78	75	75	76	75	75	74	76	79	80	83	86	89	90	91	92	92	91	91	88	84	81	80
Srhnoaa	72	72	71	70	70	70	69	69	69	71	76	81	84	86	87	87	88	89	88	87	83	78	75	76
Weatherperhour	78	76	75	77	75	73	72	71	71	74	76	79	82	84	85	86	87	88	88	87	82	80	79	78
WeatherANN	76	75	73	73	73	73	73	72	73	78	78	77	81	80	87	85	91	90	89	89	85	82	82	81
Actual Temp.	74	65	66	66	66	67	67	67	66	68	72	77	82	82	85	88	86	87	85	80	77	78	77	76
Temperture Forecast (fahrenheit) on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	75	74	72	71	70	70	71	71	71	73	76	78	81	84	87	88	89	91	91	91	90	88	86	84
Americaweater	78	77	76	75	75	75	75	75	75	78	82	85	89	92	94	95	97	96	94	93	91	88	86	85
Findlocalweather	78	77	76	75	75	75	75	75	75	78	82	85	89	92	94	95	97	96	94	93	91	88	86	85
Srhnoaa	74	72	71	70	70	69	68	67	68	72	78	84	88	90	92	92	92	92	92	91	86	81	78	76
Weatherperhour	77	75	75	75	74	73	73	72	73	77	81	84	87	90	91	94	95	94	87	84	86	83	82	82
WeatherANN	77	77	75	74	73	73	75	72	72	78	82	83	87	90	92	93	96	96	92	90	89	85	81	81
Actual Temp.	71	71	70	70	71	70	72	73	72	74	78	79	81	88	87	90	91	88	84	80	79	78	78	77

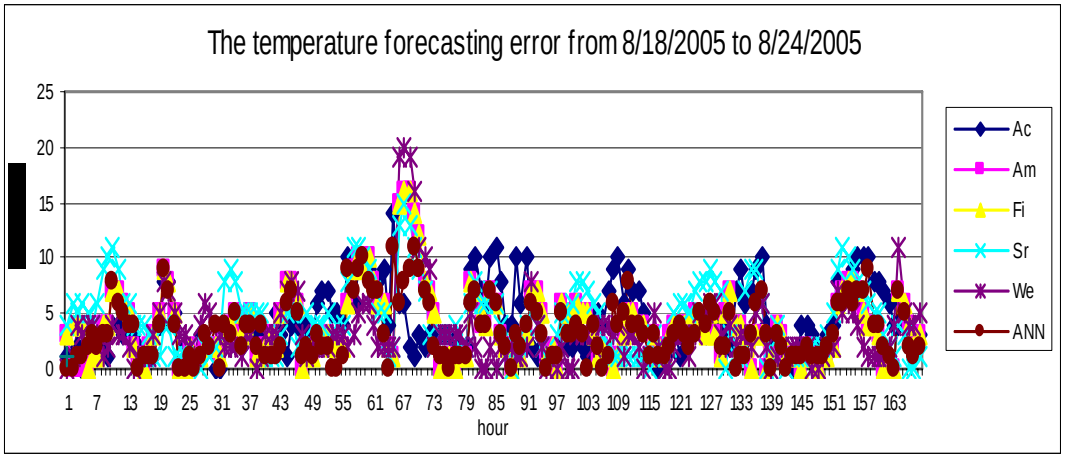


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.6 the temperature forecasting error at at Hugo during summer period.

Table 4.3 temperature forecast compare to actual temperature from multiple resources on the period 8/18/05 to 8/24/05 in Hugo.

Temperture Forecast (fahrenheit) on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	80	78	78	77	76	75	74	75	76	80	84	87	91	93	94	95	95	95	95	92	90	88	84	81
Americaweater	80	79	78	77	76	76	75	75	78	82	85	88	90	93	94	95	96	95	93	92	89	86	83	82
Findlocalweather	80	79	78	77	77	77	76	76	78	82	85	88	90	93	94	95	96	95	93	92	89	86	83	82
Srhnoaa	82	81	80	79	78	77	76	76	78	82	86	89	92	94	96	97	97	97	96	94	90	86	84	83
Weatherperhour	85	84	87	86	85	83	82	81	83	85	88	91	94	96	98	99	99	99	99	96	94	90	89	88
WeatherANN	81	80	80	79	77	77	77	77	80	84	86	91	92	94	94	96	97	98	96	93	90	87	85	83
Actual Temp.	81	80	80	79	78	77	75	77	82	86	88	91	92	94	94	95	95	94	92	89	88	85	83	82
Temperture Forecast (fahrenheit) on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	82	80	80	78	76	75	74	74	76	80	84	87	91	93	94	94	97	96	96	93	90	88	84	81
Americaweater	81	80	79	78	77	77	76	76	79	82	85	88	90	93	94	95	96	95	93	92	89	86	83	82
Findlocalweather	81	80	79	78	77	77	76	76	79	82	85	88	90	93	94	95	96	95	93	92	89	86	83	82
Srhnoaa	81	80	80	79	78	79	78	78	80	84	88	91	94	91	93	95	98	98	97	95	91	87	85	83
Weatherperhour	86	84	88	87	85	84	83	82	83	85	88	91	94	97	99	100	100	98	97	98	94	91	90	90
WeatherANN	86	81	83	83	82	78	77	77	79	83	86	90	94	93	98	98	98	97	95	94	91	88	85	85
Actual Temp.	81	80	81	80	78	75	74	78	81	85	88	89	90	92	95	95	95	95	93	88	86	84	84	83
Temperture Forecast (fahrenheit) on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	82	82	80	79	77	76	76	75	77	81	86	89	92	93	94	96	96	96	97	93	89	87	84	81
Americaweater	81	80	79	78	77	77	76	76	78	82	85	87	90	92	93	94	95	94	93	92	89	87	84	83
Findlocalweather	81	80	79	78	77	77	76	76	78	82	85	87	90	92	93	94	95	94	93	92	89	87	84	83
Srhnoaa	82	81	81	80	79	78	77	77	79	83	86	90	93	95	97	98	98	97	96	94	90	87	85	86
Weatherperhour	89	88	87	85	83	82	81	80	82	84	86	89	92	95	97	98	99	99	99	98	93	88	86	85
WeatherANN	83	82	81	79	79	79	77	77	80	82	86	88	91	93	95	95	98	96	96	92	90	87	85	84
Actual Temp.	82	81	78	76	77	75	75	80	82	86	88	91	92	94	94	96	95	95	94	89	87	86	83	81
Temperture Forecast (fahrenheit) on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	78	76	76	75	74	74	74	73	75	78	84	88	90	93	95	95	95	95	94	94	88	86	83	80
Americaweater	82	83	82	80	79	78	77	76	80	83	86	89	91	94	95	96	97	96	94	93	90	87	84	83
Findlocalweather	82	83	82	80	79	78	77	76	79	82	86	89	91	94	95	96	97	96	94	93	90	87	84	83
Srhnoaa	84	83	81	79	78	77	77	76	78	81	85	88	90	92	94	95	95	95	93	92	88	84	82	80
Weatherperhour	84	83	81	78	76	74	74	72	84	87	91	93	96	98	98	100	100	99	96	92	88	85	83	82
WeatherANN	81	81	81	78	77	76	75	74	81	82	88	88	92	98	98	98	98	97	94	93	89	86	83	81
Actual Temp.	84	82	78	76	76	75	75	78	82	88	92	93	94	97	95	97	97	96	94	90	87	84	83	81
Temperture Forecast (fahrenheit) on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	77	76	76	75	75	74	73	74	76	79	85	85	89	92	94	94	95	95	95	90	87	84	80	79
Americaweater	82	81	80	79	78	77	77	76	77	81	85	88	90	93	94	94	95	94	92	91	88	85	82	81
Findlocalweather	82	81	80	79	78	77	77	76	79	83	85	88	90	93	94	94	95	94	92	91	88	85	82	81
Srhnoaa	79	78	77	76	75	74	73	73	75	79	83	86	89	90	92	94	95	96	93	93	89	85	82	81
Weatherperhour	80	79	79	78	77	76	75	73	82	86	89	92	95	97	95	92	93	94	94	93	89	85	83	85
WeatherANN	80	80	78	77	77	76	75	75	77	82	85	88	94	93	94	94	95	95	94	92	88	85	80	81
Actual Temp.	80	78	76	76	76	75	75	79	82	87	92	93	94	96	98	100	97	97	97	91	87	85	84	85
Temperture Forecast (fahrenheit) on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	78	77	77	76	74	76	75	76	78	82	84	86	89	90	94	95	96	95	94	90	87	85	82	79
Americaweater	81	80	80	79	78	77	77	76	79	83	84	87	89	92	93	93	94	93	92	91	88	86	83	82
Findlocalweather	81	80	80	79	77	76	76	75	78	82	84	87	89	92	93	93	94	93	92	91	88	86	83	82
Srhnoaa	79	78	78	76	76	75	74	73	75	79	83	86	89	93	93	95	97	98	97	94	89	85	83	81
Weatherperhour	84	83	82	80	80	79	77	74	84	87	90	93	96	97	99	101	98	92	93	92	89	84	86	85
WeatherANN	81	80	80	78	77	77	76	73	80	86	90	88	95	93	97	98	98	94	94	90	88	85	83	81
Actual Temp.	82	81	80	79	78	77	76	79	81	88	91	92	94	95	97	99	97	98	96	92	89	86	82	80
Temperture Forecast (fahrenheit) on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	79	79	77	76	75	74	74	73	74	78	83	88	91	94	96	96	97	97	95	91	88	86	83	80
Americaweater	82	78	77	77	76	75	75	74	78	82	85	88	90	93	94	95	96	95	94	93	90	86	83	82
Findlocalweather	82	81	80	79	78	78	77	77	78	82	85	88	90	93	94	95	96	95	94	93	90	86	83	82
Srhnoaa	80	78	78	76	76	75	74	73	75	80	85	89	93	96	99	101	101	100	97	97	92	88	85	83
Weatherperhour	83	81	85	84	80	78	77	77	84	88	91	94	97	99	101	102	102	103	100	90	89	85	84	81
WeatherANN	81	79	80	79	77	76	76	75	82	82	86	93	94	95	97	102	101	101	99	93	88	86	84	82
Actual Temp.	78	76	75	75	74	73	73	76	78	83	89	91	94	96	95	97	99	91	86	82	81	81	79	77

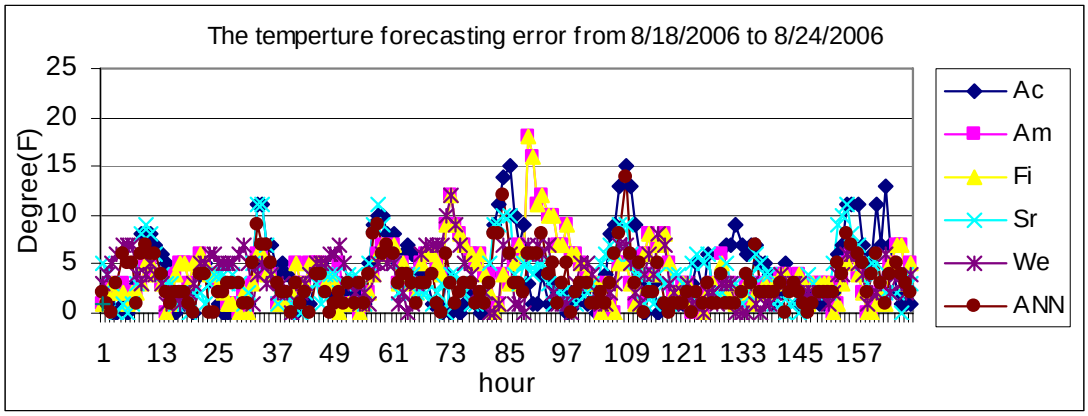


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.7 the temperature forecasting error at Pharaoh during summer period.

Table 4.4 temperature forecast compare to actual temperature from multiple resources on the period 8/18/05 to 8/24/05 in Pharaoh.

Temperture Forecast (fahrenheit) on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	81	79	81	81	81	81	81	84	86	88	91	93	93	95	97	97	97	97	96	93	90	86	83
Americaweater	79	82	81	81	80	80	79	79	81	83	85	88	91	94	96	98	100	99	98	97	93	90	86	85
Findlocalweather	79	78	77	77	80	80	79	79	81	83	85	88	91	94	96	98	100	99	98	97	93	90	86	85
Srhnoaa	78	76	76	75	75	75	74	74	75	79	83	88	90	92	93	94	95	95	94	92	89	86	85	84
Weatherperhour	82	81	85	84	84	83	83	82	83	86	89	91	94	96	98	99	99	99	98	96	92	90	89	88
WeatherANN	82	82	82	82	82	82	82	80	82	82	86	89	92	92	97	97	97	97	97	97	92	89	86	85
Actual Temp.	82	82	81	81	80	79	80	83	85	90	92	94	96	96	97	98	98	96	93	88	85	85	86	85
Temperture Forecast (fahrenheit) on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	84	84	84	81	81	79	79	79	82	84	88	91	93	93	95	95	93	91	90	90	89	88	85	82
Americaweater	83	82	82	81	81	81	80	80	82	84	87	90	92	95	96	98	99	98	98	97	93	90	86	85
Findlocalweather	83	82	82	81	81	81	80	80	82	84	87	90	92	95	96	98	99	98	98	97	93	90	86	85
Srhnoaa	83	82	81	81	80	77	76	75	77	81	85	89	92	91	92	95	97	97	96	94	90	86	84	81
Weatherperhour	87	84	85	85	84	83	82	81	84	87	89	91	94	96	98	99	99	99	98	96	93	91	89	87
WeatherANN	84	83	82	82	81	83	79	79	83	84	88	90	93	94	93	97	95	95	95	95	92	89	85	84
Actual Temp.	85	83	81	79	79	79	79	83	86	89	90	94	97	96	97	96	96	96	93	89	85	84	86	86
Temperture Forecast (fahrenheit) on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	81	77	75	75	75	75	75	73	81	82	84	88	90	90	91	93	84	75	73	76	77	78	77	77
Americaweater	83	80	79	79	78	78	77	77	78	81	85	87	90	92	94	95	97	96	95	94	90	87	83	81
Findlocalweather	83	80	79	79	78	78	77	77	78	81	85	87	90	92	94	95	97	96	95	94	90	87	83	81
Srhnoaa	80	79	78	77	77	76	75	75	76	80	84	88	91	93	95	96	96	94	94	91	87	84	82	77
Weatherperhour	86	85	84	84	83	83	82	81	84	86	88	91	94	96	98	99	100	100	99	97	92	86	85	83
WeatherANN	83	80	80	80	80	80	80	74	80	82	84	89	91	91	97	97	87	87	87	87	87	84	82	80
Actual Temp.	84	83	82	82	80	80	79	83	87	91	94	97	98	98	100	97	98	81	79	78	76	75	75	74
Temperture Forecast (fahrenheit) on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	70	70	70	70	70	70	70	72	77	81	82	82	84	88	88	84	88	84	85	81	80	77	76
Americaweater	80	73	73	72	72	72	71	71	76	80	83	85	87	89	90	92	93	93	91	90	87	83	80	79
Findlocalweather	80	73	73	72	72	72	71	71	75	79	83	85	87	89	90	92	93	93	91	90	87	83	80	79
Srhnoaa	77	76	76	76	76	73	74	73	74	78	81	85	87	88	91	92	92	92	90	88	84	80	78	76
Weatherperhour	77	76	76	76	75	74	74	74	80	84	87	90	93	94	93	94	93	93	92	91	84	80	79	78
WeatherANN	77	74	74	73	73	72	71	73	75	80	83	85	87	89	90	92	91	92	90	89	85	81	79	78
Actual Temp.	75	73	73	73	72	71	72	79	82	84	87	92	93	92	92	92	94	94	94	83	80	78	79	77
Temperture Forecast (fahrenheit) on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	75	73	75	75	75	75	77	70	70	72	72	72	72	79	79	82	82	84	84	84	80	78	75	74
Americaweater	77	72	72	72	72	72	71	71	76	78	80	81	81	82	83	84	85	85	86	85	82	78	75	74
Findlocalweather	77	72	72	72	72	72	71	71	76	78	80	81	81	82	83	84	85	85	86	85	82	78	75	74
Srhnoaa	74	73	72	71	70	69	69	68	70	73	77	80	83	84	87	88	88	88	87	85	81	78	76	73
Weatherperhour	77	76	77	77	75	74	73	72	79	80	83	84	86	86	85	86	87	89	88	87	82	79	78	76
WeatherANN	76	73	74	74	74	74	76	70	73	76	78	75	78	80	80	85	85	86	86	85	81	78	76	75
Actual Temp.	77	78	77	77	78	77	76	74	75	76	79	81	82	85	88	89	89	89	87	82	80	79	78	78
Temperture Forecast (fahrenheit) on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	77	73	73	73	73	73	73	72	72	70	72	72	73	79	82	84	84	86	84	84	82	81	79	78
Americaweater	74	73	72	72	73	73	72	72	75	78	81	83	86	88	89	90	91	90	88	87	84	81	78	77
Findlocalweather	74	73	72	72	73	73	72	72	75	78	81	83	86	88	89	90	91	90	88	87	84	81	78	77
Srhnoaa	72	71	71	70	69	68	68	67	69	73	77	80	83	78	80	84	88	90	89	87	83	80	78	77
Weatherperhour	75	74	75	74	72	71	71	69	73	75	78	81	85	88	87	88	88	88	87	84	83	79	77	76
WeatherANN	74	74	74	74	72	72	71	70	74	75	79	79	81	86	86	87	87	87	87	86	83	80	78	77
Actual Temp.	78	77	76	77	77	76	77	75	76	73	74	79	82	85	89	93	94	90	87	83	81	80	79	78
Temperture Forecast (fahrenheit) on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	73	73	73	73	73	72	72	72	77	79	81	82	84	86	90	91	91	91	91	91	88	86	82	82
Americaweater	77	75	75	75	74	74	74	74	76	79	82	85	89	92	94	96	98	97	95	94	90	87	83	82
Findlocalweather	77	76	75	75	74	74	74	74	76	79	82	85	89	92	94	96	98	97	95	94	90	87	83	82
Srhnoaa	76	75	74	73	73	72	71	71	72	77	81	84	87	90	93	94	95	95	94	91	87	83	81	80
Weatherperhour	75	75	76	75	74	73	74	73	78	81	85	88	92	95	97	98	99	99	99	98	89	87	85	84
WeatherANN	76	75	75	74	74	73	73	74	77	80	84	85	87	87	94	95	96	96	95	94	89	85	82	81
Actual Temp.	77	77	76	75	75	75	76	80	83	87	90	92	94	96	98	99	98	97	95	87	84	83	81	79



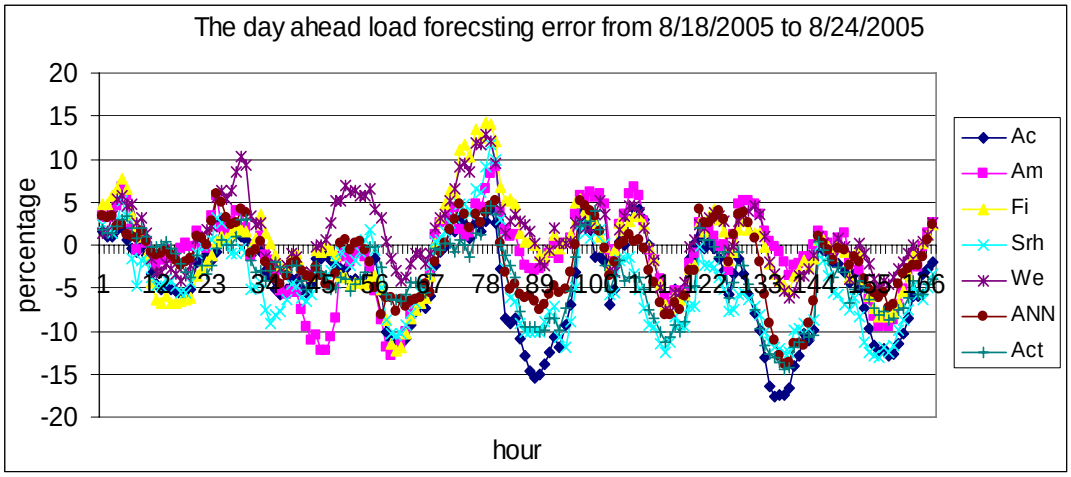
Note:

Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.8 the temperature forecasting error at Russell during summer period.

Table 4.5 temperature forecast compare to actual temperature from multiple resources on the 8/18/05 to 8/24/05 in Russell.

Temperture Forecast (fahrenheit) on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	80	78	77	76	75	74	74	73	74	79	83	87	90	92	94	96	95	95	93	92	92	90	87	85
Americaweater	82	81	80	78	77	76	75	74	79	82	86	90	93	97	99	100	102	101	98	97	94	90	87	86
Findlocalweather	82	81	80	78	76	75	75	74	79	82	86	90	93	97	99	100	102	101	98	97	94	90	87	86
Srhnoaa	76	75	74	76	75	74	74	73	74	78	83	88	92	94	95	95	96	95	95	94	90	84	80	78
Weatherperhour	84	83	82	82	81	81	80	80	79	83	86	90	93	96	96	98	98	98	97	95	93	90	89	88
WeatherANN	79	78	77	79	80	79	78	77	76	80	85	88	92	95	97	98	99	98	96	92	92	89	83	82
Actual Temp.	81	79	77	76	74	74	73	76	82	87	91	94	96	97	98	96	97	96	95	92	88	85	83	82
Temperture Forecast (fahrenheit) on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	80	80	78	78	76	74	74	73	74	78	83	86	90	92	94	95	95	95	93	90	92	91	88	85
Americaweater	84	78	77	77	76	76	75	75	79	83	86	89	93	96	97	99	100	99	97	96	93	91	88	87
Findlocalweather	84	78	77	77	76	76	75	75	79	83	86	89	93	96	97	99	100	99	97	96	93	91	88	87
Srhnoaa	77	76	75	74	73	73	73	73	74	78	83	89	93	95	96	96	96	96	96	95	91	85	81	79
Weatherperhour	86	85	83	83	82	81	80	79	81	84	87	89	92	94	96	97	98	98	97	95	93	91	90	89
WeatherANN	83	82	81	81	79	75	74	73	76	82	83	88	91	95	96	97	98	97	96	91	92	90	83	83
Actual Temp.	81	80	78	78	76	74	75	78	85	89	90	93	94	97	98	97	95	96	94	91	88	86	85	83
Temperture Forecast (fahrenheit) on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	79	78	77	76	76	75	74	73	74	78	82	86	89	91	93	92	93	93	90	87	87	86	83	81
Americaweater	85	84	78	78	77	77	76	76	79	82	85	88	90	93	94	95	96	95	98	97	94	90	87	86
Findlocalweather	85	79	78	78	77	77	76	76	79	82	85	88	90	93	94	95	96	95	98	97	94	90	87	86
Srhnoaa	78	77	76	75	74	74	74	73	74	77	83	88	92	94	95	95	95	95	95	93	89	83	80	77
Weatherperhour	88	86	84	82	80	78	77	77	79	83	86	89	92	95	97	99	100	100	99	98	95	92	90	87
WeatherANN	83	81	80	76	77	74	74	74	75	79	86	87	91	93	95	95	96	96	96	94	92	84	83	83
Actual Temp.	82	79	79	79	78	77	75	78	83	88	92	94	97	96	99	99	99	97	93	91	88	85	83	77
Temperture Forecast (fahrenheit) on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	72	71	70	69	70	70	70	71	72	74	77	79	79	82	82	84	83	82	83	79	79	78	77
Americaweater	84	80	79	78	77	76	76	75	79	82	84	87	91	94	96	97	99	98	92	91	88	86	83	82
Findlocalweather	84	80	79	78	77	76	76	75	77	81	84	87	91	94	96	97	99	98	92	91	88	86	83	82
Srhnoaa	76	75	74	73	72	72	72	69	70	72	76	81	84	85	86	86	86	86	86	84	81	77	74	73
Weatherperhour	84	80	78	76	75	73	72	73	75	81	84	84	88	90	90	91	88	88	88	85	85	78	75	74
WeatherANN	75	72	73	74	74	72	72	72	78	73	77	79	88	92	92	93	87	88	87	87	82	81	77	78
Actual Temp.	72	71	71	71	71	71	70	71	75	81	85	91	94	89	89	91	81	82	81	79	78	76	76	75
Temperture Forecast (fahrenheit) on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	73	71	71	70	71	69	71	70	71	71	74	78	79	82	85	88	90	84	86	85	82	81	79	78
Americaweater	82	79	78	77	76	75	74	73	78	80	83	86	89	92	93	95	96	95	93	92	89	85	82	81
Findlocalweather	82	79	78	77	76	75	74	73	78	80	83	86	89	92	93	95	96	95	93	92	89	85	82	81
Srhnoaa	72	71	71	70	70	69	69	68	69	72	77	82	85	89	90	90	91	90	90	89	84	79	76	75
Weatherperhour	74	73	75	77	77	76	73	72	74	77	80	84	87	90	92	93	94	93	93	93	88	83	82	80
WeatherANN	78	73	74	75	75	73	72	71	74	76	77	83	80	89	91	89	90	85	91	90	82	80	79	78
Actual Temp.	73	73	72	72	72	72	71	73	75	79	83	91	94	95	94	94	90	87	89	85	81	80	80	79
Temperture Forecast (fahrenheit) on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	76	74	74	73	74	71	70	69	69	71	74	78	82	86	88	89	91	91	91	90	87	86	83	81
Americaweater	80	78	77	77	76	75	75	74	78	81	84	88	91	95	96	98	99	98	93	92	89	85	82	81
Findlocalweather	80	78	78	77	76	75	75	74	77	80	84	88	91	95	96	98	94	93	93	92	89	85	82	81
Srhnoaa	74	73	72	72	71	71	70	70	70	73	78	84	88	90	91	90	91	92	91	90	86	81	78	79
Weatherperhour	79	78	78	77	76	75	74	73	75	81	84	87	89	92	92	95	96	97	94	91	89	84	82	81
WeatherANN	78	77	77	76	75	74	71	71	76	79	82	86	87	88	92	89	94	94	93	91	88	81	81	81
Actual Temp.	77	75	77	78	76	77	72	72	72	78	81	87	89	92	95	96	96	96	95	89	85	81	79	78
Temperture Forecast (fahrenheit) on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	77	77	75	74	73	74	74	73	74	78	80	84	86	91	92	93	88	90	83	84	84	84	83	82
Americaweater	80	79	78	78	77	76	76	75	79	82	86	89	93	96	97	99	100	99	97	96	93	90	87	86
Findlocalweather	80	79	78	78	77	76	76	75	79	82	86	89	93	96	97	99	100	99	97	96	93	90	87	86
Srhnoaa	76	74	73	72	72	71	71	70	71	75	80	87	90	93	94	94	94	94	94	93	88	83	80	78
Weatherperhour	79	78	79	77	76	75	74	73	76	81	85	89	92	94	96	97	97	94	90	89	90	86	86	85
WeatherANN	78	77	77	76	76	75	75	73	75	81	83	88	91	93	95	95	93	94	95	95	91	87	87	83
Actual Temp.	76	76	77	75	74	73	73	75	80	85	91	95	97	98	97	99	99	97	96	91	86	83	84	81



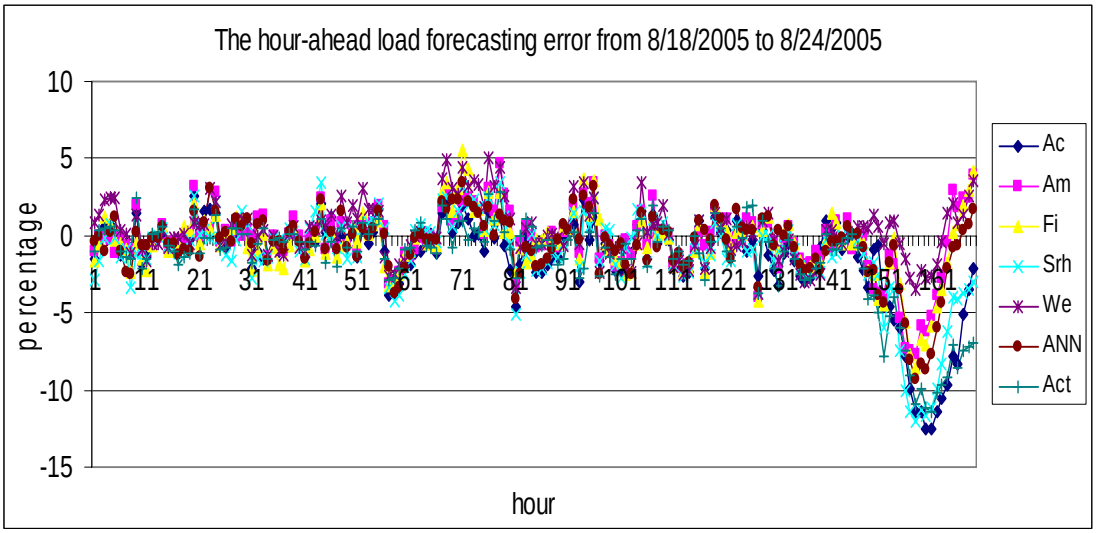
Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.9 Day-ahead load forecast error in summer season.

Table 4.6 Day-ahead load forecast compare to actual load from multiple resources on the period 8/18/05 to 8/24/05 in summer season.

Day-ahead Load Forecast on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	825	780	751	732	715	727	775	802	820	855	906	965	1019	1058	1085	1115	1141	1153	1151	1141	1128	1117	1011	917
Americaweater	797	767	739	716	697	710	765	794	823	850	921	996	1055	1100	1130	1171	1197	1208	1206	1192	1148	1137	1036	914
Findlocalweather	800	763	736	714	695	708	759	790	817	848	920	994	1054	1109	1142	1174	1197	1208	1205	1193	1147	1122	1039	919
Srhnoaa	803	770	730	709	707	715	750	780	817	852	921	1000	1060	1106	1126	1175	1209	1213	1199	1180	1128	1117	1014	922
Weatherperhour	811	767	748	736	739	761	795	827	858	929	992	1054	1108	1159	1189	1214	1225	1221	1203	1183	1161	1138	1047	964
WeatherANN	816	775	744	726	714	724	772	779	798	841	895	949	1007	1058	1097	1124	1146	1161	1158	1123	1117	1098	1017	918
Actual Load	809	767	735	711	698	719	769	801	812	866	934	998	1055	1097	1142	1178	1207	1217	1209	1162	1145	1120	1018	901
Day-ahead Load Forecast on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	871	811	773	751	748	756	773	796	824	855	905	969	1026	1076	1121	1157	1175	1173	1159	1136	1109	1080	1006	914
Americaweater	870	819	778	751	745	765	799	804	818	865	923	980	1033	1078	1130	1177	1198	1187	1156	1116	1110	1097	1046	967
Findlocalweather	852	810	779	760	756	762	774	787	809	853	913	979	1032	1081	1130	1157	1165	1160	1145	1126	1104	1077	997	913
Srhnoaa	843	796	764	746	739	744	758	778	801	837	896	953	1012	1064	1115	1164	1188	1192	1182	1158	1122	1084	1001	913
Weatherperhour	919	882	855	836	826	838	876	889	899	920	943	974	1026	1066	1097	1123	1146	1161	1156	1118	1089	1071	1014	938
WeatherANN	860	810	772	744	741	752	778	806	828	865	920	990	1051	1098	1143	1181	1202	1197	1172	1146	1129	1094	1015	939
Actual Load	834	793	761	734	719	731	785	807	828	889	947	1013	1076	1121	1154	1187	1219	1225	1204	1149	1127	1093	1020	927
Day-ahead Load Forecast on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	852	797	756	727	707	711	721	729	764	810	853	896	953	1004	1040	1065	1084	1091	1073	1033	1010	988	928	849
Americaweater	844	794	762	742	730	727	738	749	790	846	896	945	992	1034	1067	1091	1111	1117	1099	1069	1052	1031	951	873
Findlocalweather	848	796	763	737	722	719	723	728	780	838	897	952	1005	1052	1091	1115	1126	1122	1109	1090	1069	1025	941	862
Srhnoaa	840	787	750	728	721	722	723	723	770	821	865	912	968	1020	1061	1093	1117	1128	1115	1084	1050	1017	934	852
Weatherperhour	873	828	808	794	792	802	819	827	860	912	963	1012	1061	1107	1146	1174	1186	1181	1162	1136	1105	1077	1000	911
WeatherANN	862	805	766	740	726	722	727	738	768	817	865	921	984	1044	1087	1112	1123	1126	1118	1105	1091	1049	960	873
Actual Load	860	805	779	750	735	729	726	746	817	913	989	1053	1114	1155	1177	1194	1203	1204	1159	1091	1054	1017	930	845
Day-ahead Load Forecast on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	808	756	717	688	669	661	669	681	725	746	776	795	844	893	928	950	962	968	964	951	926	902	842	773
Americaweater	812	753	715	697	693	700	709	715	764	821	869	915	964	1011	1048	1077	1099	1108	1090	1057	1023	998	926	843
Findlocalweather	855	793	752	717	703	706	715	722	776	831	878	921	968	1019	1065	1100	1119	1120	1100	1076	1050	1023	940	853
Srhnoaa	830	771	731	703	685	680	693	705	749	771	804	846	894	940	977	1003	1020	1026	1012	983	946	896	833	760
Weatherperhour	800	753	717	696	686	684	690	701	747	805	869	935	993	1038	1052	1072	1083	1082	1068	1045	1015	977	907	828
WeatherANN	809	750	711	683	664	659	666	679	723	761	810	870	928	974	1001	1037	1063	1070	1059	1045	1017	971	897	813
Actual Load	776	724	696	656	648	635	635	650	728	794	842	888	961	1020	1061	1094	1122	1124	1097	1056	1049	1004	917	806
Day-ahead Load Forecast on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	791	729	699	671	655	674	715	745	763	781	805	839	877	916	949	975	1002	1018	1021	1014	998	977	898	811
Americaweater	794	735	704	678	678	695	719	745	769	806	859	927	981	1019	1051	1079	1098	1105	1098	1071	1035	1004	928	834
Findlocalweather	801	747	716	690	685	696	718	746	779	819	868	918	964	1004	1040	1070	1093	1103	1092	1060	1048	1027	946	852
Srhnoaa	775	733	707	688	678	691	724	737	760	791	827	874	924	967	1003	1034	1063	1083	1082	1065	1050	1036	948	845
Weatherperhour	779	736	706	686	677	692	725	752	782	813	849	902	960	1015	1053	1076	1087	1092	1094	1087	1059	1018	949	858
WeatherANN	771	715	686	667	670	686	709	737	765	799	838	884	927	964	996	1021	1045	1060	1059	1042	1025	1004	925	834
Actual Load	746	705	680	663	660	683	745	762	759	796	830	877	924	981	1046	1089	1136	1168	1163	1125	1113	1084	965	859
Day-ahead Load Forecast on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	801	744	711	688	674	681	715	735	734	749	776	808	838	865	902	936	971	997	1014	1020	1022	991	922	833
Americaweater	802	752	720	698	684	697	736	767	781	820	869	914	959	1007	1050	1083	1109	1121	1115	1104	1086	1054	945	846
Findlocalweather	821	770	732	705	704	718	738	765	796	832	872	915	961	1007	1036	1065	1100	1111	1102	1087	1072	1049	969	874
Srhnoaa	796	734	698	660	646	658	703	732	744	755	778	807	858	907	951	985	1014	1033	1037	1030	1017	987	894	808
Weatherperhour	798	749	717	704	707	725	751	759	776	815	867	919	966	1009	1041	1069	1092	1106	1104	1077	1066	1051	967	865
WeatherANN	794	744	713	686	672	684	728	735	743	772	815	858	883	919	960	986	1011	1029	1031	1007	1020	1017	942	855
Actual Load	788	748	711	686	680	698	765	769	758	787	830	878	931	995	1055	1100	1139	1169	1175	1140	1119	1089	995	879
Day-ahead Load Forecast on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	813	757	724	697	681	684	721	747	764	790	832	884	936	978	1009	1039	1058	1062	1060	1051	1057	1015	934	853
Americaweater	814	764	732	706	687	707	755	782	796	835	884	937	993	1053	1097	1138	1165	1175	1174	1164	1147	1122	1010	908
Findlocalweather	810	767	737	707	693	711	758	783	798	822	867	925	983	1036	1076	1113	1167	1192	1184	1163	1148	1118	1015	909
Srhnoaa	800	746	713	682	660	664	714	739	761	775	806	854	912	967	1008	1043	1081	1103	1110	1101	1080	1047	950	852
Weatherperhour	815	765	733	712	706	724	774	781	794	833	890	947	1000	1051	1094	1136	1157	1172	1173	1140	1137	1100	1013	916
WeatherANN	814	777	747	721	713	720	738	764	784	815	866	918	974	1025	1059	1085	1113	1140	1138	1111	1110	1086	988	881
Actual Load	804	758	732	717	704	726	782	788	806	858	921	995	1066	1111	1162	1196	1215	1219	1194	1146	1141	1102	998	885



Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.10 Hour-ahead load forecast error in summer season.

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Table 4.7 Hour-ahead load forecast compare to actual load from multiple resources on the period 8/18/05 to 8/24/05 in summer season.

Hour-ahead Load Forecast on 8/18/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	808	763	740	720	701	707	757	784	798	844	916	994	1054	1091	1123	1170	1204	1214	1204	1194	1154	1137	1044	919
Americaweater	800	763	736	714	695	708	759	790	817	848	920	994	1054	1109	1142	1174	1197	1208	1205	1193	1147	1122	1039	919
Findlocalweather	803	770	730	709	707	715	750	780	817	852	921	1000	1060	1106	1126	1175	1209	1213	1199	1180	1128	1117	1014	922
Srhnoaa	807	771	738	711	692	709	767	798	827	847	917	988	1050	1099	1133	1172	1191	1208	1205	1190	1135	1120	1016	916
Weatherperhour	806	769	745	733	724	729	767	785	810	853	926	991	1051	1103	1131	1173	1202	1220	1212	1176	1151	1146	1050	925
WeatherANN	797	766	741	714	699	712	769	782	824	852	925	994	1040	1100	1138	1164	1201	1222	1204	1176	1147	1124	1029	918
Actual Load	809	767	735	711	698	719	769	801	812	866	934	998	1055	1097	1142	1178	1207	1217	1209	1162	1145	1120	1018	901
Hour-ahead Load Forecast on 8/19/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	832	791	756	737	733	739	767	799	811	870	939	1007	1069	1125	1151	1176	1206	1229	1204	1160	1122	1117	1025	926
Americaweater	845	795	762	734	726	732	768	799	819	869	938	998	1059	1119	1173	1187	1200	1213	1197	1160	1118	1065	1004	935
Findlocalweather	839	787	763	741	723	730	775	799	810	868	936	1006	1068	1125	1155	1181	1211	1231	1201	1165	1125	1097	1007	938
Srhnoaa	825	782	754	733	715	730	772	800	818	871	939	1010	1072	1124	1160	1185	1210	1228	1210	1179	1125	1094	1004	931
Weatherperhour	834	796	771	750	736	736	774	806	828	874	943	1011	1070	1129	1168	1190	1208	1210	1187	1158	1130	1119	1027	947
WeatherANN	829	795	762	735	717	729	777	809	832	871	940	1005	1067	1124	1159	1181	1200	1220	1208	1176	1116	1098	1013	943
Actual Load	834	793	761	734	719	731	785	807	828	889	947	1013	1076	1121	1154	1187	1219	1225	1204	1149	1127	1093	1020	927
Hour-ahead Load Forecast on 8/20/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	852	808	770	755	732	732	739	744	780	871	949	1024	1094	1158	1182	1191	1199	1197	1183	1111	1054	1030	947	850
Americaweater	860	813	774	759	742	744	739	737	801	894	974	1051	1107	1155	1181	1192	1204	1197	1178	1125	1067	1048	960	872
Findlocalweather	858	806	768	753	735	737	736	734	788	882	962	1030	1093	1149	1185	1193	1201	1199	1194	1119	1061	1050	989	888
Srhnoaa	849	803	762	747	729	727	741	748	783	877	956	1031	1094	1147	1176	1188	1199	1210	1206	1138	1080	1036	966	867
Weatherperhour	855	820	780	765	744	743	747	755	791	886	966	1042	1100	1151	1175	1193	1227	1213	1186	1106	1050	988	945	853
WeatherANN	856	808	768	753	733	736	742	746	795	890	970	1038	1093	1141	1165	1203	1206	1195	1180	1126	1070	1035	957	859
Actual Load	860	805	779	750	735	729	726	746	817	913	989	1053	1114	1155	1177	1194	1203	1204	1159	1091	1054	1017	930	845
Hour-ahead Load Forecast on 8/21/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	772	720	688	669	649	651	638	643	697	778	840	881	938	997	1042	1075	1099	1120	1108	1080	1030	1038	940	837
Americaweater	798	740	702	672	652	650	651	655	701	785	837	889	949	1008	1050	1089	1124	1139	1106	1085	1046	1034	936	833
Findlocalweather	794	739	700	677	657	659	645	649	713	790	846	887	950	1010	1055	1094	1121	1138	1118	1090	1042	1046	938	835
Srhnoaa	794	743	706	680	660	656	642	646	692	776	836	871	942	1000	1045	1084	1109	1118	1101	1077	1038	1031	924	829
Weatherperhour	796	740	701	679	659	656	646	652	709	794	857	901	952	1011	1043	1082	1114	1128	1106	1074	1030	1020	923	839
WeatherANN	787	729	692	666	646	650	642	658	701	779	840	888	948	1007	1045	1084	1116	1124	1095	1059	1037	1024	926	824
Actual Load	776	724	696	656	648	635	635	650	728	794	842	888	961	1020	1061	1094	1122	1124	1097	1056	1049	1004	917	806
Hour-ahead Load Forecast on 8/22/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	734	709	680	664	661	673	728	759	775	787	835	865	921	973	1018	1066	1102	1136	1149	1129	1086	1071	978	863
Americaweater	752	706	677	655	643	650	736	767	774	787	840	886	937	988	1034	1081	1117	1151	1144	1129	1084	1055	979	864
Findlocalweather	729	702	678	660	651	666	734	765	765	778	843	881	930	983	1029	1076	1112	1142	1149	1107	1100	1091	984	868
Srhnoaa	730	708	679	666	660	671	726	756	771	800	833	870	927	981	1027	1074	1107	1141	1154	1132	1086	1077	981	866
Weatherperhour	730	701	672	646	648	667	725	755	770	788	838	877	928	983	1029	1076	1113	1147	1154	1113	1124	1076	976	861
WeatherANN	724	700	671	644	640	676	739	769	771	783	840	870	926	980	1026	1072	1109	1143	1154	1135	1089	1080	976	861
Actual Load	746	705	680	663	660	683	745	762	759	796	830	877	924	981	1046	1089	1136	1168	1163	1125	1113	1084	965	859
Hour-ahead Load Forecast on 8/23/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	791	734	714	682	670	698	742	773	749	767	813	878	937	988	1037	1076	1115	1153	1164	1153	1120	1103	1002	892
Americaweater	790	743	711	684	670	689	738	778	767	783	816	874	933	985	1033	1072	1112	1149	1156	1156	1122	1099	1000	886
Findlocalweather	790	747	711	680	675	697	741	781	771	786	832	884	943	996	1044	1084	1124	1155	1152	1144	1110	1087	992	879
Srhnoaa	790	742	712	680	673	694	743	783	770	786	817	872	930	982	1030	1070	1109	1146	1161	1151	1118	1087	981	882
Weatherperhour	785	743	717	690	679	700	746	774	769	785	829	876	934	985	1033	1072	1111	1148	1167	1136	1123	1085	1000	880
WeatherANN	792	746	709	687	682	693	734	774	770	785	815	872	931	983	1032	1072	1111	1148	1159	1139	1136	1092	991	886
Actual Load	788	748	711	686	680	698	765	769	758	787	830	878	931	995	1055	1100	1139	1169	1175	1140	1119	1089	995	879
Hour-ahead Load Forecast on 8/24/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	795	746	720	701	690	718	775	802	800	839	905	975	1041	1109	1141	1186	1199	1207	1194	1157	1119	1101	1006	907
Americaweater	809	756	729	709	703	723	771	793	785	837	908	981	1048	1115	1144	1192	1223	1228	1206	1165	1128	1118	1004	894
Findlocalweather	800	752	728	713	694	723	770	792	786	840	909	981	1049	1114	1145	1183	1219	1232	1206	1163	1134	1106	999	897
Srhnoaa	805	755	728	709	704	726	771	790	769	831	905	977	1044	1111	1142	1186	1216	1222	1203	1163	1125	1110	998	885
Weatherperhour	810	756	729	709	701	722	769	793	801	847	915	987	1055	1115	1146	1191	1223	1228	1206	1162	1123	1109	1009	896
WeatherANN	801	754	725	711	712	711	765	792	807	858	920	984	1051	1118	1144	1191	1220	1224	1209	1159	1156	1121	1004	899
Actual Load	804	758	732	717	704	726	782	788	806	858	921	995	1066	1111	1162	1196	1215	1219	1194	1146	1141	1102	998	885

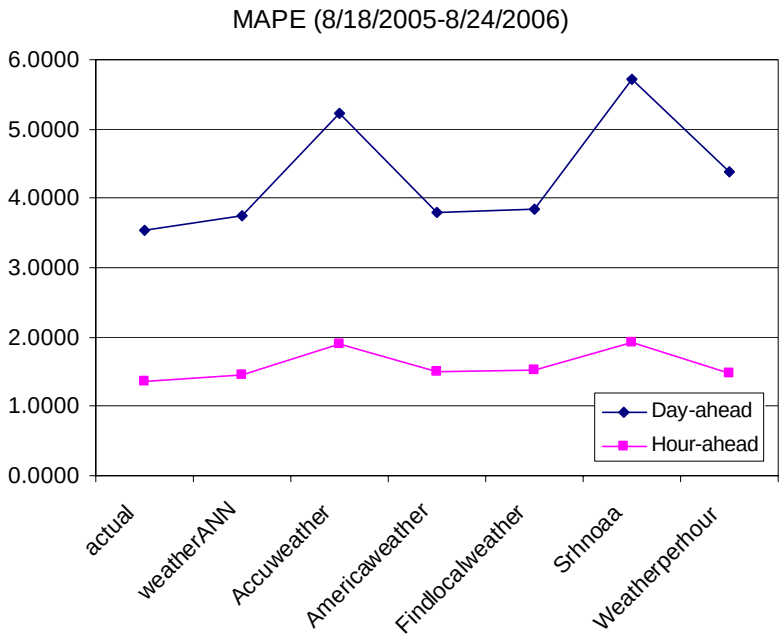
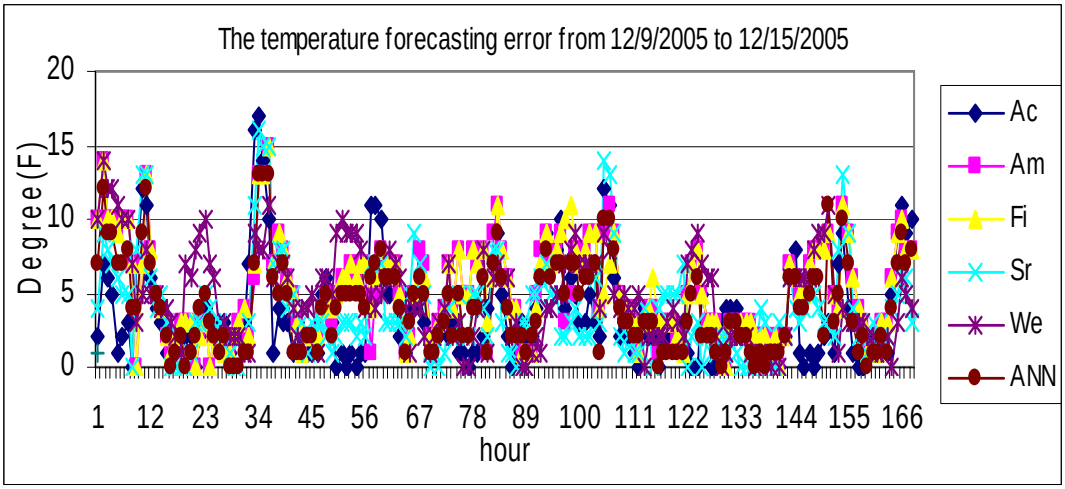


Figure 4.11 Comparing MAPE of day-ahead and hour-ahead between 8/18/05 and 8/24/05

Table 4.8 Summarization of MAPE for day-ahead and hour-ahead between 8/18/05 to 8/24/05

MAPE (August 18,2005 - August 24,2005)		
source	Day-ahead	Hour-ahead
actual	3.5369	1.3649
weatherANN	3.7407	1.4639
Accuweather	5.2197	1.9017
Americaweather	3.7866	1.4958
Findlocalweather	3.8543	1.5144
Srhnoaa	5.7094	1.9179
Weatherperhour	4.3769	1.4824

The second comparison period is from December 9, 2005 to December 15, 2005. This evaluates the forecast performance for the winter season. The forecast errors for dayahead forecast and hour ahead load forecast are shown in figure 4.17 and table 4.18, respectively. Again, the developed STLF program was improved by temperature forecasting capabilities of the program. Figure 4.17 and figure 4.18 depict the actual load error curve versus the forecast load error curve for both types of forecast. The hourly temperature forecasting error during this winter test week is plotted in figure 4.12 to 4.16. These graphs provide you the temperature forecast in each service areas. The STLF program by using the several resources yields results with 3.8936% MAPE for dayahead forecast and 2.1456% for hour ahead forecast, compared to the MAPE in each resources, the MAPE from the various resources are less then each single resource, as shown in table 4.17.

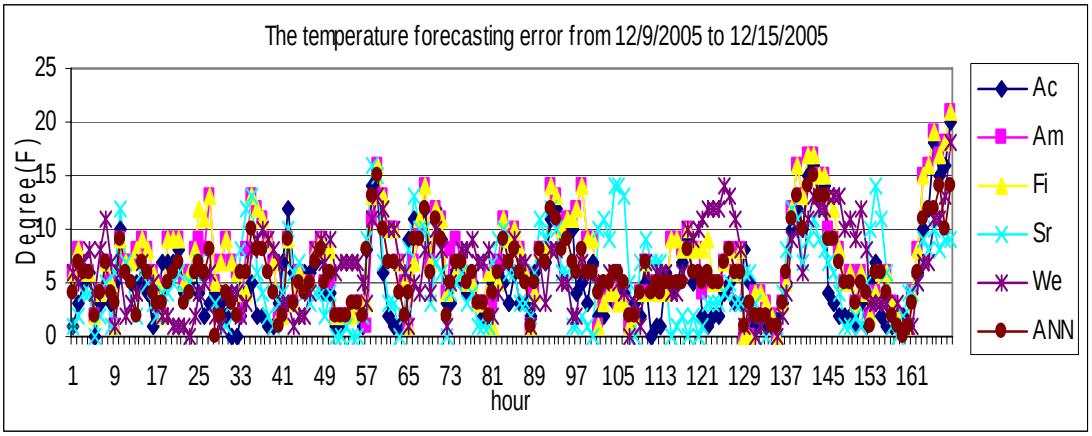


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.12 the temperature forecasting error at Anardako during winter period.

Table 4.9 temperature forecast compare to actual temperature from multiple resources on the period 12/9/05 to 12/15/05 in Anardako.

	Temperture Forecast (fahrenheit) on 12/9/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	10	10	10	9	6	7	8	10	12	16	24	30	35	37	39	40	38	37	34	32	31	29	28	27
Americaweater	18	17	14	14	14	15	15	17	19	21	22	28	34	36	38	40	39	37	35	33	31	29	29	30
Findlocalweather	18	17	14	14	14	15	15	17	19	21	22	28	34	36	38	40	39	37	35	33	31	29	29	30
Srhnoaa	12	12	12	11	11	10	10	10	11	15	22	30	35	35	37	39	37	34	32	31	28	28	27	26
Weatherperhour	18	17	16	16	16	15	15	17	16	23	27	31	34	36	36	36	35	33	25	24	23	22	22	23
WeatherANN	15	15	13	13	12	12	13	14	15	19	23	29	34	36	38	39	38	36	32	31	29	27	27	27
Actual Temp.	8	3	4	4	5	5	5	10	19	28	35	36	39	40	40	39	37	34	32	30	31	31	32	30
	Temperture Forecast (fahrenheit) on 12/10/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	25	26	24	24	22	21	19	19	19	27	36	47	54	55	57	57	58	55	50	47	45	42	39	39
Americaweater	30	30	26	26	26	26	26	28	29	31	37	42	48	50	52	54	52	49	47	44	42	39	38	38
Findlocalweather	30	30	26	26	26	26	26	28	28	31	37	42	48	50	52	54	52	49	47	44	42	39	38	38
Srhnoaa	25	25	25	24	24	23	23	23	24	28	35	42	48	51	52	56	52	50	45	45	41	38	37	35
Weatherperhour	22	26	24	23	22	21	21	25	26	36	42	46	49	52	53	54	53	50	44	42	39	40	40	39
WeatherANN	26	27	25	25	24	23	23	25	28	31	37	44	49	54	53	55	56	51	47	44	42	40	38	38
Actual Temp.	28	28	27	25	24	23	22	26	35	44	50	57	55	59	60	60	57	52	48	46	44	41	34	33
	Temperture Forecast (fahrenheit) on 12/11/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	30	31	30	29	29	28	28	27	26	31	40	49	56	58	62	63	62	55	51	47	47	45	43	43
Americaweater	36	36	35	35	35	34	34	35	36	37	42	48	54	56	59	61	59	56	54	51	47	45	44	43
Findlocalweather	37	36	35	35	35	34	34	35	33	36	42	48	54	56	59	61	59	56	52	50	47	45	44	43
Srhnoaa	34	33	32	32	31	30	30	30	30	35	43	52	58	60	61	64	62	60	53	49	45	42	41	40
Weatherperhour	38	40	39	38	37	37	35	32	32	38	45	49	53	56	58	58	58	55	50	46	44	45	44	43
WeatherANN	35	35	34	34	33	33	32	32	31	35	42	49	55	57	60	61	60	56	52	49	46	44	43	42
Actual Temp.	33	31	29	29	28	28	27	28	37	42	50	55	61	63	64	62	57	51	46	44	45	43	41	39
	Temperture Forecast (fahrenheit) on 12/12/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	37	34	34	34	34	30	30	33	33	40	44	50	55	57	58	59	58	54	51	48	47	46	44	45
Americaweater	42	41	41	40	39	39	38	39	36	38	42	47	51	53	55	57	55	53	52	50	47	45	44	44
Findlocalweather	42	41	41	40	39	39	38	39	40	41	42	47	51	53	55	57	55	53	51	49	47	45	44	44
Srhnoaa	39	39	38	37	36	36	36	35	35	39	45	52	56	58	59	59	59	57	52	48	45	43	41	37
Weatherperhour	42	39	36	35	34	33	35	39	36	41	46	49	51	55	56	56	56	53	45	43	42	42	41	40
WeatherANN	40	39	38	37	36	35	35	37	36	40	44	49	53	55	57	58	57	54	50	48	46	44	43	42
Actual Temp.	35	37	33	35	34	31	31	31	37	47	53	55	57	57	59	56	56	52	47	42	38	38	36	35
	Temperture Forecast (fahrenheit) on 12/13/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	37	37	34	33	32	34	32	33	34	38	45	50	52	55	56	57	56	53	52	52	52	51	50	50
Americaweater	36	36	37	37	37	38	38	39	37	38	42	47	51	53	54	56	55	55	54	53	53	52	51	50
Findlocalweather	43	42	37	37	37	38	38	39	41	42	42	47	51	53	54	56	55	55	56	55	53	52	51	50
Srhnoaa	35	34	33	32	31	31	35	32	32	36	42	50	54	55	56	56	56	54	50	48	45	44	43	43
Weatherperhour	40	39	38	37	36	36	36	39	37	41	46	48	50	53	53	52	52	53	52	54	52	52	52	51
WeatherANN	38	38	36	35	35	35	36	36	36	39	43	48	52	54	55	55	55	54	53	52	51	50	49	49
Actual Temp.	33	31	29	30	29	29	29	35	46	49	51	52	55	57	57	57	52	51	50	52	50	49	48	48
	Temperture Forecast (fahrenheit) on 12/14/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	45	42	40	38	35	38	40	40	38	39	42	44	48	49	52	52	51	49	45	41	40	38	36	37
Americaweater	49	48	47	46	45	44	43	43	43	43	43	45	47	48	48	49	47	45	45	43	40	38	37	35
Findlocalweather	49	48	47	46	45	44	43	43	43	43	43	45	47	48	48	49	47	45	45	43	40	38	37	35
Srhnoaa	41	43	42	41	40	39	39	39	39	41	44	47	50	51	51	52	53	50	45	41	37	38	36	33
Weatherperhour	50	50	48	47	47	47	46	42	41	42	44	46	48	49	50	51	50	48	44	42	40	38	36	35
WeatherANN	47	46	45	44	42	39	42	41	41	42	43	45	48	49	50	51	50	47	45	42	39	38	36	35
Actual Temp.	48	43	40	38	40	41	40	40	41	43	46	48	50	51	51	51	49	47	44	41	40	36	30	29
	Temperture Forecast (fahrenheit) on 12/15/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	28	27	26	24	23	22	26	29	27	33	40	45	48	49	50	50	49	46	42	40	39	37	35	35
Americaweater	34	32	32	32	32	32	32	33	30	31	35	40	44	46	48	50	48	46	44	41	39	36	34	33
Findlocalweather	34	32	32	32	32	32	32	33	30	31	35	40	44	46	48	50	48	46	44	41	39	36	34	33
Srhnoaa	32	31	30	29	28	27	26	26	26	29	35	42	46	47	50	52	49	45	43	39	35	33	32	28
Weatherperhour	35	33	31	32	33	33	34	33	33	38	41	43	45	46	47	47	46	44	39	35	33	32	31	29
WeatherANN	33	31	30	30	30	26	34	31	29	32	37	43	47	47	49	50	48	45	42	39	37	35	33	33
Actual Temp.	29	27	25	24	24	24	23	28	34	42	44	46	48	49	49	49	47	43	41	35	30	26	26	25



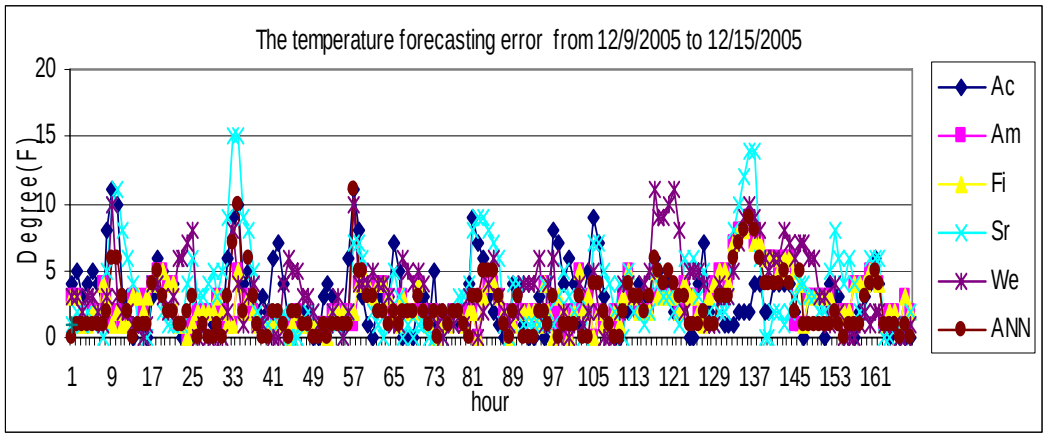
Note:

Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.13 the temperature forecasting error at Fort supply during winter period.

Table 4.10 temperature forecast compare to actual temperature from multiple resources on the period 12/9/05 to 12/15/05 in Fort supply.

Temperture Forecast (fahrenheit) on 12/9/05																							
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	15	14	14	14	12	12	13	13	13	18	22	28	32	35	37	40	40	36	34	31	29	26	25	24
Americaweater	20	19	15	14	14	13	13	15	17	19	22	26	29	31	33	35	33	31	36	33	30	27	26	26
Findlocalweather	20	19	15	14	14	13	13	15	17	19	22	26	29	31	33	35	33	31	36	33	30	27	26	26
Srhnoaa	13	13	13	12	12	11	11	11	12	16	22	30	35	34	36	38	36	33	31	29	27	26	25	24
Weatherperhour	20	16	16	16	16	17	17	17	17	22	27	30	33	33	35	36	35	31	25	23	22	21	20	20
WeatherANN	18	18	15	14	14	13	13	14	15	19	23	28	35	33	35	37	35	32	32	30	28	25	24	24
Actual Temp.	14	11	9	8	12	9	6	10	18	28	29	33	37	40	41	41	38	29	27	24	21	22	20	18
Temperture Forecast (fahrenheit) on 12/10/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	20	19	19	20	19	19	23	25	27	34	42	48	51	53	55	55	54	50	44	39	38	36	34	34
Americaweater	25	25	29	29	29	30	30	31	27	30	34	38	42	45	47	50	49	47	41	39	37	35	35	34
Findlocalweather	28	28	29	29	29	30	30	31	33	34	34	38	42	45	47	50	49	47	41	39	37	35	35	34
Srhnoaa	23	22	22	21	21	20	20	21	21	26	34	44	49	52	53	55	51	48	44	40	36	33	31	29
Weatherperhour	20	22	22	22	23	25	27	29	31	35	39	41	43	45	46	45	44	41	37	35	34	34	35	34
WeatherANN	23	23	24	24	24	25	26	27	23	32	37	42	45	48	50	51	49	47	41	38	36	35	34	33
Actual Temp.	16	17	16	24	22	21	23	25	29	38	47	50	53	54	54	52	47	38	38	33	32	30	27	25
Temperture Forecast (fahrenheit) on 12/11/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	30	29	29	28	29	28	27	26	26	32	41	50	56	59	61	62	61	55	49	45	43	40	37	37
Americaweater	31	30	30	29	29	28	28	30	33	35	38	43	48	50	53	55	53	51	49	47	43	40	39	38
Findlocalweather	34	33	30	29	29	28	28	30	31	33	38	43	48	50	53	55	53	51	50	47	43	40	39	38
Srhnoaa	28	29	28	27	26	26	25	25	25	30	39	49	55	57	60	62	60	57	49	43	39	35	34	34
Weatherperhour	33	34	34	34	34	33	32	32	31	35	41	44	48	50	53	54	53	49	43	41	40	38	36	35
WeatherANN	31	31	30	29	29	29	28	29	26	33	39	46	51	53	56	58	56	53	48	45	42	39	37	36
Actual Temp.	26	25	28	27	27	26	25	27	34	46	54	56	58	60	60	60	52	44	39	33	36	28	28	34
Temperture Forecast (fahrenheit) on 12/12/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	32	33	31	31	31	31	29	28	30	35	44	49	51	54	55	55	55	51	47	44	44	44	43	44
Americaweater	37	36	33	32	31	31	30	32	32	34	38	43	47	49	52	54	53	51	48	47	45	44	44	45
Findlocalweather	34	33	33	32	31	31	30	32	34	36	38	43	47	49	52	54	53	51	48	47	45	44	44	45
Srhnoaa	33	32	32	30	30	29	28	27	28	32	39	46	51	54	55	55	55	54	49	45	42	40	39	35
Weatherperhour	34	34	34	35	35	35	34	34	33	37	42	45	48	50	51	52	52	50	43	41	40	39	38	36
WeatherANN	34	34	33	32	32	31	30	28	31	35	40	45	49	51	53	54	54	51	47	45	43	42	42	41
Actual Temp.	29	27	26	27	26	28	27	26	35	41	49	52	57	57	58	53	49	43	40	33	32	34	33	34
Temperture Forecast (fahrenheit) on 12/13/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	37	35	33	37	38	39	38	41	41	43	44	46	48	49	47	48	48	51	49	48	48	46	43	42
Americaweater	45	44	39	39	39	38	38	40	42	44	45	47	50	51	51	52	51	49	54	52	49	47	46	44
Findlocalweather	45	44	39	39	39	38	38	40	42	44	45	47	50	51	51	52	51	49	54	52	49	47	46	44
Srhnoaa	32	32	31	30	30	30	33	30	31	34	41	49	53	53	54	54	54	50	45	42	39	37	36	36
Weatherperhour	35	37	36	36	35	36	36	38	40	43	46	46	47	51	52	53	53	51	49	47	47	47	47	46
WeatherANN	39	38	36	36	36	36	37	38	39	42	44	47	50	51	51	52	51	50	50	48	46	45	44	42
Actual Temp.	33	30	30	30	40	41	42	44	45	47	46	49	46	44	47	47	47	45	45	43	41	37	38	36
Temperture Forecast (fahrenheit) on 12/14/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	37	34	34	33	32	32	31	31	29	34	39	42	44	47	48	48	47	45	42	40	39	37	34	34
Americaweater	39	38	37	36	35	35	34	36	37	39	36	39	42	44	46	48	47	47	46	43	41	38	36	35
Findlocalweather	43	42	37	36	35	35	34	36	37	39	36	39	42	44	46	48	47	47	46	43	41	38	36	35
Srhnoaa	34	36	35	34	32	32	31	31	31	33	37	42	45	47	47	49	50	47	41	37	33	32	30	28
Weatherperhour	46	45	44	43	42	40	39	36	36	37	40	42	43	45	46	47	46	44	40	36	35	34	33	32
WeatherANN	40	39	37	36	35	35	34	34	36	36	38	41	43	45	47	48	48	46	43	40	38	36	34	33
Actual Temp.	35	33	32	31	28	27	28	28	37	39	40	43	45	46	46	45	42	35	30	30	24	21	21	20
Temperture Forecast (fahrenheit) on 12/15/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	24	23	22	24	23	24	23	23	24	30	38	41	43	44	45	44	44	41	39	38	38	35	33	32
Americaweater	30	29	28	27	27	26	26	28	31	33	34	36	39	41	42	44	44	43	44	42	39	37	35	33
Findlocalweather	33	32	28	27	27	26	26	28	31	33	34	36	39	41	42	44	44	43	44	42	39	37	35	33
Srhnoaa	27	26	24	23	22	21	19	19	19	23	29	36	41	43	45	47	44	40	38	34	30	28	26	21
Weatherperhour	33	33	33	32	32	32	32	32	32	34	37	39	40	40	42	42	41	40	36	33	31	31	30	30
WeatherANN	29	29	27	27	26	26	25	28	28	31	34	38	40	42	43	44	43	41	40	38	32	34	27	26
Actual Temp.	20	20	20	22	21	23	20	24	29	37	40	42	42	43	43	43	40	35	29	26	20	20	17	12

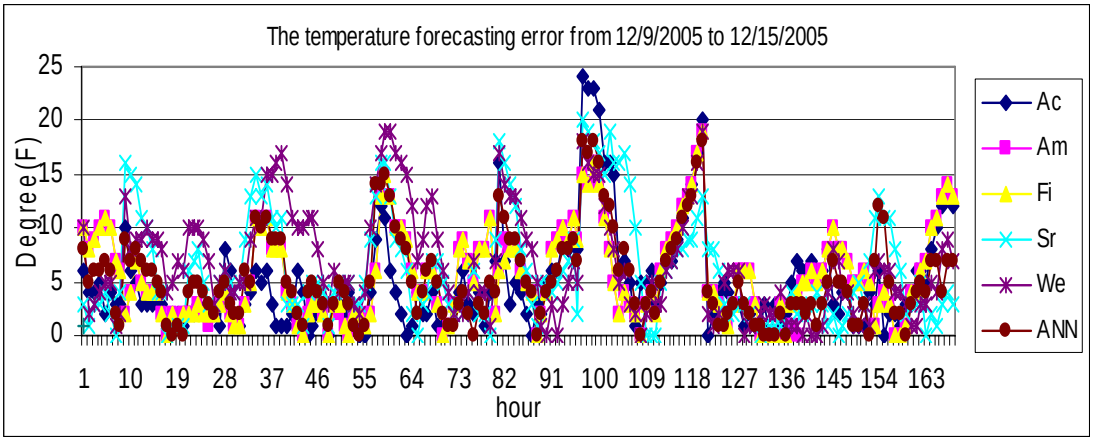


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.14 the temperature forecasting error at Hugo during winter period.

Table 4.11 temperature forecast compare to actual temperature from multiple resources on the period 12/9/05 to 12/15/05 in Hugo.

Temperture Forecast (fahrenheit) on 12/9/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	13	12	12	11	9	9	9	7	10	17	27	30	35	37	38	39	39	38	35	33	31	29	27	27
Americaweater	20	20	16	16	16	15	15	18	22	25	29	34	38	39	41	42	40	37	35	33	31	29	28	28
Findlocalweather	20	20	16	16	16	15	15	18	22	25	29	34	38	39	41	42	40	37	35	33	31	29	28	28
Srhnoaa	16	15	14	13	13	11	11	10	11	16	22	27	31	35	39	39	40	36	32	30	28	27	26	24
Weatherperhour	14	14	13	12	11	11	10	12	11	24	28	31	34	37	39	40	40	36	27	27	24	22	21	21
WeatherANN	17	16	14	14	13	12	12	13	15	21	27	31	35	37	40	40	40	37	33	31	29	27	26	26
Actual Temp.	17	17	15	15	14	13	11	15	21	27	30	33	35	36	39	39	36	32	30	29	27	28	27	28
Temperture Forecast (fahrenheit) on 12/10/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	28	26	26	26	25	24	24	21	24	30	37	41	47	52	55	56	56	54	49	45	43	40	37	36
Americaweater	27	27	26	26	26	25	25	28	32	35	39	43	47	49	51	53	51	48	46	44	41	39	38	37
Findlocalweather	27	27	26	26	26	25	25	28	32	35	39	43	47	49	51	53	51	48	46	44	41	39	38	37
Srhnoaa	22	22	21	20	19	19	18	18	18	25	32	38	44	48	51	55	52	48	47	44	42	41	40	40
Weatherperhour	20	25	25	24	24	23	23	25	25	36	40	43	45	49	51	52	50	47	41	38	37	36	36	35
WeatherANN	25	25	25	24	24	23	23	24	26	30	39	40	46	49	52	54	52	49	46	44	40	39	38	37
Actual Temp.	28	25	24	24	24	22	23	27	33	40	41	46	49	50	52	54	50	47	45	44	42	41	39	38
Temperture Forecast (fahrenheit) on 12/11/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	37	37	33	31	30	30	31	28	29	37	47	53	57	62	64	64	64	59	53	50	48	45	43	43
Americaweater	36	36	35	35	35	34	34	36	39	41	45	50	54	55	57	58	55	53	50	48	46	44	44	43
Findlocalweather	36	36	35	35	35	34	34	36	38	41	45	50	54	55	57	58	55	53	50	48	46	44	44	43
Srhnoaa	39	38	37	36	35	33	32	32	33	38	44	50	55	58	61	64	62	57	53	51	48	47	45	44
Weatherperhour	35	38	37	36	35	35	32	32	30	41	46	50	52	55	57	58	58	55	47	45	44	43	42	42
WeatherANN	37	37	35	35	34	33	33	33	29	40	45	51	54	57	59	60	59	55	51	48	46	45	44	43
Actual Temp.	37	37	36	35	33	32	32	34	40	45	50	54	57	59	61	61	57	54	53	50	48	48	46	44
Temperture Forecast (fahrenheit) on 12/12/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	38	39	38	38	37	38	36	34	33	41	49	57	62	63	64	64	63	59	54	50	48	45	42	42
Americaweater	41	40	39	38	37	37	36	40	44	48	52	56	60	61	62	63	60	57	55	52	50	47	46	45
Findlocalweather	41	40	39	38	37	37	36	40	44	48	52	56	60	61	62	63	60	57	55	52	50	47	46	45
Srhnoaa	43	42	40	39	38	36	34	34	34	39	46	52	57	58	63	63	63	59	54	51	49	47	46	45
Weatherperhour	41	41	40	39	38	37	36	41	39	48	53	56	58	61	62	62	61	57	49	46	44	42	41	39
WeatherANN	41	40	38	38	37	37	36	38	39	45	50	55	59	61	63	63	61	58	53	50	48	46	44	42
Actual Temp.	43	40	40	37	39	39	37	38	42	48	55	60	64	64	64	63	59	55	53	50	48	48	42	43
Temperture Forecast (fahrenheit) on 12/13/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	36	33	33	32	32	31	32	32	33	40	47	52	56	58	60	59	60	60	58	56	55	54	53	53
Americaweater	42	41	39	38	38	37	37	40	42	45	49	54	58	59	61	62	60	58	57	55	54	52	52	52
Findlocalweather	44	43	39	38	38	37	37	40	42	45	49	54	58	59	61	62	60	58	57	55	54	52	52	52
Srhnoaa	45	43	42	41	38	35	35	35	35	40	45	49	54	54	58	62	59	59	56	55	54	53	52	52
Weatherperhour	38	40	39	38	37	36	36	39	37	45	50	53	56	60	62	61	60	59	59	58	60	58	58	59
WeatherANN	41	40	38	37	37	35	35	37	38	43	48	52	56	58	60	61	60	59	57	56	55	54	53	54
Actual Temp.	44	40	37	38	36	32	35	37	42	47	50	53	56	58	58	57	57	56	55	53	49	49	49	49
Temperture Forecast (fahrenheit) on 12/14/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	51	52	52	55	55	50	46	48	45	46	50	51	51	51	50	49	50	48	45	43	44	43	41	41
Americaweater	52	52	52	52	52	52	52	53	53	54	56	56	57	57	56	56	53	51	49	47	46	44	43	43
Findlocalweather	52	52	52	52	52	52	52	53	53	54	56	56	57	57	56	56	53	51	49	47	46	44	43	43
Srhnoaa	51	51	50	50	49	51	48	48	48	51	53	55	58	59	60	61	60	50	43	41	38	37	36	35
Weatherperhour	60	58	58	60	60	59	57	51	50	53	54	55	55	56	57	57	55	52	49	46	46	45	45	44
WeatherANN	53	53	53	54	54	53	51	51	50	52	54	55	56	56	56	56	54	50	47	45	44	43	42	41
Actual Temp.	49	50	56	55	55	54	53	50	49	49	51	52	50	49	48	47	46	44	43	41	40	39	37	37
Temperture Forecast (fahrenheit) on 12/15/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	39	38	36	31	30	29	31	30	34	37	42	48	49	52	53	54	53	49	44	40	38	36	34	34
Americaweater	38	38	37	37	36	35	34	37	39	42	46	49	53	54	54	55	52	49	44	42	39	37	37	36
Findlocalweather	42	41	37	37	36	35	34	37	39	42	46	49	53	54	54	55	52	49	44	42	39	37	37	36
Srhnoaa	34	33	32	31	30	30	29	29	29	34	40	41	45	48	52	56	53	51	43	40	36	35	33	32
Weatherperhour	43	44	43	40	39	35	34	33	33	42	44	47	49	51	52	51	49	47	44	41	38	36	34	33
WeatherANN	39	42	37	35	34	33	32	33	35	39	44	48	48	51	53	54	52	49	44	41	38	36	35	34
Actual Temp.	37	37	36	34	33	32	31	34	37	40	44	47	49	50	50	50	47	45	43	40	37	36	34	34

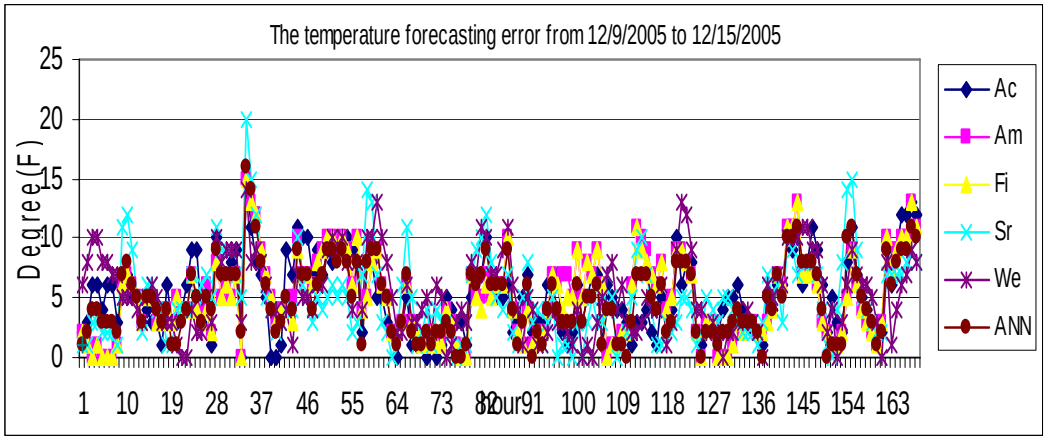


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.15 the temperature forecasting error at Pharaoh during winter period.

Table 4.12 temperature forecast compare to actual temperature from multiple resources on the period 12/9/05 to 12/15/05 in Pharaoh.

Temperture Forecast (fahrenheit) on 12/9/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	9	9	7	7	3	5	1	5	10	19	25	30	34	36	37	37	37	34	30	27	27	26	25	25
Americaweater	13	13	12	12	12	11	11	14	18	21	23	28	33	35	36	38	36	34	29	28	27	26	25	25
Findlocalweather	13	13	12	12	12	11	11	14	18	21	23	28	33	35	36	38	36	34	29	28	27	26	25	25
Srhnoaa	6	6	6	5	5	3	4	4	4	10	16	22	27	31	36	36	36	33	27	25	23	21	20	22
Weatherperhour	13	7	6	6	6	6	5	6	7	17	21	24	27	30	31	32	32	27	21	20	19	18	18	18
WeatherANN	11	10	9	8	8	7	6	9	11	18	22	26	31	33	35	36	35	32	27	26	25	23	23	23
Actual Temp.	3	5	3	2	1	1	4	8	20	25	30	33	37	39	40	40	36	32	28	26	29	28	28	27
Temperture Forecast (fahrenheit) on 12/10/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	27	27	25	19	19	25	25	25	28	34	39	45	50	54	57	57	55	54	49	45	43	40	37	37
Americaweater	24	23	23	23	23	23	23	25	27	29	34	40	45	47	50	52	50	47	45	43	41	39	38	37
Findlocalweather	23	23	23	23	23	23	23	25	27	29	34	40	45	47	50	52	50	47	45	43	41	39	38	37
Srhnoaa	22	22	21	21	20	20	19	19	19	25	31	37	42	45	47	53	50	45	44	41	39	37	36	36
Weatherperhour	18	22	21	21	21	20	19	23	23	29	33	36	38	39	41	42	42	38	35	34	33	34	35	34
WeatherANN	22	23	22	22	22	22	22	22	27	29	34	40	44	46	49	51	49	46	44	41	39	38	37	36
Actual Temp.	25	25	26	27	25	24	24	28	32	40	44	51	53	55	58	56	53	48	45	45	44	42	40	37
Temperture Forecast (fahrenheit) on 12/11/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	36	36	36	34	34	34	34	34	34	39	46	54	57	61	64	64	63	59	53	50	50	48	45	44
Americaweater	42	41	39	38	37	36	35	36	37	38	42	47	51	53	55	57	55	53	49	48	48	47	45	44
Findlocalweather	36	36	39	38	37	36	35	36	37	38	42	47	51	53	55	57	55	53	49	48	48	47	45	44
Srhnoaa	35	34	34	33	32	31	29	29	30	35	41	47	52	55	58	61	59	54	51	47	44	42	41	39
Weatherperhour	33	35	33	33	32	32	30	28	29	34	38	41	44	47	49	51	52	48	43	41	42	41	40	39
WeatherANN	36	34	34	35	34	34	33	33	29	37	42	47	51	54	56	58	57	53	49	47	46	45	43	42
Actual Temp.	39	39	38	38	35	34	34	38	43	51	57	60	61	63	64	63	59	57	55	54	51	47	44	41
Temperture Forecast (fahrenheit) on 12/12/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	45	45	43	43	41	37	36	34	34	46	54	55	57	59	61	61	55	54	51	47	46	43	40	40
Americaweater	49	48	47	46	45	44	43	43	44	44	49	52	55	56	57	58	55	53	53	50	47	44	42	41
Findlocalweather	49	48	47	46	45	44	43	43	44	46	49	52	55	56	57	58	55	53	53	50	47	44	42	41
Srhnoaa	38	37	36	35	35	34	32	32	32	37	43	48	53	55	58	59	58	54	49	46	43	42	40	34
Weatherperhour	38	37	36	34	33	32	31	34	33	39	44	47	50	52	53	53	52	49	42	41	40	40	38	37
WeatherANN	44	43	42	41	40	38	37	37	37	42	48	51	54	56	57	58	55	53	50	47	45	43	40	39
Actual Temp.	41	39	40	41	37	36	32	41	50	53	57	60	61	61	61	58	53	49	45	41	37	35	31	32
Temperture Forecast (fahrenheit) on 12/13/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	30	30	28	28	30	27	25	34	34	39	48	54	55	57	57	57	57	54	53	53	53	53	53	53
Americaweater	39	39	35	35	35	35	35	38	37	41	45	49	53	55	56	58	57	56	54	54	53	53	53	52
Findlocalweather	39	39	35	35	35	35	35	38	37	41	45	49	53	55	56	58	57	56	54	54	53	53	53	52
Srhnoaa	34	34	33	32	31	24	24	24	24	30	37	44	50	51	54	57	55	54	52	50	49	48	47	46
Weatherperhour	36	37	36	34	34	33	32	35	35	41	45	49	52	56	57	55	55	54	52	52	53	52	52	52
WeatherANN	36	36	33	33	33	31	30	34	33	38	44	49	53	55	56	57	56	55	53	53	52	52	52	51
Actual Temp.	54	53	51	49	46	43	40	40	41	44	47	49	50	51	54	52	49	47	44	42	40	39	36	33
Temperture Forecast (fahrenheit) on 12/14/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	54	55	55	54	50	46	43	41	39	43	46	52	50	54	55	54	54	54	50	48	47	45	42	41
Americaweater	50	49	48	47	47	46	46	46	47	47	47	49	50	51	51	52	50	47	49	47	46	44	42	41
Findlocalweather	50	49	48	47	47	46	46	46	47	47	47	49	50	51	51	52	52	51	49	47	46	44	42	41
Srhnoaa	46	45	45	46	44	45	43	43	43	45	47	48	51	52	53	53	53	49	42	39	37	35	33	32
Weatherperhour	52	52	53	54	52	49	46	40	40	43	45	46	48	49	50	51	50	48	44	40	40	39	37	37
WeatherANN	50	50	50	50	48	46	45	43	43	45	46	49	50	51	52	52	52	50	47	44	43	38	39	38
Actual Temp.	54	53	51	49	46	43	40	40	41	44	47	49	50	51	54	52	49	47	44	42	40	39	36	33
Temperture Forecast (fahrenheit) on 12/15/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	32	32	34	34	30	30	30	28	34	37	45	46	50	50	52	50	50	46	43	41	41	39	37	36
Americaweater	39	38	38	37	36	36	35	37	38	40	41	45	48	49	50	51	48	46	45	43	42	40	38	37
Findlocalweather	39	38	38	37	36	36	35	37	38	40	41	45	48	49	50	51	48	46	45	43	42	40	38	37
Srhnoaa	31	30	29	28	27	26	26	25	26	30	34	37	40	43	47	50	47	45	38	35	32	30	28	27
Weatherperhour	37	37	34	34	33	32	32	31	31	36	39	42	44	45	46	46	45	43	41	38	35	35	33	31
WeatherANN	36	35	35	34	32	32	32	32	30	31	34	43	46	47	49	50	48	45	42	40	38	31	31	31
Actual Temp.	29	30	30	30	31	31	29	32	37	43	45	48	48	49	49	47	44	40	38	33	31	27	24	24



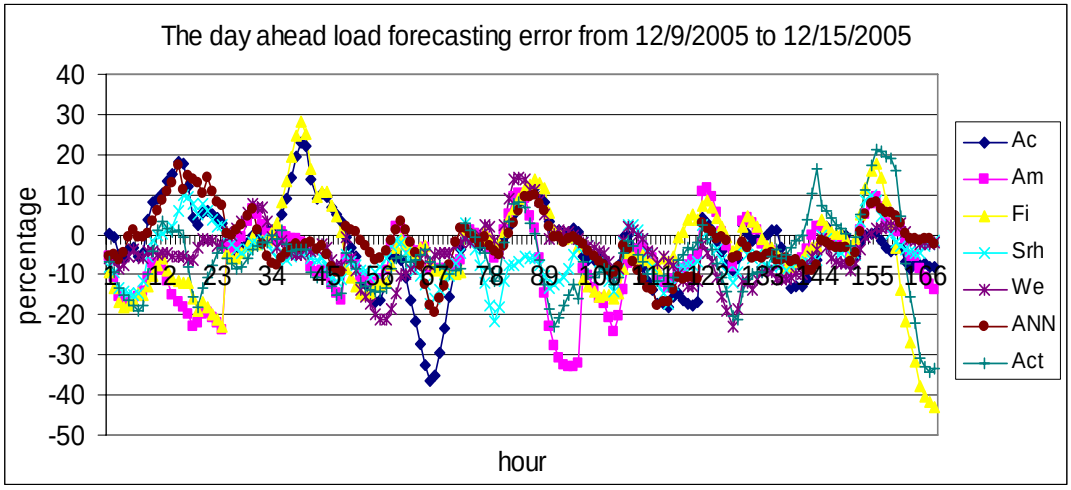
Note:

Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.16 the temperature forecasting error at Russell during fall period.

Table 4.13 temperature forecast compare to actual temperature from multiple resources on the period 12/9/05 to 12/15/05 in Russell.

	Temperture Forecast (fahrenheit) on 12/9/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	15	15	16	15	14	15	15	15	17	21	28	32	36	39	42	42	42	41	36	32	31	31	30	31
Americaweater	11	11	10	10	10	9	9	13	17	21	27	32	36	38	40	42	40	39	36	34	31	29	28	26
Findlocalweather	11	11	10	10	10	9	9	13	17	21	27	32	36	38	40	42	40	39	36	34	31	29	28	26
Srhnoaa	14	13	13	12	12	11	11	11	12	16	24	32	37	37	39	41	39	36	34	33	31	29	28	27
Weatherperhour	19	20	20	19	18	17	16	19	18	23	28	33	36	38	39	40	40	38	30	28	27	25	25	24
WeatherANN	14	14	14	13	13	12	12	14	16	20	27	32	36	38	40	41	40	39	34	30	30	29	28	27
Actual Temp.	13	12	10	9	10	9	9	12	23	28	33	37	39	43	45	45	43	35	33	29	27	25	21	22
	Temperture Forecast (fahrenheit) on 12/10/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	24	24	22	24	23	22	23	27	30	34	41	48	51	53	58	58	57	55	49	45	44	42	39	38
Americaweater	25	25	23	22	21	21	20	25	30	34	39	44	49	51	53	55	52	50	47	44	41	39	38	37
Findlocalweather	24	23	23	22	21	21	20	25	30	34	39	44	49	51	53	55	52	50	45	43	41	39	38	37
Srhnoaa	27	26	26	25	25	24	24	25	25	29	37	44	50	53	54	56	53	50	46	44	40	37	35	34
Weatherperhour	23	24	24	24	24	24	24	27	27	35	44	47	50	52	54	54	53	50	41	41	39	37	36	35
WeatherANN	24	24	25	23	23	22	22	25	28	33	38	45	50	52	54	56	53	51	46	43	41	39	36	35
Actual Temp.	21	19	21	14	16	15	15	18	30	49	52	56	58	58	58	58	56	46	42	34	34	32	32	29
	Temperture Forecast (fahrenheit) on 12/11/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	35	35	32	33	32	33	34	32	32	38	46	54	56	59	60	60	59	55	50	48	47	45	43	43
Americaweater	37	36	34	33	32	32	31	34	38	41	46	50	55	57	60	62	59	56	52	49	47	44	43	42
Findlocalweather	37	36	34	33	32	32	31	34	38	41	46	50	55	57	60	62	59	56	52	49	47	44	43	42
Srhnoaa	32	31	30	29	28	28	27	27	27	32	41	52	58	60	62	62	62	61	54	48	44	41	40	39
Weatherperhour	34	35	34	33	32	31	29	32	30	36	44	46	51	54	57	58	58	56	46	44	42	40	39	37
WeatherANN	35	35	33	32	31	31	30	32	33	38	45	50	55	57	60	61	59	57	51	48	45	43	42	41
Actual Temp.	28	26	24	24	22	23	25	24	34	46	54	59	61	62	62	60	56	50	49	47	46	45	41	43
	Temperture Forecast (fahrenheit) on 12/12/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	42	40	39	39	39	37	37	38	38	40	47	52	56	60	60	64	60	57	52	48	47	46	44	44
Americaweater	40	39	38	37	36	36	35	38	40	43	48	51	55	56	58	59	56	54	49	47	46	44	44	43
Findlocalweather	40	39	38	37	36	36	35	38	41	44	48	51	55	56	58	59	56	54	49	47	46	44	44	43
Srhnoaa	38	38	37	36	35	35	35	34	35	38	45	52	57	59	60	60	60	58	53	49	45	43	42	37
Weatherperhour	36	35	34	33	32	33	34	36	34	40	46	50	52	55	56	57	56	55	46	44	43	42	41	40
WeatherANN	39	38	37	36	36	35	35	37	38	41	47	51	55	57	58	60	58	56	50	47	45	44	43	41
Actual Temp.	41	35	35	36	36	36	42	43	45	50	53	57	61	66	62	61	55	50	50	45	44	40	37	37
	Temperture Forecast (fahrenheit) on 12/13/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	38	36	36	36	36	35	37	37	36	38	44	46	49	51	51	51	50	50	47	46	47	47	47	47
Americaweater	43	42	39	39	38	38	37	39	43	44	48	51	55	56	58	59	57	55	52	51	50	49	48	46
Findlocalweather	40	40	39	39	38	38	37	39	43	44	48	51	55	56	58	59	56	54	52	51	50	49	48	46
Srhnoaa	35	34	34	33	33	33	35	33	34	37	44	50	54	56	57	57	57	53	49	46	43	42	41	40
Weatherperhour	39	37	35	34	33	31	30	33	32	37	41	46	47	51	50	50	50	51	49	49	48	46	46	46
WeatherANN	39	38	37	36	36	35	35	36	38	40	45	49	52	54	55	55	54	53	50	49	48	47	46	45
Actual Temp.	36	35	34	30	33	30	30	30	37	44	49	50	53	54	52	48	47	46	45	45	42	45	43	37
	Temperture Forecast (fahrenheit) on 12/14/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	40	42	42	40	38	38	37	37	37	38	41	44	47	50	51	51	51	48	43	40	39	36	34	34
Americaweater	43	42	41	40	39	38	37	39	41	43	45	47	49	50	50	51	48	46	43	41	39	37	36	36
Findlocalweather	43	42	41	40	39	38	37	39	41	43	45	47	49	50	50	51	48	46	43	41	39	37	36	36
Srhnoaa	39	39	38	37	37	36	36	36	36	38	42	47	49	51	51	52	53	50	44	40	36	36	34	30
Weatherperhour	47	46	43	42	43	43	43	41	41	41	44	46	48	49	50	51	50	49	44	41	39	36	35	33
WeatherANN	42	42	41	40	39	39	38	38	39	41	43	46	48	50	50	51	50	48	43	41	38	36	35	34
Actual Temp.	34	34	34	38	39	41	40	39	41	43	46	50	51	53	53	53	50	43	39	34	33	26	25	23
	Temperture Forecast (fahrenheit) on 12/15/05																						
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	27	28	31	29	28	28	29	31	30	34	38	43	46	48	49	49	49	46	42	40	39	36	34	34
Americaweater	28	27	27	26	25	24	23	27	34	37	40	44	47	49	50	52	50	47	43	40	37	34	34	33
Findlocalweather	28	27	27	26	25	24	23	27	34	37	40	44	47	49	50	52	50	47	43	40	37	34	34	33
Srhnoaa	29	28	28	27	26	25	24	24	24	28	34	41	46	48	49	49	49	44	43	38	34	32	30	30
Weatherperhour	32	31	29	29	28	28	28	28	29	36	40	43	45	46	47	48	47	45	37	35	33	31	30	30
WeatherANN	29	28	28	27	26	26	25	27	31	32	38	43	46	48	49	50	49	46	42	39	36	33	32	32
Actual Temp.	21	20	20	20	22	26	24	28	32	42	49	50	51	52	52	51	47	37	36	31	27	24	21	22



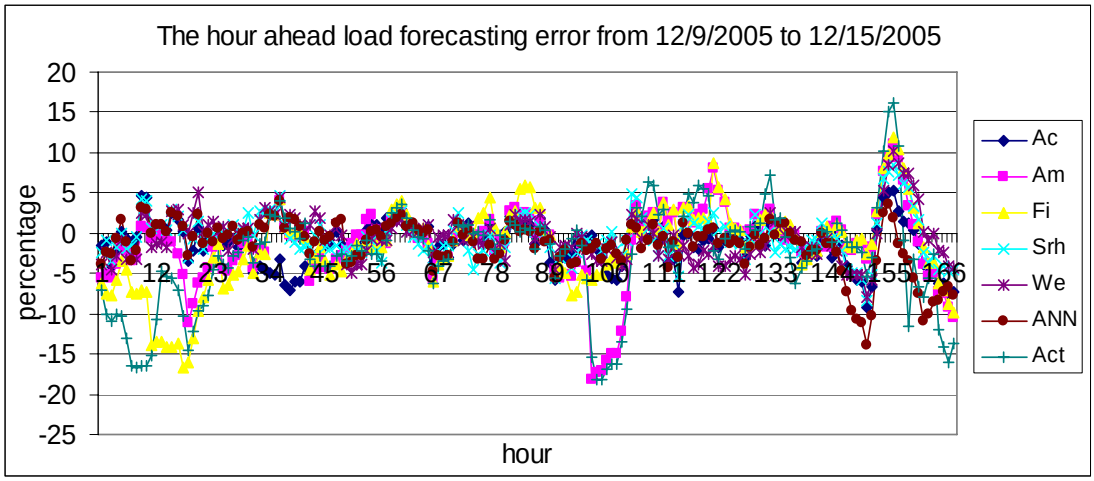
Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.17 Day-ahead load forecast error in winter season.

Table 4.14 Day-ahead load forecast compare to actual load from multiple resources on the period 12/9/05 to 12/15/05 in winter season.

Day-ahead Load Forecast on 12/9/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	998	971	965	985	1017	1058	1108	1119	1070	1005	945	888	837	803	774	762	789	867	926	938	953	938	898	851
Americaweater	1058	1051	1044	1059	1075	1079	1095	1098	1034	982	923	870	830	800	774	774	802	867	947	958	969	942	902	856
Findlocalweather	1050	1048	1039	1071	1095	1118	1168	1225	1150	1100	1040	981	930	894	862	843	852	926	1016	1028	1003	1008	993	928
Srhnoaa	1017	1015	1022	1054	1085	1119	1198	1201	1155	1086	998	941	892	858	854	841	865	925	1013	1025	1004	1008	990	941
Weatherperhour	1064	1062	1081	1114	1165	1237	1277	1281	1237	1147	989	914	849	802	764	743	745	778	863	885	912	927	932	907
WeatherANN	966	940	921	926	956	1005	1078	1113	1095	1034	986	948	923	919	933	963	997	1077	1126	1139	1135	1103	1045	987
Actual Load	1054	1037	1057	1069	1090	1151	1234	1241	1136	1069	1011	949	899	871	840	835	868	965	1033	1018	1029	1020	991	944
Day-ahead Load Forecast on 12/10/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	890	855	839	848	888	943	1005	1019	997	934	865	814	745	708	678	665	675	738	796	814	809	788	763	730
Americaweater	890	855	838	839	868	913	973	1020	1004	941	872	820	757	717	684	673	691	750	805	824	822	799	762	723
Findlocalweather	904	885	882	900	941	994	1049	1035	992	931	873	821	776	745	720	707	726	776	827	846	851	826	789	751
Srhnoaa	883	860	858	875	906	948	985	982	946	890	841	797	764	728	687	664	663	703	762	780	781	767	736	696
Weatherperhour	899	866	861	869	892	931	978	1002	989	937	879	827	774	736	715	714	738	787	847	866	877	877	859	820
WeatherANN	906	875	861	867	900	942	998	1013	992	933	873	821	763	725	704	708	735	781	825	844	844	820	786	750
Actual Load	917	906	899	906	919	943	995	1012	1009	968	917	846	797	752	719	706	721	793	857	865	870	872	847	807
Day-ahead Load Forecast on 12/11/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	748	729	721	720	725	736	757	794	840	846	784	718	668	610	568	536	522	556	602	622	630	622	596	565
Americaweater	781	759	746	740	740	751	770	818	867	850	790	729	688	636	597	581	588	651	713	729	737	722	690	638
Findlocalweather	786	746	728	693	669	645	610	579	558	532	518	521	562	599	641	671	699	781	810	812	798	762	701	654
Srhnoaa	772	747	731	730	756	795	859	925	965	972	957	877	818	764	734	720	748	817	868	887	882	856	819	757
Weatherperhour	746	719	704	679	661	641	614	599	607	584	579	578	572	561	562	582	610	683	752	770	767	751	718	671
WeatherANN	803	783	769	759	760	771	795	833	868	856	811	770	733	693	659	638	639	684	731	748	752	737	706	663
Actual Load	786	779	778	792	803	830	868	911	930	887	821	764	739	707	685	674	691	780	840	855	865	849	802	741
Day-ahead Load Forecast on 12/12/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	723	704	702	708	731	792	852	882	872	837	805	774	742	703	680	665	690	756	826	847	834	803	753	706
Americaweater	718	708	698	694	720	777	866	894	865	840	819	807	791	767	742	731	758	825	875	893	893	879	830	763
Findlocalweather	710	693	678	670	670	705	774	814	818	797	780	757	726	692	666	646	652	697	754	773	798	803	780	738
Srhnoaa	694	677	664	675	701	767	857	873	841	822	802	793	790	770	745	731	754	817	868	880	880	862	807	737
Weatherperhour	707	695	693	697	714	752	820	864	879	846	815	778	733	686	654	625	620	662	738	766	790	787	761	707
WeatherANN	717	698	689	686	688	722	784	839	854	844	790	752	713	672	647	627	635	689	771	790	788	757	712	670
Actual Load	710	701	702	714	727	796	895	924	867	822	777	740	705	687	665	668	703	798	871	886	898	877	822	763
Day-ahead Load Forecast on 12/13/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	731	727	717	715	737	789	862	887	877	869	831	789	739	704	659	632	617	650	694	716	723	699	652	611
Americaweater	728	729	728	732	750	792	856	889	877	849	815	780	739	706	661	640	638	672	713	733	736	713	664	607
Findlocalweather	731	707	699	705	727	766	831	857	822	788	762	735	700	671	640	626	645	713	764	769	759	726	677	630
Srhnoaa	723	709	699	695	709	761	832	853	826	825	816	792	750	719	698	697	721	777	825	841	844	817	761	686
Weatherperhour	725	704	698	693	708	755	823	846	835	825	790	753	711	681	649	635	656	714	764	771	764	738	685	618
WeatherANN	711	692	694	712	739	772	822	852	852	868	854	821	786	758	744	755	790	832	869	884	870	824	768	703
Actual Load	741	737	746	753	774	841	935	946	873	828	809	791	765	759	743	761	782	858	893	879	876	845	790	722
Day-ahead Load Forecast on 12/14/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	687	664	650	672	695	734	788	842	854	829	784	758	725	700	682	675	693	769	838	859	866	863	820	753
Americaweater	700	677	655	640	630	656	712	769	781	781	749	718	689	668	650	648	674	741	821	844	855	844	811	762
Findlocalweather	675	651	640	647	669	722	791	811	764	738	721	706	692	679	664	656	682	764	824	845	840	812	770	728
Srhnoaa	674	654	648	654	676	723	799	824	783	755	721	693	662	638	624	634	659	724	777	800	810	801	755	696
Weatherperhour	664	641	620	602	587	606	659	715	726	712	690	688	683	667	651	648	674	750	825	847	858	854	824	779
WeatherANN	697	666	640	618	600	612	657	716	727	741	724	696	666	642	630	633	659	739	809	835	846	847	816	768
Actual Load	675	669	664	675	696	753	860	884	826	815	806	780	762	740	726	727	757	839	919	935	947	928	879	819
Day-ahead Load Forecast on 12/15/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	812	807	790	786	800	849	917	954	951	936	889	839	799	770	742	732	742	799	875	905	919	907	869	815
Americaweater	809	809	804	808	826	872	933	965	961	933	895	859	821	785	735	721	696	735	772	800	821	836	821	774
Findlocalweather	787	778	770	771	785	825	899	928	909	894	876	846	816	794	785	781	810	887	944	955	958	943	899	845
Srhnoaa	746	727	728	749	780	831	880	908	928	941	937	903	864	829	802	787	809	859	915	945	956	949	898	829
Weatherperhour	792	772	751	734	738	763	829	890	895	854	813	779	752	730	713	712	742	810	883	914	933	927	893	840
WeatherANN	791	778	769	770	796	852	926	952	927	910	882	857	836	819	803	799	836	911	962	975	984	975	936	881
Actual Load	792	793	803	816	840	898	1002	1014	945	888	846	805	783	763	742	745	773	865	945	965	986	972	931	871



Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.18 Hour-ahead load forecast error in winter season.

Table 4.15 Hour-ahead load forecast compare to actual load from multiple resources on the period 12/9/05 to 12/15/05 in winter season

Hour-ahead Load Forecast on 12/9/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	1036	1029	1020	1051	1084	1135	1214	1229	1175	1119	1030	971	920	885	856	847	876	931	1021	1033	1014	1018	980	944
Americaweater	1037	1031	1027	1058	1101	1148	1227	1250	1177	1106	1038	979	928	892	860	841	853	920	1009	1021	989	994	985	944
Findlocalweather	1017	1015	1022	1054	1085	1119	1198	1201	1155	1086	998	941	892	858	854	841	865	925	1013	1025	1004	1008	990	941
Srhnoaa	1002	1000	1017	1049	1063	1096	1136	1174	1130	1074	1034	975	923	888	856	837	854	914	1003	1014	993	993	968	937
Weatherperhour	1016	1001	998	1029	1070	1116	1205	1225	1163	1093	1007	967	916	882	863	858	864	950	1041	1050	1022	1026	1000	939
WeatherANN	1015	1006	1005	1036	1083	1120	1188	1234	1159	1088	959	930	881	847	843	825	844	923	1011	1023	1006	1010	992	947
Actual Load	1054	1037	1057	1069	1090	1151	1234	1241	1136	1069	1011	949	899	871	840	835	868	965	1033	1018	1029	1020	991	944
Hour-ahead Load Forecast on 12/10/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	911	904	910	908	924	948	985	1040	1032	996	941	885	805	747	717	705	721	765	840	859	854	857	833	788
Americaweater	903	895	895	896	916	954	999	1035	1027	981	927	871	793	735	700	695	716	762	837	856	849	854	845	809
Findlocalweather	894	884	880	880	905	916	959	1000	993	976	936	884	805	751	716	697	709	766	842	861	862	869	856	800
Srhnoaa	909	892	889	902	928	967	997	1033	1025	994	939	883	805	778	741	722	735	794	856	876	860	854	842	805
Weatherperhour	916	902	903	902	919	950	982	1040	1038	993	944	891	813	757	721	702	717	787	864	884	879	864	837	788
WeatherANN	898	891	897	902	924	952	985	1012	1005	973	919	864	787	729	699	685	714	781	849	869	863	866	854	817
Actual Load	917	906	899	906	919	943	995	1012	1009	968	917	846	797	752	719	706	721	793	857	865	870	872	847	807
Hour-ahead Load Forecast on 12/11/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	771	767	768	778	803	828	867	906	936	892	831	776	738	696	669	658	679	746	820	837	847	847	820	743
Americaweater	771	769	772	786	812	842	875	915	936	891	830	776	738	710	689	684	693	746	820	839	850	850	813	737
Findlocalweather	750	745	753	765	789	823	867	895	918	906	844	789	751	719	692	673	687	747	818	836	847	847	809	734
Srhnoaa	752	742	746	750	774	799	843	872	925	899	837	782	744	719	691	672	674	739	812	832	842	842	800	731
Weatherperhour	753	749	757	771	796	825	864	893	923	905	843	793	754	725	697	678	691	753	827	847	846	842	807	736
WeatherANN	780	767	766	776	801	818	858	899	927	896	834	780	742	722	694	677	679	752	826	846	850	846	815	740
Actual Load	786	779	778	792	803	830	868	911	930	887	821	764	739	707	685	674	691	780	840	855	865	849	802	741
Hour-ahead Load Forecast on 12/12/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	708	688	702	715	740	778	889	918	891	842	789	757	720	689	667	654	690	769	844	857	843	833	802	750
Americaweater	720	702	689	699	725	781	892	912	887	838	785	750	713	679	679	662	694	755	827	844	867	863	810	744
Findlocalweather	686	670	684	699	725	770	872	917	873	826	806	769	736	701	678	660	697	765	850	869	863	860	823	755
Srhnoaa	699	686	691	705	725	767	878	902	877	840	787	752	715	689	683	664	688	771	850	867	876	872	821	745
Weatherperhour	696	679	692	708	734	779	865	910	878	830	801	768	731	696	673	658	694	770	865	886	873	864	828	748
WeatherANN	706	691	689	703	729	779	892	914	889	841	798	762	725	690	669	656	692	754	845	866	863	853	817	740
Actual Load	710	701	702	714	727	796	895	924	867	822	777	740	705	687	665	668	703	798	871	886	898	877	822	763
Hour-ahead Load Forecast on 12/13/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	729	713	722	739	765	806	894	947	897	865	831	791	759	745	752	767	801	843	890	881	866	838	781	708
Americaweater	737	722	730	747	775	823	911	927	901	851	811	790	758	737	748	753	790	832	900	875	858	833	781	722
Findlocalweather	716	719	728	745	762	810	914	964	894	863	822	792	765	749	729	733	778	829	890	865	848	836	782	723
Srhnoaa	729	721	730	747	774	816	913	939	871	829	790	770	766	743	739	733	758	798	882	877	860	834	778	708
Weatherperhour	723	714	723	740	767	817	898	914	893	843	803	801	765	735	738	738	783	828	881	856	839	817	776	705
WeatherANN	728	711	719	736	763	819	899	918	889	850	810	791	753	736	747	753	787	829	901	875	858	836	783	726
Actual Load	741	737	746	753	774	841	935	946	873	828	809	791	765	759	743	761	782	858	893	879	876	845	790	722
Hour-ahead Load Forecast on 12/14/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	681	657	653	670	692	746	831	878	822	824	805	789	751	742	722	726	755	816	899	921	921	924	877	809
Americaweater	681	660	653	670	693	747	832	879	838	812	818	796	754	741	712	717	746	818	892	914	925	929	881	800
Findlocalweather	678	655	654	669	692	746	835	867	800	795	804	788	757	748	735	725	754	837	895	917	923	926	874	801
Srhnoaa	669	650	663	668	691	731	815	860	797	798	805	803	761	747	727	731	760	815	889	908	913	917	850	791
Weatherperhour	654	631	635	651	673	726	812	858	809	802	799	783	751	742	727	727	756	817	899	921	924	927	875	813
WeatherANN	679	655	651	664	686	740	828	874	823	795	793	799	772	747	725	730	759	828	893	916	926	929	875	809
Actual Load	675	669	664	675	696	753	860	884	826	815	806	780	762	740	726	727	757	839	919	935	947	928	879	819
Hour-ahead Load Forecast on 12/15/05																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	785	788	797	815	846	890	968	1000	955	915	864	815	765	761	754	748	774	829	917	941	945	954	905	852
Americaweater	784	787	796	814	846	899	965	1006	965	906	856	816	773	762	737	728	761	842	914	939	955	972	917	839
Findlocalweather	773	774	783	801	833	885	957	1005	928	914	863	823	783	761	755	749	776	830	917	940	945	968	921	852
Srhnoaa	783	765	773	791	823	886	945	986	954	910	895	829	776	761	736	731	765	843	906	937	931	930	913	834
Weatherperhour	765	764	772	790	821	891	970	1013	950	896	865	819	774	763	754	745	779	847	929	956	963	981	924	858
WeatherANN	775	770	776	793	825	891	969	1014	955	904	871	817	773	759	746	740	774	843	920	944	950	968	919	848
Actual Load	792	793	803	816	840	898	1002	1014	945	888	846	805	783	763	742	745	773	865	945	965	986	972	931	871

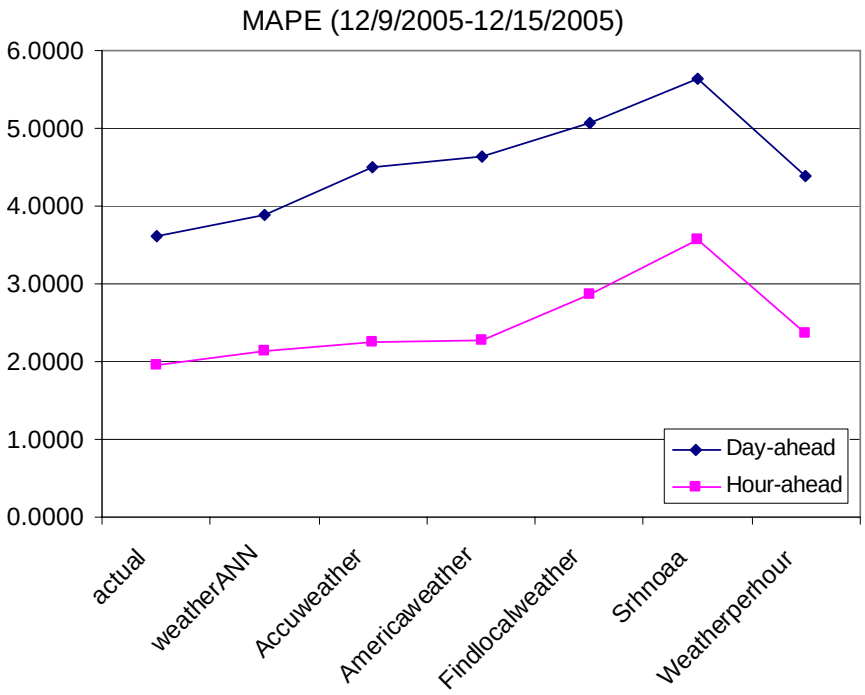
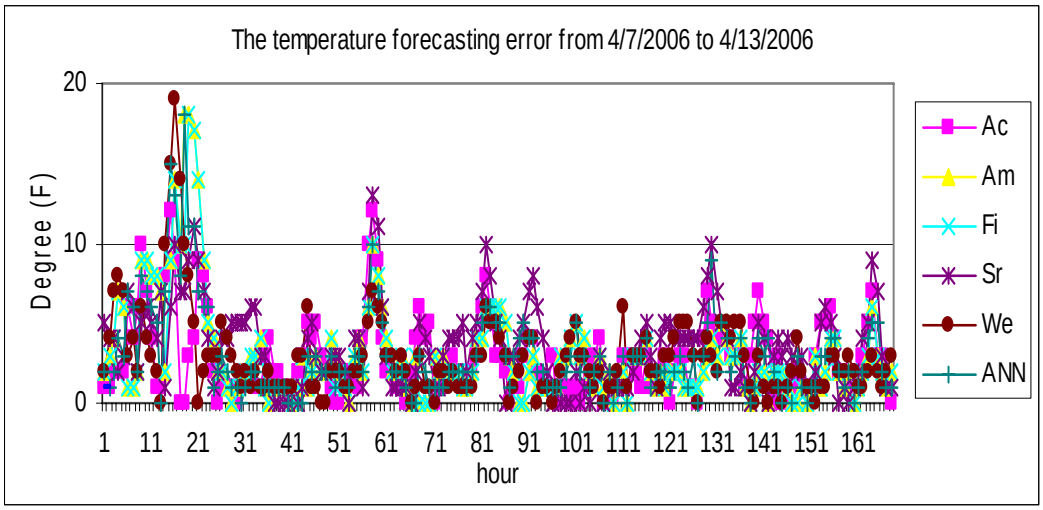


Figure 4.19 Comparing MAPE of day-ahead and hour-ahead between 12/9/2005- 12/15/2005.

Table 4.16 Summarization of MAPE for day-ahead and hour-ahead between 12/9/2005- 12/15/2005.

MAPE (December 9, 2005 - December 15,2005)		
source	Day-ahead	Hour-ahead
actual	3.6124	1.9634
weatherANN	3.8936	2.1456
Accuweather	4.5083	2.2431
Americaweather	4.6351	2.2808
Findlocalweather	5.0616	2.8615
Srhnoaa	5.6342	3.5612
Weatherperhour	4.3951	2.3648

The most challenging period to perform load forecast is in the spring and fall seasons, since the temperature of this period fluctuate a lot and unpredictable. Due to using a single resource in the past, the target utility encounters most problems of forecast load during this period. By integrating the various resources provider, we get the better forecast result and can find the forecast trend, since the forecast information from others helps us to know how the forecasting result shapes are supposed to be. The period using to perform load forecast results is during April 7, 2006 to April 13, 2006. The comparison of forecast results from actual and load forecast is shown in table 4.22 and table 4.23. The forecast temperature data is shown in figure 4.20 to figure 4.24. The MAPE of this period is 4.1362% for day ahead forecast and 2.5654% for hour ahead, as shown in table 4.24, while the average error of the service websites is 4.9312% and 2.7938% for day ahead and hour ahead, respectively. Thus, the accuracy is increased by 8.9046% for hour ahead and 19.2205% for day ahead.

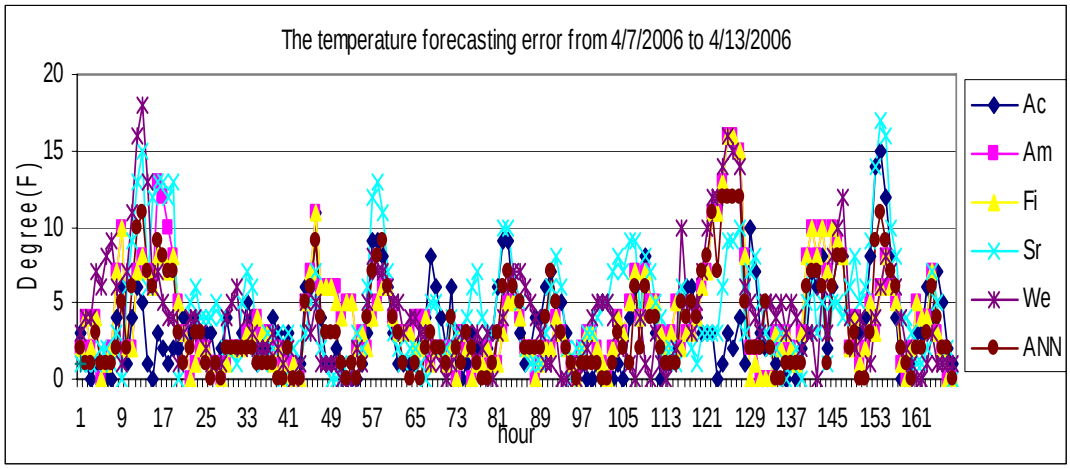


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.20 the temperature forecasting error at Anardako during spring period.

Table 4.17 temperature forecast compare to actual temperature from multiple resources on the period 4/7/06 to 4/13/06 in Anadarko.

Temperture Forecast (fahrenheit) on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	60	57	54	54	53	54	53	53	59	65	70	72	72	68	60	54	53	54	54	58	57	55	51
Americaweater	62	64	63	63	62	60	59	57	54	57	61	63	64	66	65	65	64	71	69	67	63	58	54	53
Findlocalweather	62	64	63	63	62	60	59	57	54	57	61	63	64	66	65	65	64	63	69	67	63	58	54	53
Srhnoaa	59	57	55	54	53	52	52	57	58	60	64	67	64	63	62	61	61	60	60	61	58	56	53	48
Weatherperhour	66	65	66	64	63	62	62	61	57	62	66	69	71	74	71	70	68	63	59	55	49	47	46	46
WeatherANN	66	62	61	60	59	52	52	57	55	59	63	66	71	71	71	64	62	71	62	61	56	55	55	50
Actual Temp.	64	61	59	56	56	59	58	59	63	66	69	71	71	64	56	51	54	53	51	50	49	49	49	49
Temperture Forecast (fahrenheit) on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	49	49	50	50	48	48	48	47	46	46	47	50	55	58	61	64	64	65	65	63	58	56	52	49
Americaweater	51	48	48	49	49	49	48	48	48	49	51	54	56	59	61	62	64	64	59	59	56	54	51	49
Findlocalweather	51	48	48	49	49	49	48	48	48	49	51	54	56	59	61	62	64	64	59	59	56	54	51	49
Srhnoaa	47	46	45	44	43	42	41	39	39	42	47	53	57	60	62	63	63	63	63	62	59	54	51	49
Weatherperhour	46	45	45	46	46	46	44	44	43	46	49	52	56	59	61	64	65	66	65	64	55	50	49	47
WeatherANN	47	47	47	48	47	47	47	47	47	46	49	53	56	59	61	63	64	63	62	61	56	54	51	49
Actual Temp.	49	50	49	49	48	47	46	45	45	45	50	54	57	60	62	63	64	63	62	58	54	51	49	47
Temperture Forecast (fahrenheit) on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	45	43	42	41	41	41	39	39	40	48	55	63	67	70	73	74	76	77	77	75	70	68	63	59
Americaweater	48	46	44	43	43	42	42	41	44	50	56	61	65	70	72	73	75	75	70	69	66	63	60	59
Findlocalweather	48	44	44	43	43	42	42	41	44	50	56	61	65	70	72	73	75	75	70	69	66	63	60	59
Srhnoaa	47	46	45	44	43	43	42	42	43	47	53	61	66	71	73	75	75	75	75	74	70	66	62	60
Weatherperhour	46	45	44	43	42	41	40	40	45	53	58	62	66	69	72	73	74	75	74	72	67	64	63	63
WeatherANN	47	44	44	44	42	42	41	41	44	50	57	62	66	70	72	74	75	75	73	72	68	64	62	60
Actual Temp.	44	43	42	42	43	39	38	43	50	60	64	67	69	72	74	76	76	75	73	69	66	63	63	61
Temperture Forecast (fahrenheit) on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	60	59	57	57	56	55	55	55	55	59	64	70	73	76	77	79	78	79	78	76	73	70	67	65
Americaweater	58	59	58	57	56	55	55	54	57	61	64	67	70	73	74	76	77	76	76	75	72	70	67	67
Findlocalweather	58	59	58	57	56	55	55	54	57	61	64	67	70	73	74	76	77	76	76	75	72	70	67	67
Srhnoaa	58	57	56	55	52	54	53	53	54	57	62	68	72	78	80	81	81	81	81	80	77	73	70	68
Weatherperhour	63	62	62	60	58	57	56	55	58	61	65	68	72	75	77	79	79	79	78	76	71	70	69	68
WeatherANN	62	59	58	57	55	55	55	55	56	61	64	68	71	75	76	81	81	81	78	76	73	71	67	67
Actual Temp.	61	61	60	59	57	56	57	58	61	67	70	73	76	78	77	78	77	76	74	72	71	69	68	68
Temperture Forecast (fahrenheit) on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	66	66	65	63	62	62	62	60	61	64	69	71	73	75	75	79	79	78	76	76	73	72	69	66
Americaweater	67	68	67	67	66	65	65	64	63	65	68	70	73	75	76	78	79	79	78	77	74	72	69	68
Findlocalweather	67	68	67	67	66	65	65	64	63	65	68	70	73	75	76	78	79	79	78	77	74	72	69	68
Srhnoaa	67	65	64	63	63	62	62	62	62	65	69	70	72	75	77	77	78	79	79	78	75	70	67	64
Weatherperhour	67	67	67	67	66	65	64	64	63	66	69	71	74	74	72	77	79	79	78	77	74	73	72	72
WeatherANN	67	66	66	66	66	64	64	63	62	65	69	70	73	75	75	78	79	79	78	77	73	73	69	71
Actual Temp.	66	65	64	63	61	62	61	62	64	68	69	72	73	76	78	78	76	76	75	73	72	71	71	69
Temperture Forecast (fahrenheit) on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	68	68	68	67	64	61	62	60	60	67	71	76	79	82	84	86	89	89	89	87	82	79	74	70
Americaweater	66	68	67	65	64	63	63	62	64	68	72	75	79	82	84	85	87	86	83	82	79	75	72	71
Findlocalweather	66	68	67	65	64	63	63	62	64	68	72	75	79	82	84	85	87	86	83	82	79	75	72	71
Srhnoaa	63	62	61	60	59	58	58	58	59	62	68	75	79	86	86	87	87	86	86	85	81	75	71	69
Weatherperhour	71	70	70	69	68	65	62	61	63	69	73	75	78	81	82	84	85	85	84	83	78	75	73	72
WeatherANN	69	68	68	66	62	59	62	61	62	63	73	75	79	83	84	85	87	86	85	84	80	79	72	72
Actual Temp.	68	66	65	64	63	62	62	64	67	72	75	80	83	85	87	89	88	86	84	80	77	75	74	73
Temperture Forecast (fahrenheit) on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	71	70	69	68	65	63	62	61	63	68	72	78	82	85	88	90	91	90	90	88	82	80	76	73
Americaweater	69	69	68	66	65	64	62	61	67	71	74	78	82	86	87	89	90	89	88	87	82	79	76	75
Findlocalweather	69	69	68	66	65	64	62	61	67	71	74	78	82	86	87	89	90	89	88	87	82	79	76	75
Srhnoaa	68	66	65	64	63	63	62	62	63	67	73	79	84	88	89	90	91	91	90	90	86	80	76	74
Weatherperhour	71	69	70	70	68	65	64	64	67	72	75	79	82	85	86	87	88	88	87	84	81	78	77	76
WeatherANN	71	69	68	69	65	64	62	63	65	70	74	78	82	86	87	89	90	89	89	86	84	79	76	74
Actual Temp.	71	70	68	66	66	64	63	64	68	73	78	82	84	87	89	89	89	87	85	81	79	77	75	73

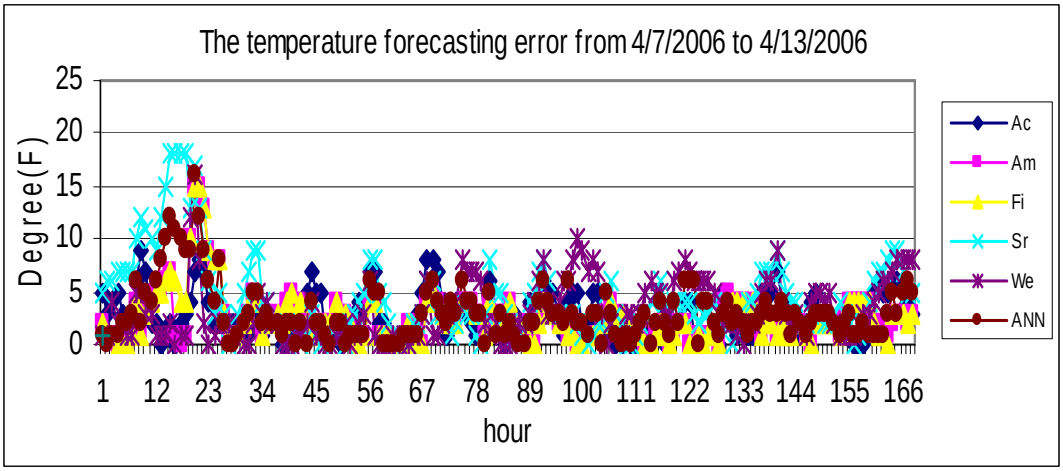


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.21 the temperature forecasting error at Fort supply during spring period.

Table 4.18 temperature forecast compare to actual temperature from multiple resources on the period 4/7/06 to 4/13/06 in Fortsupply.

Temperture Forecast (fahrenheit) on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	52	51	52	50	51	50	49	48	50	52	53	51	49	47	47	48	47	46	46	47	42	44	43	43
Americaweater	57	56	54	53	51	49	47	45	46	49	51	52	52	53	53	58	57	55	52	50	49	47	46	44
Findlocalweather	57	56	54	53	51	49	47	45	46	49	51	52	52	53	53	53	53	52	52	50	49	47	46	44
Srhnoaa	54	53	51	50	49	48	48	55	56	57	58	58	59	52	59	58	58	57	57	45	43	42	41	42
Weatherperhour	58	56	56	56	57	58	58	58	55	58	60	61	62	59	53	52	50	49	48	46	43	43	43	43
WeatherANN	53	53	53	52	52	51	50	50	51	53	55	55	55	53	53	54	53	52	51	48	45	45	44	43
Actual Temp.	55	52	52	49	51	50	49	52	56	51	49	45	44	46	47	45	45	45	44	45	46	47	47	46
Temperture Forecast (fahrenheit) on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	48	47	45	44	43	39	37	35	36	40	45	48	51	54	56	59	61	63	63	63	58	56	51	47
Americaweater	43	45	43	42	40	39	37	36	44	47	50	53	56	59	61	62	64	64	62	62	59	56	53	52
Findlocalweather	43	45	43	42	40	39	37	36	44	47	50	53	56	59	61	62	64	64	62	62	59	56	53	52
Srhnoaa	41	40	39	38	37	35	34	33	34	38	44	51	56	60	62	61	61	61	61	60	57	52	49	47
Weatherperhour	43	43	43	43	43	42	41	40	37	41	44	48	51	55	57	60	62	63	63	62	55	50	48	47
WeatherANN	44	44	43	42	41	39	37	36	39	46	47	51	54	57	59	61	62	63	62	62	58	54	51	49
Actual Temp.	45	44	44	42	39	37	35	38	41	44	46	50	53	58	59	61	64	63	62	57	52	45	47	46
Temperture Forecast (fahrenheit) on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	46	46	43	42	41	43	43	43	44	50	57	63	69	74	78	80	81	83	82	80	74	70	64	60
Americaweater	51	50	48	47	46	45	45	44	49	54	59	63	68	72	74	76	76	75	74	73	70	68	65	64
Findlocalweather	51	49	48	47	46	45	45	44	49	54	59	63	68	72	74	76	78	77	74	73	70	68	65	64
Srhnoaa	45	44	43	42	41	40	40	40	41	46	54	62	69	73	76	77	78	78	78	77	73	68	64	62
Weatherperhour	46	45	44	42	41	41	41	41	45	52	58	63	67	70	74	75	76	76	75	73	70	67	66	65
WeatherANN	48	47	43	42	42	43	43	42	46	51	56	63	68	72	76	79	81	79	76	75	70	68	65	62
Actual Temp.	45	44	44	42	41	43	42	46	53	59	65	69	72	75	77	79	80	79	78	72	68	66	66	66
Temperture Forecast (fahrenheit) on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	61	60	59	58	57	55	54	55	59	65	72	77	82	84	86	86	86	84	79	77	74	70	69
Americaweater	63	64	63	62	61	60	59	58	62	65	69	72	76	79	80	82	83	82	79	78	75	73	70	69
Findlocalweather	63	64	63	62	61	60	59	58	62	65	69	72	76	79	80	82	83	82	79	78	75	73	70	69
Srhnoaa	60	58	57	56	53	55	54	54	55	58	64	70	75	79	81	83	83	83	83	82	78	73	69	67
Weatherperhour	65	64	64	64	63	61	60	57	58	64	68	70	73	75	77	78	79	79	78	77	72	71	70	69
WeatherANN	61	62	64	64	61	59	57	56	58	62	67	71	75	79	84	84	84	84	84	79	75	73	70	69
Actual Temp.	63	61	61	62	60	59	57	57	61	68	74	77	80	81	82	82	82	80	77	74	72	71	69	69
Temperture Forecast (fahrenheit) on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	68	66	65	64	65	65	66	66	67	68	71	73	76	80	83	86	87	87	86	80	77	73	67	62
Americaweater	69	69	68	67	66	65	64	63	64	67	70	73	77	80	81	83	84	83	79	77	74	70	67	65
Findlocalweather	69	69	68	67	66	65	64	63	64	67	70	73	77	80	81	83	84	83	79	77	74	70	67	65
Srhnoaa	65	63	62	61	60	60	59	59	60	63	68	73	76	78	81	82	84	84	83	81	76	69	64	62
Weatherperhour	68	68	69	70	70	70	70	70	69	73	77	81	83	85	83	85	86	87	86	85	76	70	68	66
WeatherANN	68	67	66	66	65	65	65	64	65	71	71	75	78	81	82	84	85	85	83	80	75	72	67	66
Actual Temp.	67	66	65	65	65	65	66	67	67	72	77	77	84	85	86	86	86	86	84	75	71	67	63	59
Temperture Forecast (fahrenheit) on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	60	57	52	49	46	44	45	46	48	56	64	70	73	77	79	81	83	84	84	79	77	74	70	66
Americaweater	64	65	63	61	59	58	56	55	60	65	67	72	76	81	83	84	86	85	85	84	80	76	72	71
Findlocalweather	64	65	63	61	59	58	56	55	58	62	67	72	76	81	83	84	86	85	85	84	80	76	72	71
Srhnoaa	60	57	55	54	52	51	51	50	51	55	62	69	74	76	78	81	83	82	82	81	77	71	67	65
Weatherperhour	67	66	64	62	59	57	55	53	53	59	64	67	71	74	76	78	79	80	80	79	73	68	68	67
WeatherANN	65	65	59	60	55	54	53	52	60	65	65	67	74	78	81	82	83	83	83	82	77	75	68	65
Actual Temp.	57	54	52	48	43	42	41	47	58	63	67	72	76	78	81	81	84	84	82	76	70	68	62	64
Temperture Forecast (fahrenheit) on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	65	65	65	64	63	61	60	59	59	66	75	82	89	94	96	97	98	97	97	90	90	85	80	78
Americaweater	69	66	65	64	63	63	62	62	70	75	79	84	88	93	95	98	100	98	95	93	86	82	78	77
Findlocalweather	69	66	65	64	63	63	62	62	70	75	79	84	88	93	95	98	100	98	95	93	86	82	78	77
Srhnoaa	64	62	61	60	59	59	58	58	59	64	71	80	85	90	91	93	94	93	93	93	88	81	76	77
Weatherperhour	67	67	69	70	69	68	67	66	69	75	79	83	87	90	93	95	95	94	92	89	84	81	79	78
WeatherANN	65	65	65	64	64	64	64	64	64	70	78	83	87	92	94	96	97	96	94	92	87	82	80	77
Actual Temp.	59	57	57	66	67	64	64	67	73	81	87	90	93	94	95	96	95	94	91	86	83	80	78	77

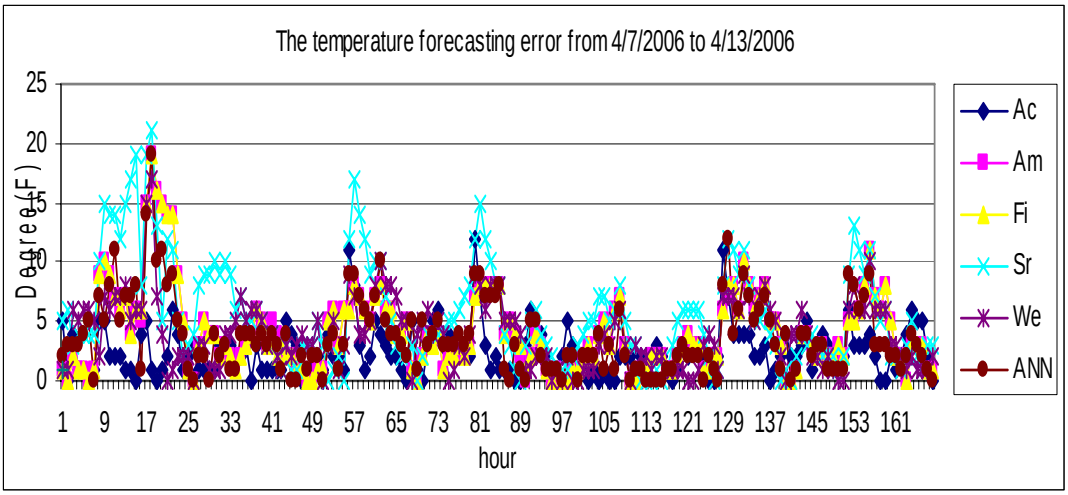


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.22 the temperature forecasting error at Hugo during spring period.

Table 4.19 temperature forecast compare to actual temperature from multiple resources on the period 4/7/06 to 4/13/06 in Hugo.

Temperture Forecast (fahrenheit) on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	64	62	61	62	62	61	60	60	65	73	75	79	80	81	82	83	77	71	67	64	62	59	56
Americaweater	66	68	67	66	65	64	63	62	68	69	71	72	74	75	76	81	81	79	77	75	71	68	64	62
Findlocalweather	66	68	67	66	65	64	63	62	68	69	71	72	74	75	76	76	77	76	77	75	71	68	64	62
Srhnoaa	63	61	60	59	58	57	57	56	57	61	65	68	67	66	65	64	63	62	80	77	69	64	61	57
Weatherperhour	69	68	70	68	67	65	63	61	64	69	72	76	78	80	81	82	82	81	79	76	64	57	55	53
WeatherANN	67	67	67	67	67	62	61	60	67	67	71	71	71	71	71	71	71	71	76	76	68	64	61	58
Actual Temp.	68	67	66	66	65	64	64	66	69	72	75	77	79	81	83	82	81	80	67	60	56	55	55	54
Temperture Forecast (fahrenheit) on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	55	55	55	55	55	55	54	54	54	56	56	58	60	63	65	67	69	70	70	68	63	60	54	50
Americaweater	61	56	55	54	53	52	52	51	53	54	56	58	59	61	62	63	64	63	63	62	60	57	55	53
Findlocalweather	61	56	55	54	53	52	52	51	53	54	56	58	59	61	62	63	64	63	63	62	60	57	55	53
Srhnoaa	58	56	54	52	51	49	48	47	48	51	55	58	60	63	64	66	66	67	66	64	59	55	52	50
Weatherperhour	51	51	52	52	53	54	55	54	52	52	55	58	60	63	66	68	68	68	67	65	59	56	53	51
WeatherANN	61	55	54	53	53	52	52	51	52	53	56	58	60	62	64	66	67	65	65	65	60	57	54	51
Actual Temp.	53	53	54	53	54	54	55	56	57	55	59	60	62	63	66	68	67	67	65	61	58	55	53	51
Temperture Forecast (fahrenheit) on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	49	47	45	45	44	43	43	42	44	51	55	60	63	66	68	71	72	73	73	71	67	64	59	55
Americaweater	52	50	49	49	48	47	46	45	47	52	56	59	62	65	67	68	69	68	68	67	64	61	58	56
Findlocalweather	52	50	49	49	48	47	46	45	47	52	56	59	62	65	67	68	70	69	68	67	64	61	58	56
Srhnoaa	49	48	46	45	44	43	42	41	43	48	53	58	62	66	68	70	72	72	71	69	65	60	58	56
Weatherperhour	49	48	48	47	46	45	44	43	50	53	57	60	63	65	68	70	71	71	71	69	60	58	57	57
WeatherANN	50	49	46	46	46	46	46	43	46	48	57	60	62	65	68	69	71	71	71	68	65	61	58	56
Actual Temp.	48	47	46	47	47	47	47	49	51	53	57	60	62	65	67	70	70	70	68	63	59	57	55	54
Temperture Forecast (fahrenheit) on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	55	54	52	51	49	48	49	48	50	56	62	67	71	74	75	74	78	75	74	73	70	68	64	61
Americaweater	55	53	52	52	51	50	50	49	52	57	61	64	66	69	71	72	74	73	72	71	68	66	63	62
Findlocalweather	55	53	52	52	51	50	50	49	52	57	61	64	66	69	71	72	74	73	72	71	68	66	63	62
Srhnoaa	54	53	52	51	50	48	47	47	48	54	59	64	68	72	74	76	78	78	77	75	71	66	64	63
Weatherperhour	57	55	56	55	54	54	53	52	57	61	64	67	70	73	75	76	77	77	76	75	68	66	65	66
WeatherANN	57	54	54	52	51	50	50	50	51	58	61	66	68	72	73	74	76	75	74	73	69	66	64	62
Actual Temp.	53	51	48	48	47	47	47	50	56	59	64	67	70	71	73	74	74	73	70	67	65	63	61	60
Temperture Forecast (fahrenheit) on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	62	62	59	59	60	59	58	58	63	67	70	72	74	75	76	76	75	75	75	70	70	68	66
Americaweater	60	58	57	57	56	56	55	55	58	62	65	67	70	72	73	75	75	74	74	73	71	69	67	66
Findlocalweather	60	58	57	57	56	56	55	55	58	62	65	67	70	72	73	75	75	74	74	73	71	69	67	66
Srhnoaa	62	60	59	58	57	56	56	55	56	60	64	68	71	74	76	78	78	78	78	77	74	72	70	68
Weatherperhour	65	65	67	66	64	63	61	60	61	64	68	71	74	77	77	79	80	80	78	76	73	72	72	71
WeatherANN	65	60	59	59	58	58	57	57	56	63	66	70	70	74	76	78	78	74	75	75	72	70	70	66
Actual Temp.	59	57	57	57	57	55	54	57	61	66	67	70	71	74	75	76	75	74	73	71	70	69	66	64
Temperture Forecast (fahrenheit) on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	67	67	64	63	63	62	61	61	62	67	71	74	76	79	81	83	84	84	83	81	75	73	69	68
Americaweater	65	63	63	62	62	62	61	61	63	66	69	71	73	75	76	77	78	77	76	75	73	70	68	67
Findlocalweather	65	63	63	62	62	62	61	61	64	67	69	71	73	75	76	77	78	77	76	75	73	70	68	67
Srhnoaa	67	67	66	65	65	64	64	63	65	69	73	76	79	82	84	85	86	86	85	83	78	74	71	69
Weatherperhour	71	70	69	69	68	67	65	64	65	68	71	74	77	80	82	83	84	85	84	83	75	72	69	68
WeatherANN	69	69	69	63	66	65	62	62	64	67	71	72	75	79	82	82	82	83	81	77	75	72	68	68
Actual Temp.	63	63	63	63	62	61	60	61	67	71	73	75	77	78	80	80	79	79	78	74	71	69	67	65
Temperture Forecast (fahrenheit) on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	66	66	66	65	62	62	61	60	62	67	70	75	78	80	83	86	87	86	84	82	78	76	72	69
Americaweater	67	63	62	62	61	61	60	60	63	66	69	71	74	76	77	79	79	79	78	78	75	73	70	69
Findlocalweather	67	63	62	62	61	61	60	60	63	66	69	71	74	76	77	79	80	80	79	79	75	73	70	69
Srhnoaa	67	66	65	63	62	61	60	59	60	66	71	75	79	82	85	87	88	88	87	85	81	77	73	71
Weatherperhour	67	65	66	65	64	63	63	64	65	70	72	76	80	83	84	85	86	87	85	83	80	78	76	74
WeatherANN	67	65	64	63	62	62	61	64	63	67	70	74	79	82	80	82	80	82	82	81	75	75	74	71
Actual Temp.	65	64	62	60	59	59	58	62	64	69	73	75	78	80	81	81	81	81	79	76	72	70	68	66

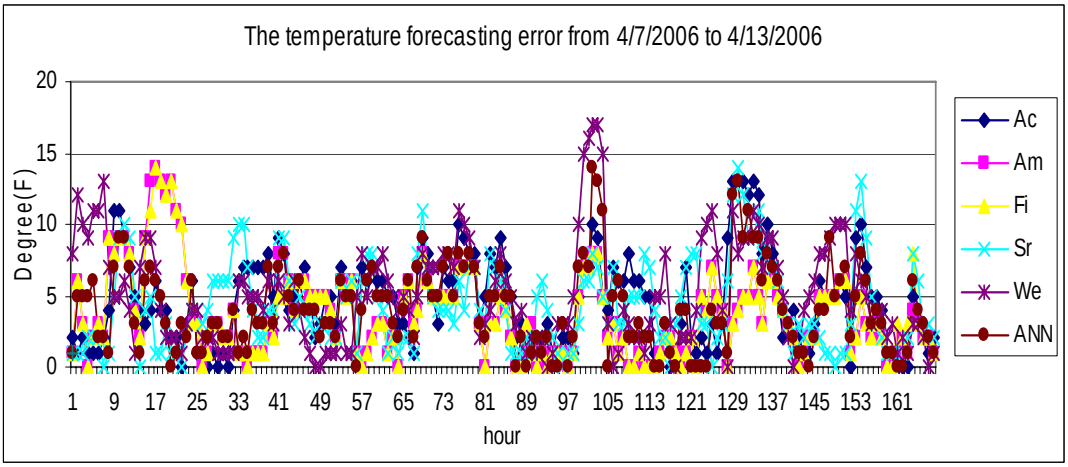


Note:
Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.23 the temperature forecasting error at Pharaoh during spring period.

Table 4.20 temperature forecast compare to actual temperature from multiple resources on the period 4/7/06 to 4/13/06 in Pharoah.

Temperture Forecast (fahrenheit) on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	66	66	61	61	59	57	59	64	70	73	75	79	81	81	73	64	55	55	54	55	56	56	55
Americaweater	66	66	64	63	61	59	57	55	59	63	68	71	73	76	75	74	74	73	71	70	67	64	61	59
Findlocalweather	66	66	64	63	61	59	57	55	59	63	68	71	73	76	75	75	74	73	71	70	67	64	61	59
Srhnoaa	62	60	59	58	56	55	54	54	54	58	61	65	65	63	62	61	78	75	68	60	65	61	57	52
Weatherperhour	68	67	68	67	66	65	63	62	62	66	68	70	72	75	75	75	74	71	62	59	53	51	50	52
WeatherANN	65	63	65	65	64	64	58	57	64	64	64	72	73	73	73	70	73	73	65	66	61	59	57	58
Actual Temp.	67	66	62	62	60	59	58	64	69	72	75	77	80	80	81	69	59	54	55	55	53	50	52	54
Temperture Forecast (fahrenheit) on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	57	57	57	55	55	54	54	54	54	54	54	55	61	61	64	64	66	66	64	62	58	54	50	47
Americaweater	56	54	53	51	50	49	49	48	53	53	54	55	57	58	60	62	62	61	60	59	56	52	49	48
Findlocalweather	56	54	53	51	50	49	49	48	53	53	54	55	57	58	60	62	64	63	60	59	56	52	49	48
Srhnoaa	52	50	48	47	45	43	42	41	42	46	49	53	56	58	60	62	63	63	62	60	55	50	47	45
Weatherperhour	53	54	53	53	53	52	50	47	47	47	49	53	55	58	60	62	63	63	62	60	52	48	46	45
WeatherANN	54	54	54	54	54	49	49	48	50	51	52	54	57	61	61	62	63	62	62	61	54	51	48	47
Actual Temp.	55	54	56	56	54	53	51	51	51	52	56	58	61	64	65	65	67	65	63	57	54	51	50	48
Temperture Forecast (fahrenheit) on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	46	45	45	43	39	37	37	36	46	55	61	63	66	72	73	75	75	75	75	73	67	64	60	56
Americaweater	47	46	45	44	43	42	42	41	46	51	56	60	64	68	70	71	73	72	70	69	66	62	59	58
Findlocalweather	47	46	45	44	43	42	42	41	46	51	56	60	64	68	70	71	73	72	70	69	66	62	59	58
Srhnoaa	44	42	41	39	38	37	36	35	37	44	50	56	61	66	69	72	74	74	73	71	66	62	59	57
Weatherperhour	44	42	44	42	42	40	39	38	47	54	58	60	63	66	68	69	70	71	70	68	62	59	57	57
WeatherANN	45	45	44	42	41	40	39	38	45	51	56	60	64	66	71	73	73	73	73	73	65	59	60	57
Actual Temp.	47	47	44	39	37	39	36	47	54	58	62	65	71	76	76	77	77	76	75	68	66	64	63	61
Temperture Forecast (fahrenheit) on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	54	55	54	54	54	54	54	48	57	64	70	73	79	79	81	81	81	81	81	76	74	70	67	65
Americaweater	56	57	56	55	54	54	53	53	56	59	63	67	70	74	75	77	79	78	77	76	73	69	66	65
Findlocalweather	56	57	56	55	54	54	53	53	56	59	63	67	70	74	75	77	78	77	77	76	73	69	66	65
Srhnoaa	56	54	53	52	51	49	48	48	49	55	61	67	70	74	77	80	81	81	80	78	74	71	68	67
Weatherperhour	55	54	58	56	54	54	52	51	56	61	63	67	70	73	75	76	77	77	76	74	68	66	66	65
WeatherANN	55	55	55	54	53	53	52	51	55	60	64	68	70	79	80	78	80	78	80	77	72	69	67	65
Actual Temp.	60	58	58	57	57	56	56	60	64	67	71	75	78	78	80	81	81	78	75	72	70	68	66	66
Temperture Forecast (fahrenheit) on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	61	63	64	64	66	66	66	66	68	73	75	79	79	79	79	75	79	79	77	72	72	71	69
Americaweater	65	66	65	65	64	63	63	62	62	65	67	70	74	77	78	78	76	75	74	73	72	71	70	69
Findlocalweather	65	66	65	65	64	63	63	62	62	65	67	70	74	77	78	78	76	75	74	73	72	71	70	69
Srhnoaa	66	65	64	63	62	61	60	59	60	63	67	69	72	74	75	77	77	77	77	75	72	69	67	66
Weatherperhour	65	64	66	66	65	65	64	63	63	65	68	71	74	77	75	79	79	78	78	77	72	71	71	71
WeatherANN	65	64	64	66	64	64	63	62	66	65	72	71	75	77	77	78	77	77	76	75	72	71	70	69
Actual Temp.	65	66	66	66	66	66	65	66	67	68	73	77	77	77	78	77	77	77	76	75	73	72	72	72
Temperture Forecast (fahrenheit) on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	73	73	72	68	63	61	59	57	66	73	75	81	82	84	86	88	90	90	88	86	81	78	73	69
Americaweater	67	67	66	65	64	63	63	62	66	69	73	75	78	80	81	83	85	84	83	82	79	75	72	70
Findlocalweather	67	67	66	65	64	63	63	62	65	69	73	75	78	80	81	83	85	84	83	82	79	75	72	70
Srhnoaa	65	64	63	62	61	61	60	60	61	66	70	74	78	81	83	85	86	86	86	83	79	74	72	71
Weatherperhour	71	70	70	69	67	64	62	61	66	70	73	76	79	81	81	83	84	84	84	82	75	72	70	70
WeatherANN	69	68	67	66	61	62	61	60	61	73	73	76	79	81	82	84	85	86	85	86	79	75	72	70
Actual Temp.	71	70	69	66	63	61	61	68	73	77	79	85	86	86	88	91	90	89	86	82	79	76	76	74
Temperture Forecast (fahrenheit) on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	73	73	72	70	68	66	66	64	72	75	79	84	86	90	93	93	93	93	91	89	85	83	79	75
Americaweater	69	72	71	69	68	67	66	65	70	72	74	77	81	84	85	86	90	89	87	86	83	81	78	76
Findlocalweather	69	72	71	69	68	67	66	65	70	72	74	77	81	84	85	86	90	89	87	86	83	81	78	76
Srhnoaa	68	67	66	65	64	63	62	61	62	67	73	77	81	85	87	89	90	90	90	88	82	77	74	72
Weatherperhour	70	68	69	69	65	64	64	64	67	72	76	78	82	84	87	88	89	89	88	85	81	79	78	77
WeatherANN	70	73	71	68	67	65	65	61	67	72	75	79	85	87	90	93	90	90	89	87	83	80	78	75
Actual Temp.	72	70	68	67	66	64	64	70	75	78	82	88	88	90	93	91	92	91	87	83	80	78	77	75



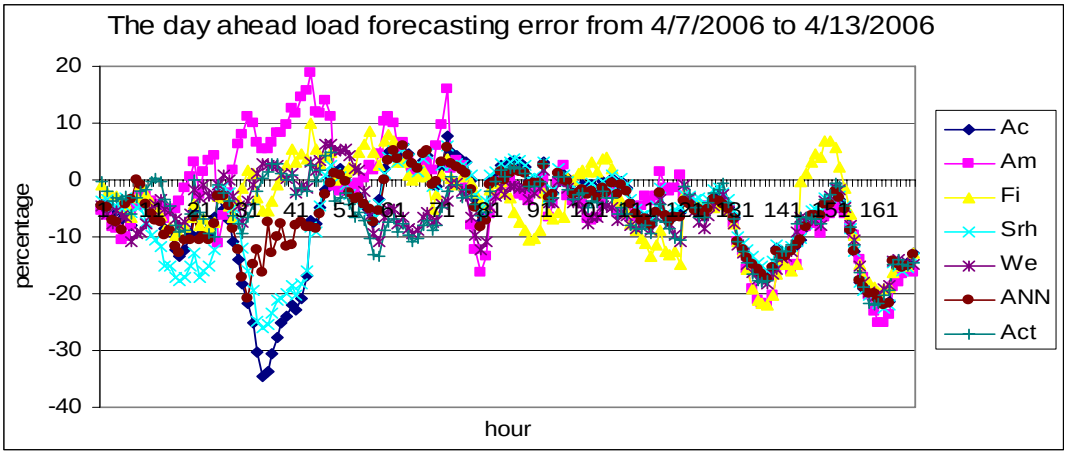
Note:

Ac=Accuweather Am=Americanweather Fi=Findlocalweather Sr=Srhnoaa
We=Weatherperhour ANN=weaterANN

Figure 4.24 the temperature forecasting error at Russell during spring period.

Table 4.21 temperature forecast compare to actual temperature from multiple resources on the period 4/7/06 to 4/13/06 in Russell.

Temperture Forecast (fahrenheit) on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	56	55	56	53	54	53	52	51	51	56	63	66	66	63	58	55	53	54	52	51	50	50	48	46
Americaweater	59	60	57	54	51	49	48	46	54	58	63	65	67	69	70	72	73	71	68	66	63	60	57	55
Findlocalweather	59	60	57	54	51	49	48	46	54	58	63	65	67	69	70	70	73	71	68	66	63	60	57	55
Srhnoaa	57	55	53	52	51	50	50	56	57	58	62	64	66	67	65	64	60	59	59	52	51	50	48	48
Weatherperhour	66	66	64	63	64	63	63	62	57	62	66	69	72	74	70	68	66	62	58	55	50	49	48	48
WeatherANN	59	59	59	59	59	54	48	54	55	58	63	66	68	68	67	66	53	63	53	53	53	53	53	46
Actual Temp.	58	54	54	54	53	52	50	55	62	67	72	73	71	67	61	59	59	58	56	53	52	50	51	52
Temperture Forecast (fahrenheit) on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	50	50	49	48	48	47	45	42	42	44	47	51	54	57	60	63	64	65	66	65	61	58	54	50
Americaweater	54	49	48	46	45	44	43	42	47	50	54	57	60	63	65	66	65	65	64	64	61	57	54	53
Findlocalweather	54	49	48	46	45	44	43	42	47	50	54	57	60	63	65	66	68	68	64	64	61	57	54	53
Srhnoaa	47	46	45	43	42	40	39	37	38	41	47	54	59	62	64	64	64	64	64	63	60	55	52	50
Weatherperhour	47	47	47	47	47	47	46	45	42	45	49	53	56	60	62	65	67	68	67	66	59	53	50	48
WeatherANN	52	48	47	46	45	44	43	42	47	49	53	54	58	61	61	65	66	65	65	64	61	55	53	52
Actual Temp.	51	49	49	49	48	46	45	46	48	51	54	58	61	64	68	68	73	73	70	60	55	51	49	48
Temperture Forecast (fahrenheit) on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	49	49	49	47	46	46	44	43	44	51	57	63	68	71	74	76	78	79	79	77	72	69	64	61
Americaweater	51	49	48	46	45	45	44	44	51	56	62	66	71	75	77	79	76	75	75	74	71	67	64	63
Findlocalweather	51	49	48	46	45	45	44	44	51	56	62	66	71	75	77	79	76	75	75	74	71	67	64	63
Srhnoaa	49	47	46	46	45	45	44	44	45	49	56	64	70	75	77	78	79	79	79	78	74	68	64	62
Weatherperhour	46	45	45	43	42	41	39	38	43	52	57	62	66	70	74	75	76	77	76	75	71	68	66	65
WeatherANN	48	47	47	46	45	45	43	43	47	51	57	64	69	71	76	77	77	75	76	77	72	67	64	63
Actual Temp.	46	44	44	44	39	40	38	43	51	57	64	69	74	76	79	79	81	81	78	70	63	61	59	58
Temperture Forecast (fahrenheit) on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	63	61	60	60	58	56	55	53	53	58	64	68	72	76	79	80	81	81	79	75	72	71	68	66
Americaweater	61	60	59	57	56	55	54	53	58	63	68	72	75	79	81	83	81	80	79	78	75	71	68	67
Findlocalweather	61	60	59	57	56	55	54	53	58	63	68	72	75	79	81	83	85	84	79	78	75	71	68	67
Srhnoaa	60	59	57	56	53	55	54	54	55	58	64	71	75	80	82	84	84	84	84	83	79	74	70	68
Weatherperhour	64	63	61	61	59	57	54	52	55	62	65	69	73	76	78	79	81	81	80	79	75	73	72	71
WeatherANN	63	63	59	58	56	56	54	53	56	61	66	70	74	76	81	81	82	82	81	76	73	72	69	71
Actual Temp.	56	55	54	50	49	48	47	50	58	66	71	77	79	81	81	83	82	83	79	77	75	72	69	68
Temperture Forecast (fahrenheit) on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	69	66	65	63	62	63	62	60	60	64	66	67	70	76	79	80	80	83	84	82	76	73	68	64
Americaweater	67	66	65	63	62	61	61	60	66	68	71	75	78	82	84	85	85	84	82	81	78	74	71	70
Findlocalweather	67	66	65	63	62	61	61	60	66	68	71	75	78	82	84	85	85	84	82	81	78	74	71	70
Srhnoaa	66	64	63	62	61	61	60	60	61	64	69	70	73	77	80	77	78	80	81	81	76	70	66	64
Weatherperhour	70	70	70	71	71	70	70	70	67	71	73	77	81	84	83	86	88	89	88	87	79	73	73	73
WeatherANN	67	67	67	64	62	67	66	66	64	66	66	68	76	80	82	83	83	84	83	82	77	73	67	67
Actual Temp.	67	65	60	56	55	53	53	55	64	71	72	73	78	82	85	85	85	84	83	79	76	73	71	71
Temperture Forecast (fahrenheit) on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	68	67	64	62	60	59	55	52	55	61	66	71	75	78	82	84	87	88	89	86	84	80	74	70
Americaweater	68	68	67	65	64	63	62	61	65	70	74	78	81	85	87	88	89	88	87	86	82	78	74	73
Findlocalweather	68	68	67	65	64	63	62	61	65	70	74	78	81	85	87	88	89	88	87	86	82	78	74	73
Srhnoaa	62	60	59	58	57	56	55	55	56	60	67	74	79	79	82	85	88	87	87	86	81	75	71	68
Weatherperhour	72	72	71	71	68	66	62	61	57	66	70	74	77	80	83	85	86	86	86	85	80	77	77	76
WeatherANN	70	68	62	61	61	61	61	60	56	61	70	72	79	81	84	86	88	87	87	86	82	79	74	71
Actual Temp.	70	68	62	61	57	58	58	61	68	74	79	83	88	90	90	94	95	93	91	83	80	78	73	71
Temperture Forecast (fahrenheit) on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	72	72	69	68	66	65	63	62	62	68	74	79	83	87	91	92	92	92	90	89	84	82	78	75
Americaweater	71	71	69	68	66	65	64	63	69	73	78	82	85	89	91	93	91	90	89	88	84	81	77	76
Findlocalweather	71	71	69	68	66	65	64	63	69	73	78	82	85	89	91	93	95	94	93	92	84	81	77	76
Srhnoaa	66	64	63	62	61	60	59	59	60	65	72	79	85	89	90	92	93	93	92	92	87	81	76	75
Weatherperhour	75	74	72	72	71	69	68	66	63	72	76	81	84	87	89	90	91	90	89	87	84	81	79	78
WeatherANN	71	70	68	72	66	65	65	64	66	70	75	81	84	88	90	92	92	92	91	90	85	82	77	76
Actual Temp.	69	66	64	63	61	59	58	62	71	78	81	84	88	91	91	93	92	92	90	84	81	79	79	77



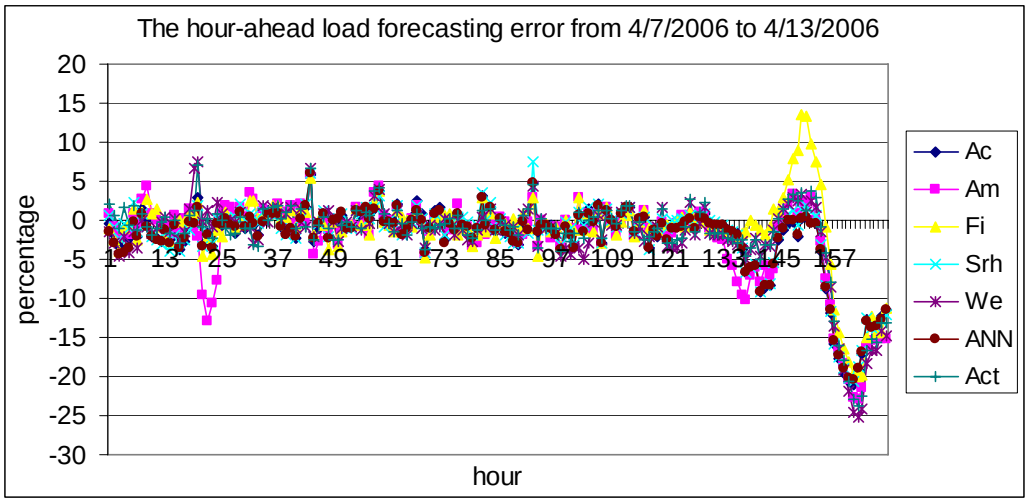
Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.25 Day-ahead load forecast error in spring season.

Table 4.22 Day-ahead load forecast compare to actual load from multiple resources on the period 4/7/06 to 4/13/06 in spring season.

Day-ahead Load Forecast on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	541	523	509	499	502	532	583	622	629	616	608	602	601	600	589	575	572	581	607	633	651	648	621	597
Americaweater	563	536	523	520	527	571	621	659	642	629	627	625	636	640	641	630	644	658	672	688	697	701	663	637
Findlocalweather	539	520	501	490	489	522	589	630	637	622	608	597	588	587	585	585	588	594	613	630	642	640	615	579
Srhnoaa	557	530	517	506	517	561	617	654	640	630	626	623	634	635	642	636	652	659	673	683	689	693	648	620
Weatherperhour	565	533	518	496	495	518	563	596	603	596	583	574	573	577	580	583	586	590	619	663	705	695	652	601
WeatherANN	539	520	502	489	492	541	612	650	636	615	603	596	595	591	590	578	576	593	599	626	645	642	613	589
Actual Load	565	546	541	528	539	566	634	649	641	642	642	642	643	656	648	655	661	663	670	669	720	713	686	638
Day-ahead Load Forecast on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	581	546	524	504	487	478	478	483	475	454	457	462	461	465	462	461	469	482	519	575	623	650	632	607
Americaweater	574	552	542	542	547	551	560	601	647	668	680	687	686	678	661	645	639	635	652	676	697	712	678	635
Findlocalweather	568	554	538	525	514	506	506	517	518	530	538	538	530	521	511	504	501	509	533	572	614	647	639	612
Srhnoaa	574	550	541	543	553	562	576	623	673	687	691	687	674	655	629	614	608	609	629	655	681	703	675	638
Weatherperhour	571	549	539	537	540	540	548	589	638	665	673	681	680	673	661	646	640	638	653	678	717	727	682	624
WeatherANN	584	559	539	518	498	485	482	485	476	454	447	453	452	459	458	459	468	479	514	569	617	644	626	602
Actual Load	601	576	565	566	567	585	609	644	682	694	688	666	639	624	608	592	609	608	624	620	675	684	643	605
Day-ahead Load Forecast on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	579	572	558	549	554	567	588	618	643	669	666	664	661	657	656	656	658	662	682	706	722	719	686	635
Americaweater	612	602	601	607	620	647	692	732	752	757	749	728	707	673	667	669	673	679	688	700	717	727	694	624
Findlocalweather	572	554	536	533	541	557	583	618	639	651	648	652	654	652	652	654	658	665	678	702	718	720	687	615
Srhnoaa	614	603	601	606	618	646	690	730	754	759	751	730	709	679	668	666	669	674	682	695	715	737	704	650
Weatherperhour	616	603	601	605	619	647	691	731	748	750	743	724	703	691	686	686	686	688	693	703	721	728	694	617
WeatherANN	577	566	554	545	552	565	589	621	643	654	652	656	656	654	653	653	657	665	689	711	721	726	693	625
Actual Load	571	561	555	558	572	584	616	655	694	692	652	633	623	630	616	627	639	652	659	677	728	728	671	590
Day-ahead Load Forecast on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	577	554	543	536	533	560	615	647	651	651	656	661	666	675	678	680	683	695	714	729	736	741	710	630
Americaweater	563	538	522	517	534	570	624	654	650	668	682	692	698	702	705	713	722	732	742	749	752	739	701	629
Findlocalweather	559	545	534	524	520	546	602	635	639	641	644	645	648	655	657	663	670	683	705	725	731	737	707	625
Srhnoaa	563	541	523	518	539	577	629	656	657	677	690	697	701	700	701	704	712	723	734	742	744	734	697	625
Weatherperhour	554	535	513	506	526	565	619	648	647	667	681	690	696	699	703	710	719	730	739	747	752	738	696	624
WeatherANN	565	544	533	526	525	552	609	641	645	645	648	650	655	664	667	673	680	692	709	726	736	739	707	625
Actual Load	550	531	525	520	534	581	664	690	651	647	639	650	647	653	658	666	686	696	713	708	760	758	700	625
Day-ahead Load Forecast on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	575	548	533	532	543	575	638	664	638	636	639	637	633	625	617	616	621	637	663	694	711	707	666	590
Americaweater	577	552	536	524	524	566	631	643	621	604	595	593	595	598	601	608	619	635	654	671	689	682	631	560
Findlocalweather	572	546	530	527	538	573	637	660	634	632	635	634	630	623	615	614	619	634	660	692	710	704	663	586
Srhnoaa	573	548	536	526	527	569	637	649	627	610	600	597	597	599	602	606	617	631	648	664	685	685	635	567
Weatherperhour	572	545	528	515	515	552	615	625	608	591	584	584	588	593	594	602	614	631	649	664	687	681	623	546
WeatherANN	572	546	531	527	538	569	631	655	632	631	634	633	629	622	615	614	619	634	661	692	709	704	663	585
Actual Load	573	561	543	537	552	581	651	665	646	634	650	639	642	651	655	660	665	690	700	708	758	760	709	626
Day-ahead Load Forecast on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	554	531	516	509	510	546	624	652	622	616	615	612	617	628	644	661	681	703	722	739	756	752	696	611
Americaweater	567	544	531	527	533	567	639	658	635	626	621	622	622	623	628	640	659	682	696	698	728	738	680	601
Findlocalweather	557	534	519	509	510	542	619	643	613	610	612	611	616	629	644	661	680	699	714	728	747	745	691	609
Srhnoaa	571	548	539	537	546	583	655	673	648	634	625	621	619	619	624	637	657	682	696	698	729	740	683	605
Weatherperhour	558	535	519	512	515	547	621	645	624	614	610	611	612	613	618	629	649	673	688	692	724	734	675	595
WeatherANN	554	532	517	509	510	544	621	645	617	614	614	613	617	629	645	663	682	702	719	733	751	747	694	610
Actual Load	575	556	546	536	544	574	644	669	644	647	659	688	704	728	758	788	818	849	851	840	869	863	794	690
Day-ahead Load Forecast on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	569	549	539	527	536	568	634	664	643	637	637	632	627	640	657	682	696	700	706	743	752	744	688	630
Americaweater	596	558	535	523	522	567	635	664	637	636	637	641	642	639	648	666	690	712	722	711	736	741	686	616
Findlocalweather	569	550	541	531	538	571	637	665	641	634	635	632	628	642	656	680	691	694	705	741	746	742	687	627
Srhnoaa	597	560	537	525	525	570	640	667	646	641	635	635	632	629	638	658	683	709	717	706	728	736	682	610
Weatherperhour	596	557	531	519	517	560	629	654	633	631	633	638	640	640	649	667	691	712	722	715	737	741	686	619
WeatherANN	569	550	541	528	537	569	634	666	646	639	639	634	629	642	657	681	694	697	705	742	750	741	685	628
Actual Load	635	599	577	564	574	594	662	680	666	674	701	724	765	791	820	851	881	894	899	867	880	876	806	723



Note:

Ac=Accuweather	Am=Americanweather	Fi=Findlocalweather	Sr=Srhnoaa
We=Weatherperhour	ANN=weaterANN	Act=Actual Load	

Figure 4.26 Hour-ahead load forecast error in spring season

Table 4.23 Hour-ahead load forecast compare to actual load from multiple resources on the period 4/7/06 to 4/13/06 in spring season.

Hour-ahead Load Forecast on 4/7/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	563	536	523	520	527	571	621	659	642	629	627	625	636	640	641	630	644	658	672	688	697	701	663	637
Americaweater	560	541	527	532	533	571	622	658	635	629	636	638	636	640	647	649	663	681	695	712	712	720	674	639
Findlocalweather	557	530	517	506	517	561	617	654	640	630	626	623	634	635	642	636	652	659	673	683	689	693	648	620
Srhnoaa	552	545	531	538	539	581	632	657	633	629	636	638	636	634	641	637	654	670	691	712	714	721	674	640
Weatherperhour	570	542	529	533	534	566	619	656	632	628	636	641	643	647	655	653	663	673	690	712	724	725	678	649
WeatherANN	557	530	517	507	520	564	621	654	636	629	626	624	635	637	643	632	646	662	667	681	696	699	662	636
Actual Load	565	546	541	528	539	566	634	649	641	642	642	642	643	656	648	655	661	663	670	669	720	713	686	638
Hour-ahead Load Forecast on 4/8/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	597	579	563	557	571	579	611	640	669	694	697	672	645	619	597	587	595	609	634	656	656	677	646	592
Americaweater	602	582	567	558	567	591	618	648	680	709	699	679	652	644	621	610	608	622	618	646	645	672	648	604
Findlocalweather	593	579	563	561	572	580	611	640	666	689	691	671	644	618	597	586	597	611	626	660	659	680	646	589
Srhnoaa	605	584	570	569	588	597	625	653	685	714	702	680	653	640	618	607	607	620	616	645	647	674	650	605
Weatherperhour	606	585	570	558	570	591	618	648	683	712	701	681	654	643	620	609	606	619	615	644	650	677	653	606
WeatherANN	597	577	561	561	573	581	611	641	667	692	693	671	645	619	597	586	596	610	636	657	660	680	649	591
Actual Load	601	576	565	566	567	585	609	644	682	694	688	666	639	624	608	592	609	608	624	620	675	684	643	605
Hour-ahead Load Forecast on 4/9/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	572	562	559	553	567	592	620	664	695	703	677	633	624	628	628	616	633	655	675	682	700	722	679	600
Americaweater	568	555	556	560	567	591	605	658	698	709	662	619	623	620	623	626	632	655	675	682	701	722	680	601
Findlocalweather	563	558	561	552	563	588	622	667	695	703	676	632	623	627	630	620	638	651	679	680	698	719	676	596
Srhnoaa	568	555	556	561	570	592	607	660	706	719	671	627	623	620	623	626	631	655	669	672	693	715	677	598
Weatherperhour	568	555	556	561	570	592	608	662	701	709	662	619	623	622	625	625	632	655	672	678	697	718	674	595
WeatherANN	571	562	560	552	567	591	622	665	695	703	676	632	622	627	628	615	633	651	667	677	698	720	676	597
Actual Load	571	561	555	558	572	584	616	655	694	692	652	633	623	630	616	627	639	652	659	677	728	728	671	590
Hour-ahead Load Forecast on 4/10/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	536	529	520	525	528	577	649	683	672	645	650	641	646	642	645	648	665	694	704	741	749	753	696	621
Americaweater	551	530	507	514	535	567	646	680	655	647	646	636	642	651	654	668	682	706	712	733	726	752	702	626
Findlocalweather	538	529	519	525	528	577	649	683	669	643	649	644	649	645	649	650	662	690	707	741	749	755	697	618
Srhnoaa	553	534	510	519	540	567	650	684	667	647	648	637	643	652	655	668	681	704	710	729	722	748	697	624
Weatherperhour	546	524	501	509	529	567	643	677	654	647	646	637	642	651	655	668	682	706	712	734	726	752	697	624
WeatherANN	534	529	519	525	530	577	649	683	670	643	649	642	648	644	647	648	666	694	704	741	749	753	696	618
Actual Load	550	531	525	520	534	581	664	690	651	647	639	650	647	653	658	666	686	696	713	708	760	758	700	625
Hour-ahead Load Forecast on 4/11/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	564	541	540	529	534	586	646	675	646	647	631	648	642	645	660	671	676	680	701	711	731	752	695	624
Americaweater	576	548	551	540	544	588	647	673	642	638	633	651	641	639	654	665	675	680	698	699	739	755	694	631
Findlocalweather	563	540	538	527	533	586	644	673	644	646	631	648	642	646	661	671	676	680	701	711	731	752	695	625
Srhnoaa	576	548	551	540	544	589	648	674	643	640	633	652	642	639	655	666	676	680	697	698	738	756	695	631
Weatherperhour	576	548	551	541	544	587	645	671	641	637	632	650	641	639	655	665	674	679	696	697	738	754	692	630
WeatherANN	563	540	538	527	533	585	642	671	644	646	631	648	642	646	661	671	676	680	701	711	731	751	695	624
Actual Load	573	561	543	537	552	581	651	665	646	634	650	639	642	651	655	660	665	690	700	708	758	760	709	626
Hour-ahead Load Forecast on 4/12/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	562	550	541	533	543	577	639	673	649	645	656	684	700	719	748	774	788	793	799	794	790	789	728	651
Americaweater	562	539	532	527	537	587	634	660	645	644	647	679	694	713	741	768	800	811	827	812	829	848	773	680
Findlocalweather	564	551	541	532	541	573	636	673	644	642	653	684	700	719	748	774	789	791	801	788	790	791	728	651
Srhnoaa	568	546	540	534	542	592	644	672	654	648	648	678	694	713	741	767	799	810	823	808	827	847	773	680
Weatherperhour	556	534	525	521	534	583	634	663	649	644	647	679	695	714	742	768	800	810	826	811	830	848	774	680
WeatherANN	561	550	540	532	543	576	637	672	646	645	655	684	700	719	748	774	788	792	800	790	790	792	728	651
Actual Load	575	556	546	536	544	574	644	669	644	647	659	688	704	728	758	788	818	849	851	840	869	863	794	690
Hour-ahead Load Forecast on 4/13/06																								
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Accuweather	620	597	578	565	564	610	663	678	669	658	684	714	737	759	789	826	858	880	880	869	881	860	797	711
Americaweater	600	583	568	555	550	597	659	692	656	670	697	729	753	775	805	834	856	883	894	886	879	856	798	734
Findlocalweather	621	599	580	567	564	610	663	678	666	657	684	714	737	760	789	826	859	880	879	869	882	858	795	712
Srhnoaa	603	589	572	559	554	601	661	695	671	673	701	732	756	779	809	836	856	883	893	890	883	857	798	733
Weatherperhour	599	580	562	549	546	592	652	686	659	669	697	728	752	774	804	834	856	883	894	885	878	856	799	736
WeatherANN	621	597	579	566	564	610	663	676	668	658	684	714	737	760	789	826	858	880	879	869	880	859	797	712
Actual Load	635	599	577	564	574	594	662	680	666	674	701	724	765	791	820	851	881	894	899	867	880	876	806	723

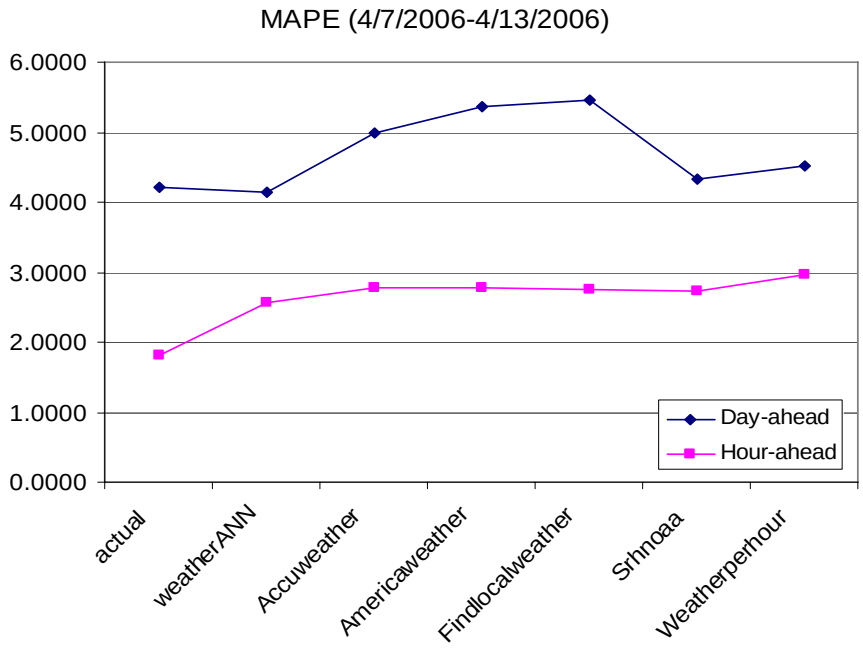


Figure 4.27 Comparing MAPE of day-ahead and hour-ahead between 4/7/2006-4/13/2006.

Table 4.24 Summarization of MAPE of day-ahead and hour-ahead between 4/7/2006- 4/13/2006.

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MAPE (April 7,2006- April 13,2006)		
source	Day-ahead	Hour-ahead
actual	4.2203	1.8097
weatherANN	4.1362	2.5654
Accuweather	4.9913	2.7710
Americaweather	5.3574	2.7679
Findlocalweather	5.4487	2.7432
Srhnoaa	4.3405	2.7243
Weatherperhour	4.5181	2.9628

The STLF program by integrating the multiple resources can achieve the accuracy with the average forecast error less than 4% for day ahead forecast and 2% for hour ahead forecast. With minimum effort to maintain updates and its ease of interpreting forecast results via the graphic user interface, the multiple service resources are proven that they can provide the better forecast result to the target utility.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The Artificial Neural Network (ANN) has been utilized to solve the nonlinear problem which occurs from the relationship between energy demand consumption and its affecting variables. Due to its ability to provide good function mapping with robustness and fault tolerance, the model has been widely used for Short-Term Load Forecast (STLF) for cost effective generation scheduling.

Various ANN algorithms have been proposed and claimed to successfully operate in load forecast application. However, the forecast temperature is the most important variable input in Artificial Neural Network based Short-Term Load Forecasting program because the customer loads are closely correlated with the temperature. This thesis fetches various resources to provide the hourly forecast data in stead of relying on a single resource to improve the accuracy of the load forecasting.

Artificial Neural Network based Short-term Load Forecasting program has been established for real time hourly load and temperature data update. The program is capable of forecasting 24 hour loads on an hourly basis by using the forecast temperature data as input. Two types of forecast files – day-ahead forecast and hour-

ahead forecast are generated by ANN STLF program. Our resources provide the hourly forecast data for 15 days in each region of WFEC service area. The data are recorded in the MySQL database which can be seen directly by using SQLyog. A user Graphical User Interface (GUI) was also developed by using Java webpage to provide the operator access to glance the forecast results.

Variation of forecast temperature has a significant effect on the performance of program. At present, temperature forecast data is obtained from online weather forecast stations fifteen days ahead. The program has achieved an average error of less than 4% for day ahead forecast and 2% for hour ahead forecast. The performance of developed STLF program is very encouraging in terms of the accuracy of the forecast, the computation efficiency, and its relative ease of use.

Despite the quality performance of the program developed in term of the accuracy of the forecast data or a realistic forecast in the thesis, a number of developments can be considered as future extensions of the present work. Some possible future research recommended could include interfacing websites presenting the forecast temperatures in other forms such as graph and map. Since most of the forecast temperatures come from satellites, most of the websites choose to present the forecast temperatures in the form of graph or maps.

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BIOGRAPHICAL INFORMATION

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