Decoding United States Severe Weather Events

Bhagya Athukorallage and Dimitri Volchenkov
Department of Mathematics and Statistics, Texas Tech University, Lubbock, Texas.

Abstract

Primary aim of this project is to quantify and graphically visualize the number of severe weather events and use property damage to study economic impact due to severe weather events. Further, we examine the spatial–temporal clustering of severe tornadoes in Texas. In particular, we take all pairs of severe tornadoes and for each consecutive pair calculate the spatial lag (distance between touchdown points) and the temporal lag (time between touchdown points).

Introduction

❖ Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life.

❖ These extreme weather events carry substantial economic costs. In the updated data, thunderstorm losses in North America have doubled -- from under US$10 billion in 1980 to almost $20 billion in 2015.

❖ This research uses the U.S. National Oceanic and Atmospheric Administration's (NOAA) severe weather database that contains more than 1 million events.

❖ Objective: Learn from the past - Use *Data Analytic* techniques to understand weather patterns and damages for a given location.
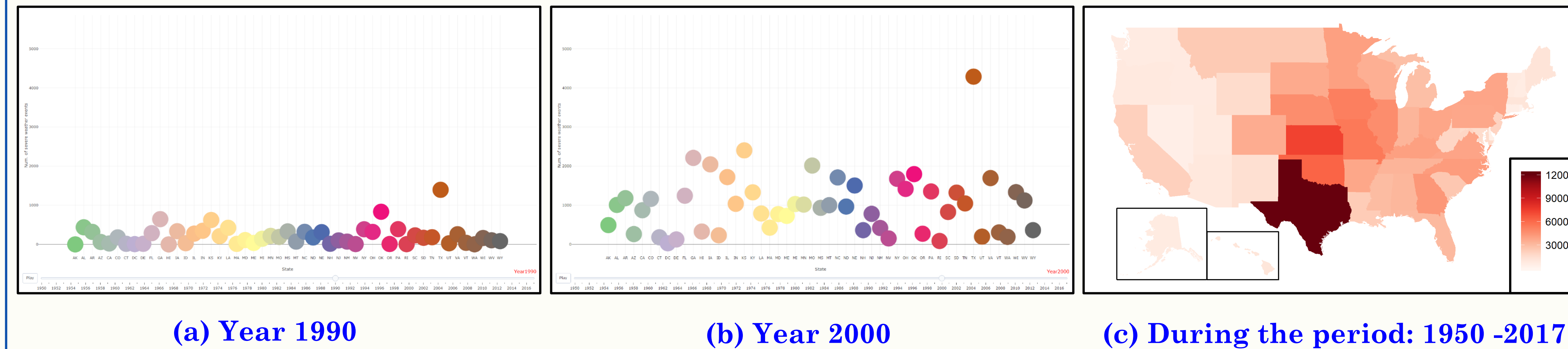
Severe Weather Data

➢ Data Source: National Oceanic and Atmospheric Administration (NOAA)

➢ Time period: 1950 – 2017

➢ Regions – 69

➢ Severe weather types: 74

➢ Data: Location, Timing, Human fatalities, Injuries, Property, and Crop damages.

First Glimpse at the Data

(a) Year 1990   (b) Year 2000   (c) During the period: 1950 -2017

Fig 1: Total number of severe weather events recorded in the US

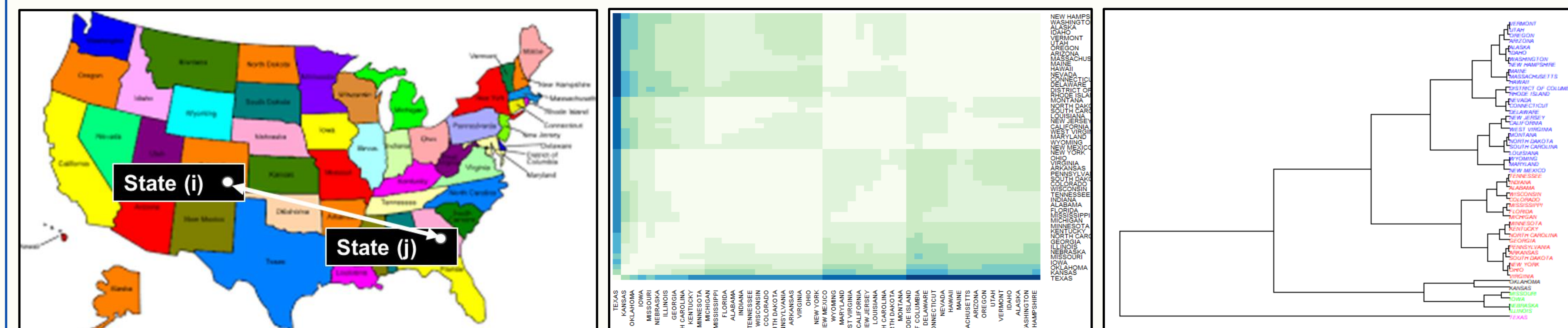### Clustering States Based on the Total Number of Severe Weather Events

Fig 2: Heatmap for the distance matrix   Fig 3: Cluster dendrogram

➢ Defined the distance as the difference between the total number of severe weather events occurred in state (i) and state (j). The corresponding distance matrix is a square matrix containing these distances.

➢ Used Hierarchical clustering technique to group states. The basic idea is to assemble a set of states into a tree, where states are joined by very short branches if they are very similar to each other, and by increasingly longer branches as their similarity decreases. Distance matrix is used for deciding which clusters to merge/split.

Lone Star State

➢ Calculated the time difference between two consecutive severe weather events and the corresponding property and crop damages (data is shown on log-log graphs).
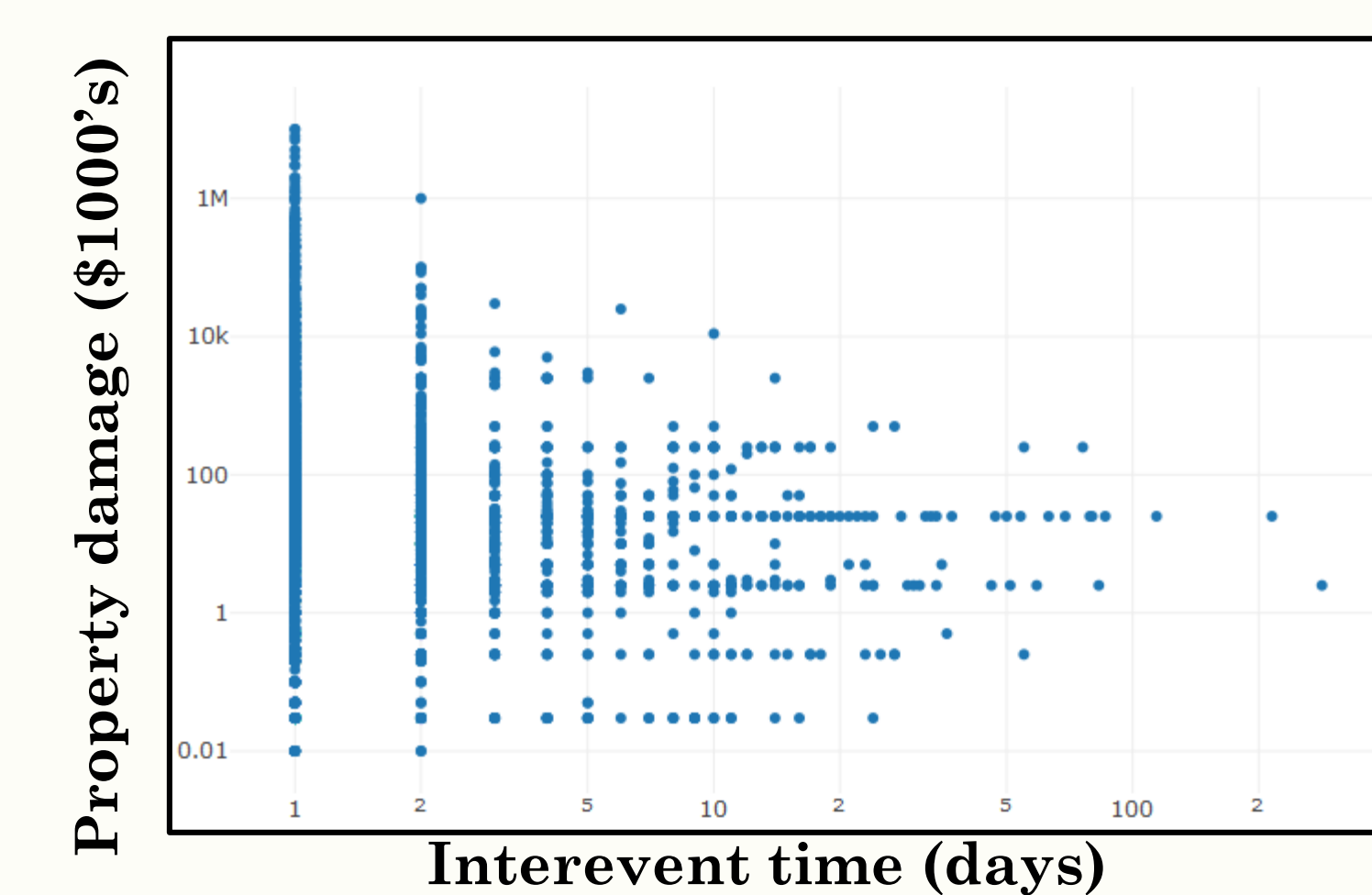

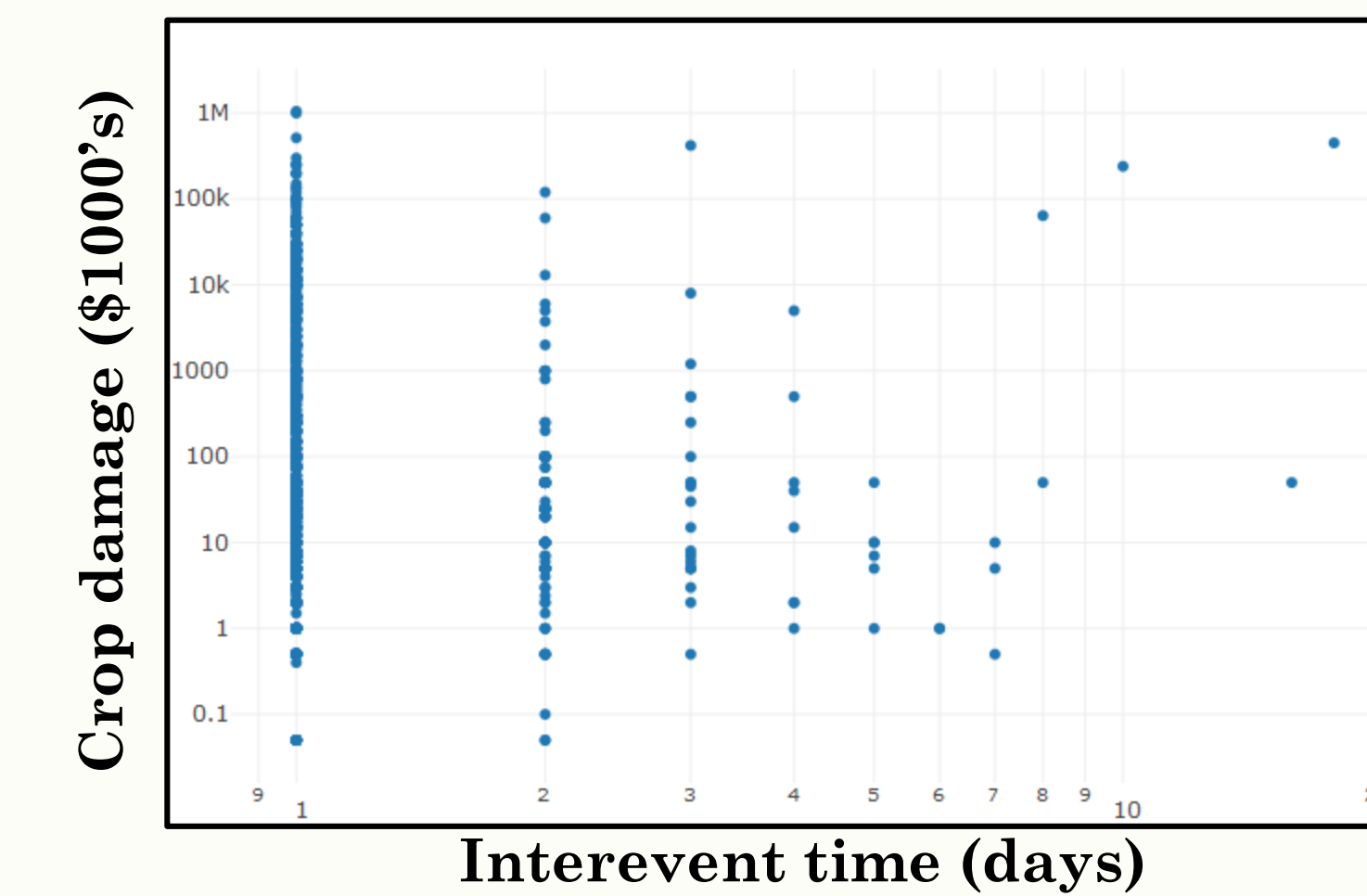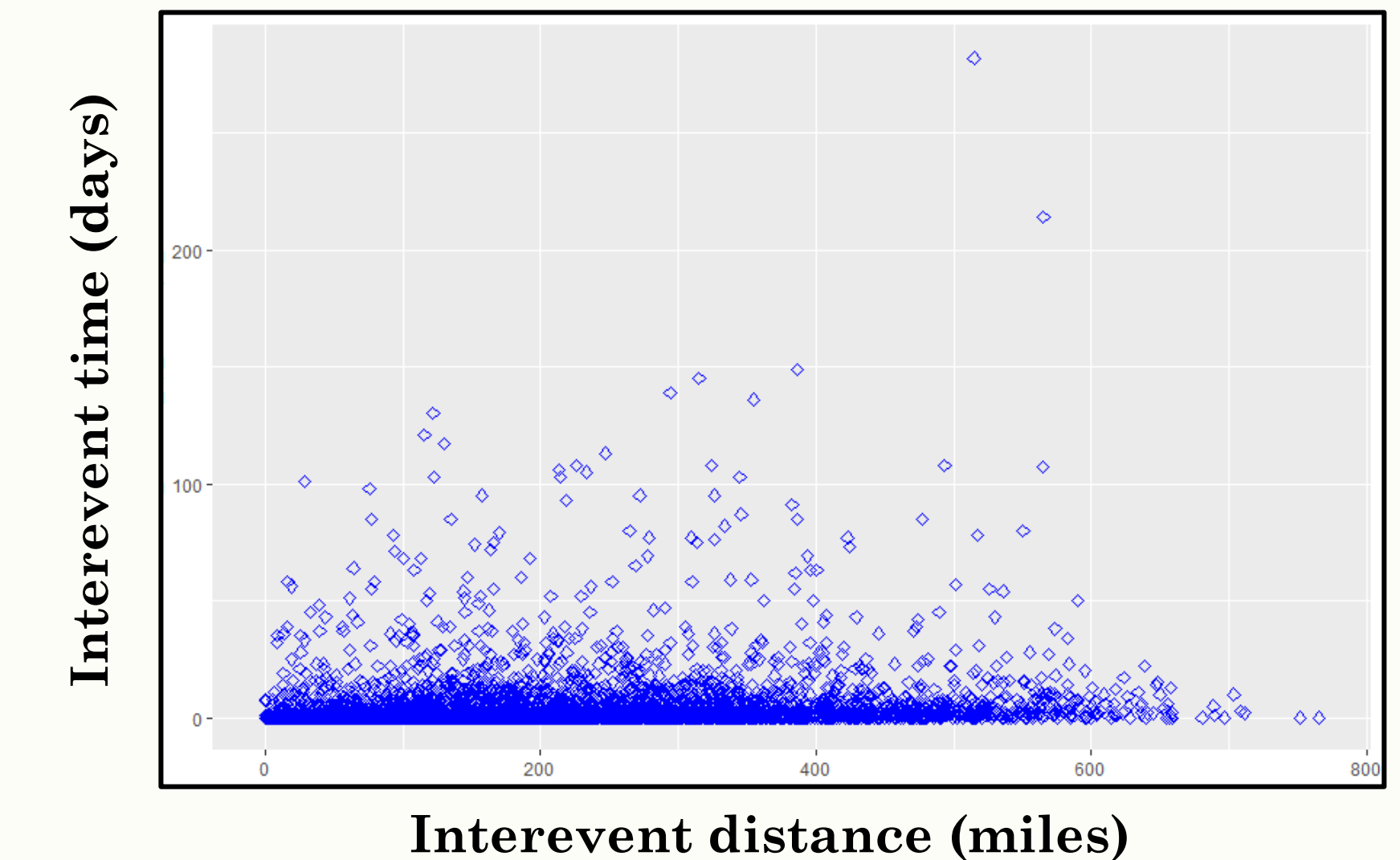Fig 4: Time gap between two consecutive severe weather events and property damage
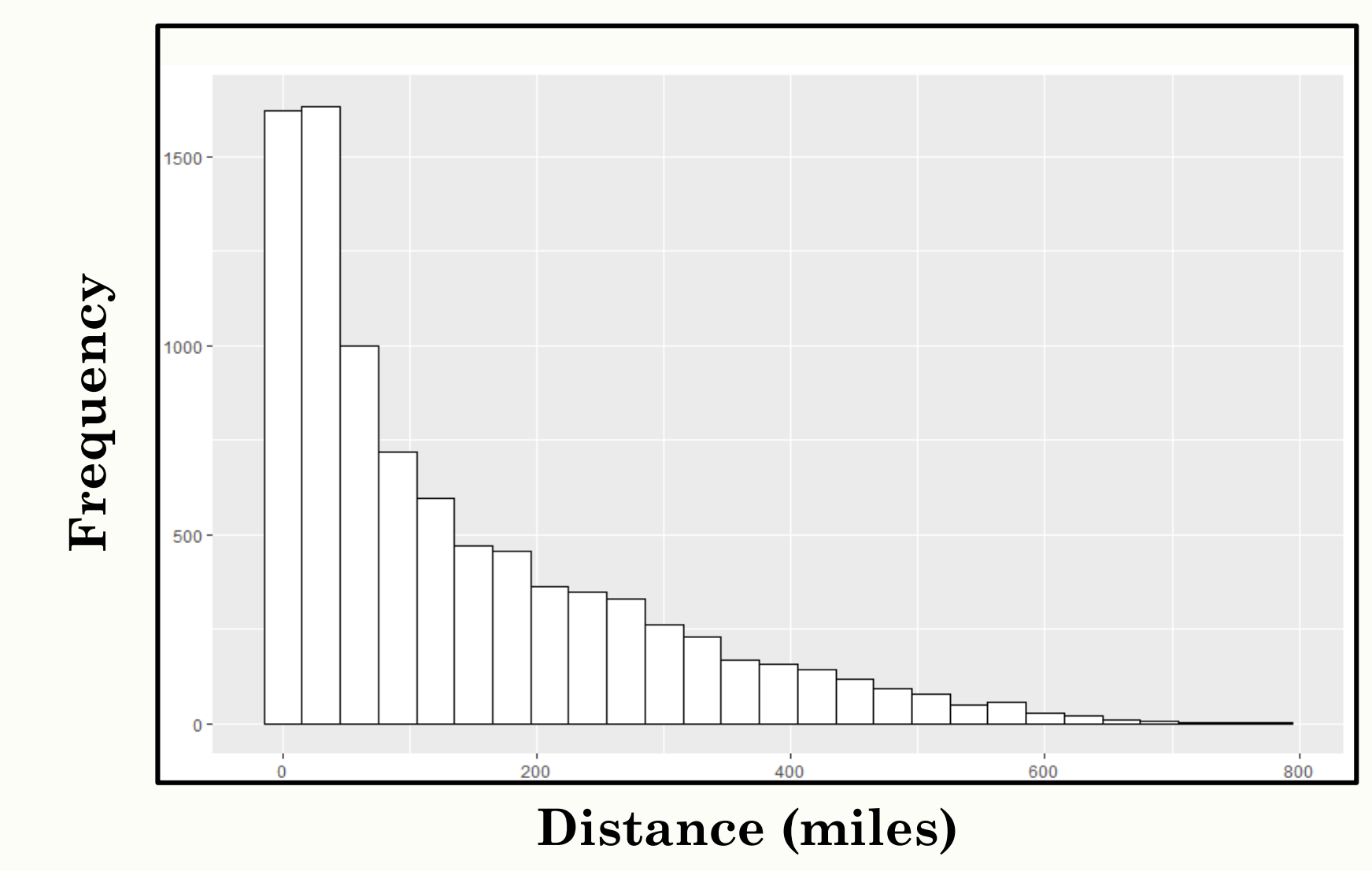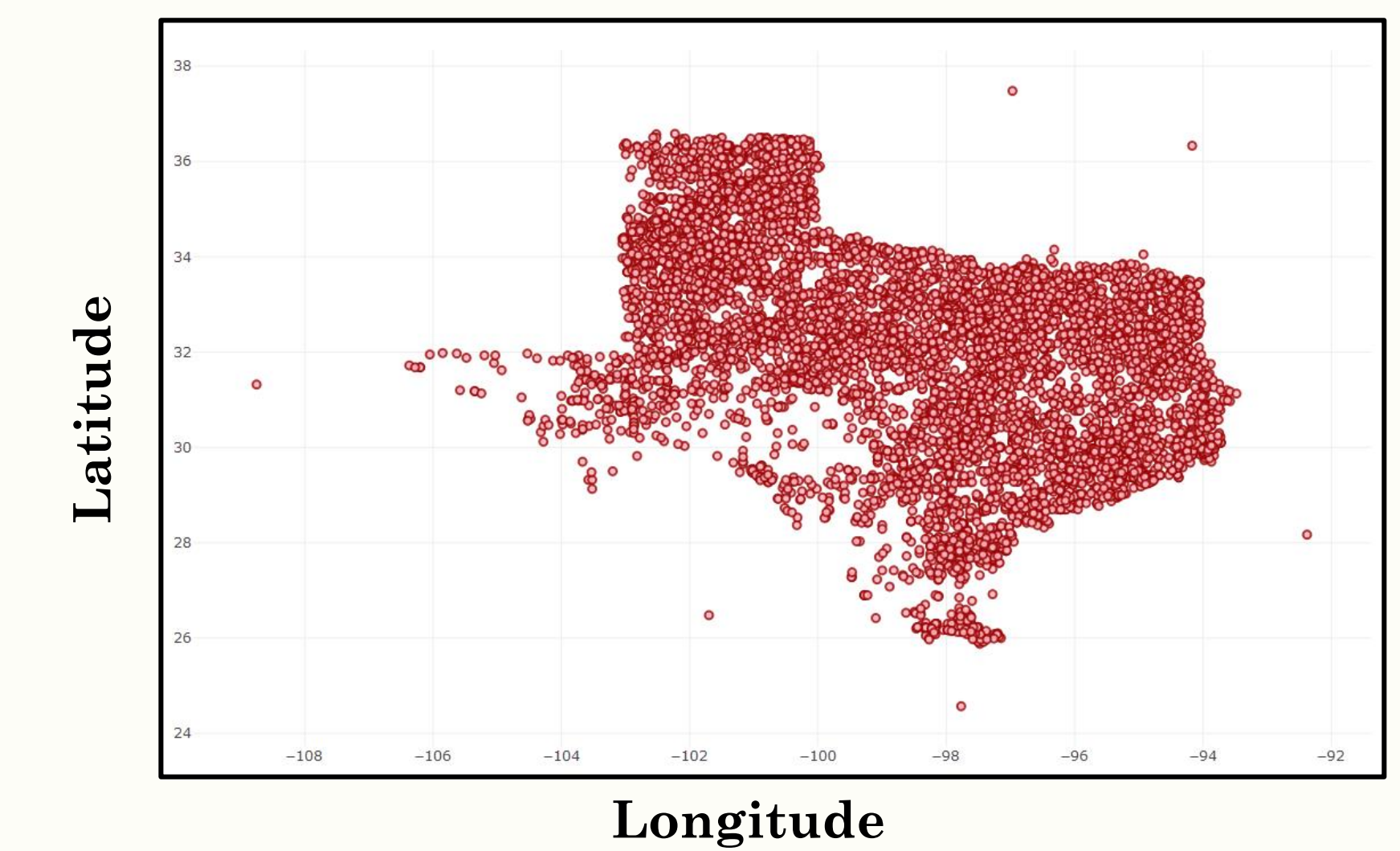
Fig 5: Time gap between two consecutive severe weather events and crop damage

➢ Highest number of events occurred with small ΔT, and events with small ΔT have the largest range of property and crop damages

Reference

Tornadoes in Texas

Figs 6: Spatial-temporal analysis

Conclusions and Future Perspectives

➢ Data suggested that Texas state has greater vulnerabilities to severe weather events.

➢ Highest number of severe weather events occurred with a small ΔT, and events with small ΔT have the largest range of property/ crop damage.

➢ Highest number of tornadoes in Texas occurred within a shorter interevent distance. Spatial-temporal analysis depicted a predominantly random behavior between the interevent distance and time.

➢ Currently, a Time-series model is applied to investigate the frequency of tornadoes during the period 1990 - 2017.