LOUISIANA TRANSPORTATION RESEARCH CENTER
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Building Accurate Historic and Future Climate MEPDG Input Files for Louisiana DOTD

INTRODUCTION

The new pavement design process (originally MEPDG, then DARWin-ME, and now Pavement ME Design) requires two types of inputs to influence the prediction of pavement distress for a selected set of pavement materials and structure. One input is traffic, more specifically, truck axle loadings. The other input is climate, a multi-year set of hourly data including temperature, precipitation, wind speed, humidity, and percent sunshine. The climate data is then transformed into temperature gradients that influence pavement material properties. For this study, the term MEPDG is used and refers to all of the software versions and name changes.

When the MEPDG was initially launched in 2007, the climate files were generally 5-10 years of data, some were incomplete records (gaps in the continuous hourly data), and files started with climate data in the 1990s. As the MEPDG developed, more data was added to many files and incomplete files were corrected or omitted. The most common geographic locations of MEPDG climate data files are associated with regional and large airports. Although there were 11 files, the distribution of the files across the state was limited. A pavement analysis would require the use of a climate record that may not be near the project location and would require the same climate data to be repeated to complete a 20- to 40-year pavement distress prediction period.

This study applies climate science to improve the depth and length of climate data so the pavement engineer can apply the best climate input data when examining a pavement design. There is a deeper body of climate history and significantly more climate stations to draw from. The climatologist can assemble longer, higher quality climate history files and convert those files using global climate models into data representing a predicted future climate.

OBJECTIVE

The objective of this study was to apply the best available climate science to build climate input files for use in the MEPDG. The objective was expanded to consider the naturally occurring cycles in climate temperature and precipitation.

METHODOLOGY

The first step was to generate a historic climate file for each parish in Louisiana and assemble the climate data in electronic format required for input into MEPDG model. By building a climate file for each parish, a pavement designer can simply select the climate file for the parish where a project is located. The appropriate historic length of time for these data was established as 1970 through 2009. Every parish does not have a site with an observational record for that period, so an interpolation method in space and time was used to fill in data gaps.

The Automated Surface Observation System (ASOS) and the Cooperative Observer Program (COOP) were two sources used to generate historical climate files. For the 40-year time period and types of data needed for this study, these are the only two sources of data archives available.

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A summary of the procedural steps taken to assemble historic climate files is illustrated as a flow chart in Figure 1 and consists of the following steps:

1. Collect an archive of daily and hourly observations and check the quality of the data.
2. Produce gridded data using an interpolation analysis of available data.
3. Generate grid-point data sets and produce .hcd files for MEPDG.
4. Check the quality of the .hcd files to ensure no processing errors have occurred.

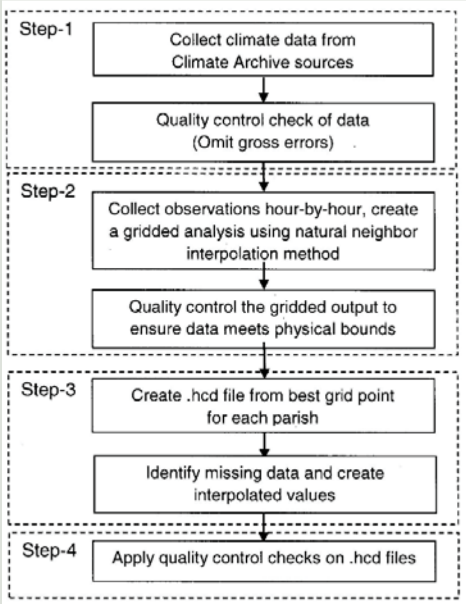

Figure 1
Process for generating historical climate files

Once all of the data analysis was completed, nine climatic regions were established for Louisiana as presented in Figure 2.

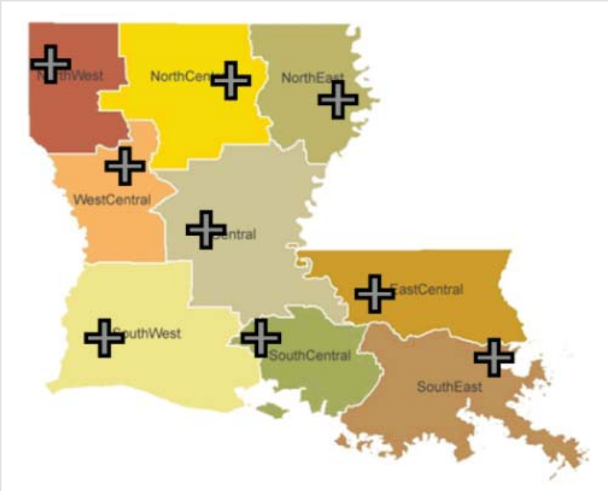

Figure 2
Climatic zones for Louisiana

Table 1 is a summary list of all climate files prepared for the study. A brief description of each climate file is provided below.

- MEPDG climate files are the climate files within the MEPDG software. The locations are generally associated with airports, and the number of years of data in each climate file varies.
- Historic climate files were prepared as part of the study. One file was created for each parish and each file contains a complete set of data from 1970 to 2010. Details on how each file was generated are described in the "Developing Historic Climate Files" section.
- Future climate files were prepared by applying projected changes in climate based on global and regional models to the 40-year historic climate data. One future climate file was created for each parish and each file contains a complete set of data from 2010 to 2050. Details on how each file was generated are described in the "Developing Future Climate Files" section.
- Random climate files were prepared by dividing the 40-year historic climate file into four- to seven-year temperature cycles and randomly re-sorting the cycles into a modified 40-year data set. This process randomly changes the chronologic sequence of extreme annual temperature periods. The modified file was adjusted by the future global and regional models to create a random future climate file. One random climate file was created for each climate zone and contains a complete set of data from 2010 to 2050. Details on how each file was generated are described in the "Developing Random Climate Files" section.

Table 1
Climate files developed for the study

Climate File Name	Description	Discussion
MEPDG	Climate files included with MEPDG software. Each file contains less than 20 years of recent climate data at locations not uniformly distributed across the state.	Business as usual. Uses narrow window of historic data for predicting future pavement performance.
Historic	Climate files containing 40 years of historic data from 1970 to 2010 for each parish.	Good climate input data for calibrating MEPDG models. Allows a match of historic climate data with pavement performance data.
Future	Climate files containing 40 years of data for nine climate zones adjusted for projected changes in climate from global and regional models.	Better climate input data for predicting future pavement performance that reflects long-term climate trends, but will still use the historic year-to-year sequence.
Random or Random Future	The 40-year historic data for nine climate zones randomly re-sorted to change the chronologic sequence of extreme annual periods, then adjusted by projected global and regional models.	Best climate input data for predicting future pavement performance. The data reflects long-term climate trends and is an unbiased series of climate cycle sequences.
Extreme includes: HIT LIT HIP LIP	The 40-year historic data for nine climate zones re-sorted to match extreme annual climate periods with the weakest pavement conditions, then adjusted by projected global and regional models.	These climate files are intended to examine predicted future pavement performance based on a worst-case climate scenario.

CONCLUSIONS

Climate scientists have access to numerous types of climate data that can be merged to create a high-quality historic hourly climate database. This study used several climate data sources to build complete 40-year historic climate files from 1970 to 2010. Historic data files were created for each parish in the state to give the pavement designer easy access to the correct historic climate. The data used to create these historic data sets are based on higher quality data from more locations.

RECOMMENDATIONS

Climate files for predicting future pavement performance should consider the predicted changes in global climate and not simply apply the historic climate record. Each agency needs to understand the options for building future climate files and select the option that best fits the state. The options have advantages and disadvantages based on the predictive climate models and climate patterns used. For this study, the future climate files applied a 70-year global model and adjusted for regional land features, with the base climate data randomly sorted by climate cycles. Additional future climate files were built with the intent of generating extreme climate sequences for temperature and precipitation.