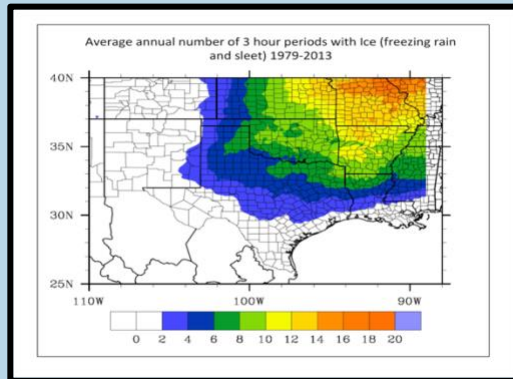


## Trends in Weather Extremes: Providing Datasets for Transportation Safety & Infrastructure Research

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Extreme weather conditions produce substantial strain on numerous facets of the transportation system, with impacts on infrastructure, maintenance and safety. A majority of the states in the U.S. Department of Transportation Region 6 rank among the highest in the nation for the number of federal disaster declarations resulting from severe weather and climate extremes. Also, the diversity of topographic and climatic variations in this region produces thermal and moisture variability that

challenge the longevity of existing infrastructure.

As a result, the Southern Plains Transportation Center has identified the area of “climate-adaptive surface transportation” as a research priority. To aid in this endeavor, the South-Central Climate Science Center is working to develop regionally specific and spatially extensive datasets that substantially expand climatologies of multiple weather hazards. Furthermore, this data will be used to check, validate and optimize future projections of climate models for the region. This ongoing study will benefit transportation research and operations, ranging from traffic safety and risk, to infrastructure sensitivities, as well as present future climatic extremes and their trends. The present work is especially focused on icy precipitation, freeze-thaw cycles, temperature extremes and precipitation variability.

The initial stage of this ongoing project identified existing meteorological data that extend over the entire Region 6 domain, are high-resolution in time and space, and can provide value-added output that is transportation-relevant. Developing representative climatologies and climate trends also requires a long-duration time series (30+ years) that captures a large range of historical variability. Examples of products developed for two key winter hazards are described in this article. Forthcoming products will examine variability of precipitation (extremes, wet days, dry days and their trends) and temperature (cold air outbreaks, warm extremes).

Icy precipitation encompasses freezing precipitation such as freezing rain and sleet. Its impacts on traffic safety, volume and the economy are well-known and have been keenly felt over large swaths of the nation’s winters in 2013-2015. Measuring icy precipitation is difficult and typically relies on human observers or automated sensors to determine the type of precipitation that is falling. Heavy ice accumulation can lead to power disruption and data collection error. As a result, information on icy precipitation is spatially coarse and typically only available at airports. However, the meteorological environment within which it forms is well understood since computer algorithms have been developed operationally to aid forecasters in determining

expected precipitation types. Three such algorithms support the present study, in combination with data from the North American Regional Reanalysis, to create a spatial analysis for icy precipitation. Use of more than one algorithm potentially reduce errors in diagnosing precipitation type. This dataset extends from 1979-2013 and has a minimum time interval of three hours. The ability of this product to reproduce observed trends is presently under evaluation using station reports compiled from the National Climatic Data Center; however, preliminary results are very encouraging and show strong positive correlation. This dataset will be the highest resolution, long duration information currently available and could be used to generate county-by-county statistics of frequency, timing and severity of icy precipitation. It also could be used as a resource for projects that examine traffic impacts, vulnerability and risk when coupled with socioeconomic and transportation safety data.

High number of oscillations about the freezing point of water can be particularly damaging to roadway infrastructure, leading to potholes, scaling and crumbling, particularly coupled with high traffic and improper mix design or construction. Resistance to freeze-thaw is laboratory tested; however, knowledge of the regional climatology is important to ascertain the types of field conditions experienced over the potential lifetime of a structure. Using a very high-resolution temperature dataset, the research team has been able to construct freeze-thaw maps and time series from 1948-2012. This work also will evaluate the magnitude and trends of temperature ranges during freeze-thaw and probabilities of freeze-thaw temporally proximal to precipitation.

The prospect of increased climate variability and future changes in extremes will have substantial impacts on the transportation sector and it's increasingly recognized that climate model data is a potentially useful resource to incorporate in infrastructure planning and hazard risk assessment. Numerous climate projections are presently available but not all are able to provide accurate future projections on the regional scale. Work is presently underway to ascertain the reliability of a suite of global climate models for the South Central United States. Outcomes from that work, coupled with validations of model versus observed statistics over the historical period, will be used to develop a set of climate scenarios for the region applicable to transportation safety.

In addition to the previously stated benefits, this study aims to develop collaboration between weather and climate researchers as well as the transportation community. The goal is that the datasets can be applied to existing and future projects, which aim to anticipate and reduce risk, improve resiliency and cost-effectiveness, and foster additional cross-disciplinary partnerships. To that end, we have developed a brief online survey that seeks information from the transportation community on their climate-data needs, including types of ways that data products and resources can best be disseminated.

For further information, please email Esther Mullens at [ester.white@ou.edu](mailto:ester.white@ou.edu)

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