# Exploring Links between Climate Shocks and Migration

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## Introduction

There is a long history of migration out of Mexico into the United States. Traditionally, human migration patterns have been attributed to historical events or changes in the political climate. More recently, however, climate shock events have so deeply affected the Mexican environment that they have likely become a contributing factor in determining human migration out of Mexico. In this project, we pursue a mathematical model to assess the effect of precipitation changes on peoples' likelihood of migration, and we interpret the results of the model from climate and social science perspectives.

## Motivation

***Does precipitation play a role in influencing migration out of Mexico?***

- Data from the Mexican Migration Project surveyed 170 communities across Mexico from 1982-2018.
- CHIRPS precipitation data can be analyzed for each MMP community surveyed.
- Based on that analysis, we will examine how changes in precipitation correlate to patterns of human migration.

## Background Historical Analysis

- 1942-1964: The Bracero Program brings an influx of mostly male agricultural workers from Mexico into the U.S.
- 1960's-1970's: Family reunification process brings more women and children from Mexico into the U.S.
- 1982: An oil crisis in Mexico spikes migration out of the country
- 1986: U.S. Immigration Reform and Control Act diminishes migration starting in 1987
- 1993-1994: Operation Blockade El Paso and Operation Gatekeeper do not noticeably deter migration across the U.S.-Mexican border

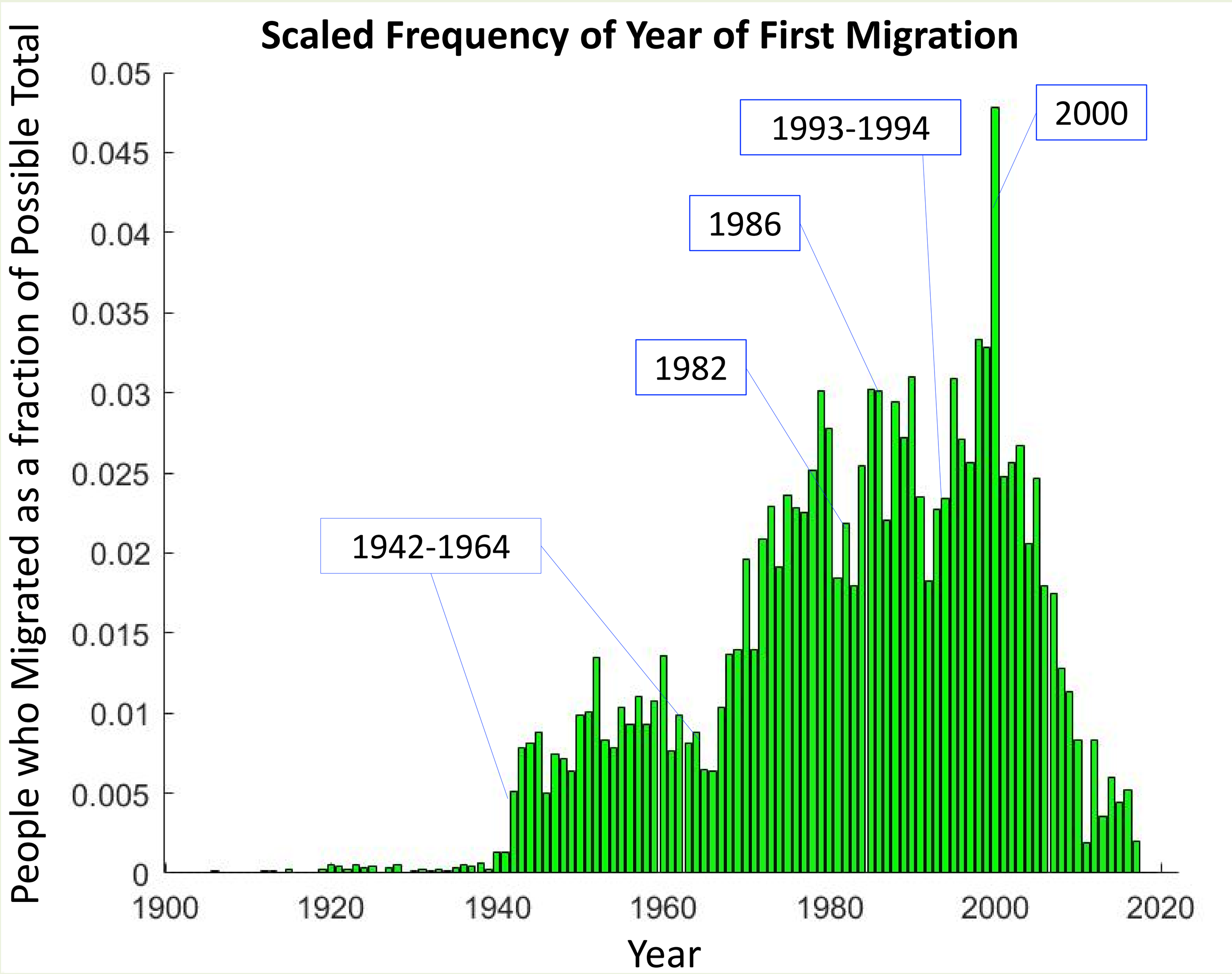



***Figure 1:*** *Frequency of years of first migration, scaled for survey timing.*

## Research Goals

Model the likelihood of migration as a function of historical and environmental factors.

→ Create a model that can predict migration based on precipitation patterns.

## Early Methods: A Neuron Model

### *The Wiener Process*

- Here we define *v(t)* as the probability that an individual migrates at time *t*, $\mu_w$ are the factors that influence migration (measured in $\frac{1}{time}$), $\sigma_w$ accounts for randomness, and $\dot{W}$ is white noise.

$$\frac{dv}{dt} = \mu_w + \sigma_w \dot{W}$$

- We calculate an individual's probability of migration:

$$v(i+1) = v(i) + dt * \mu_w + \sigma_w * \sqrt{dt} * randn$$

Graphed against migration with no uncertainty:

$$y = \mu_w * t$$

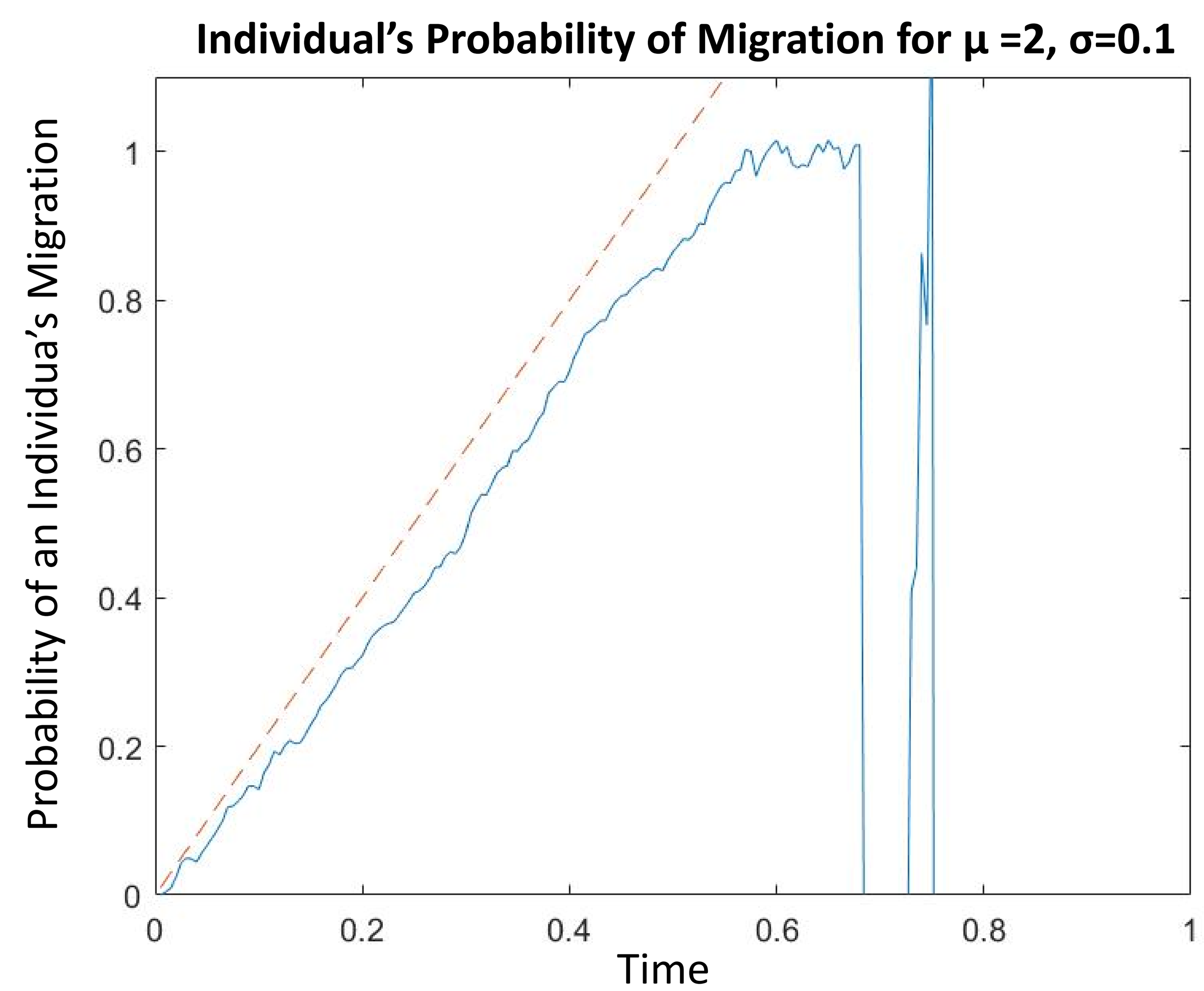



***Figure 2****: v(t) shown in blue solid line, y(t) shown in red dashed line.*

### *Probability Distribution*

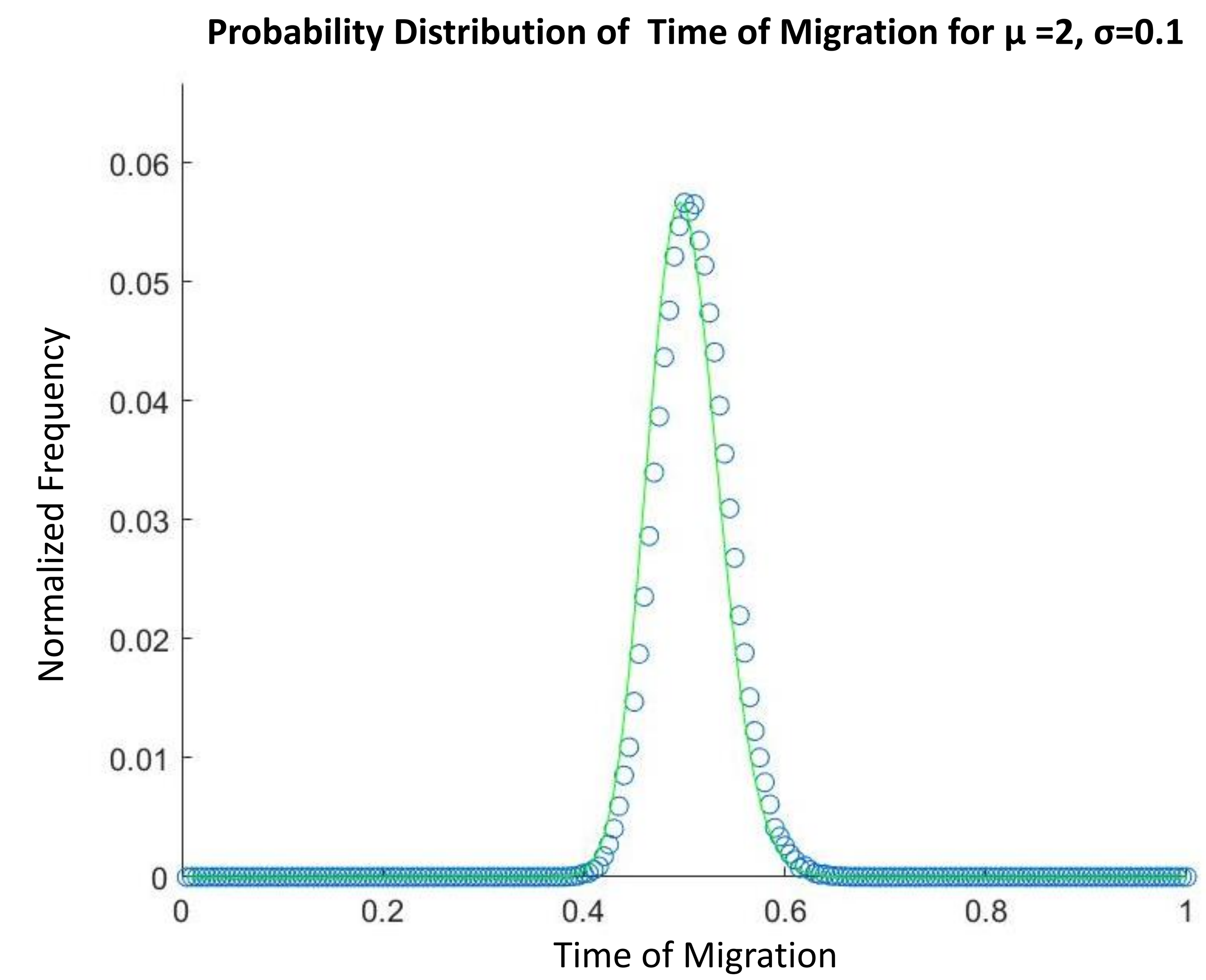
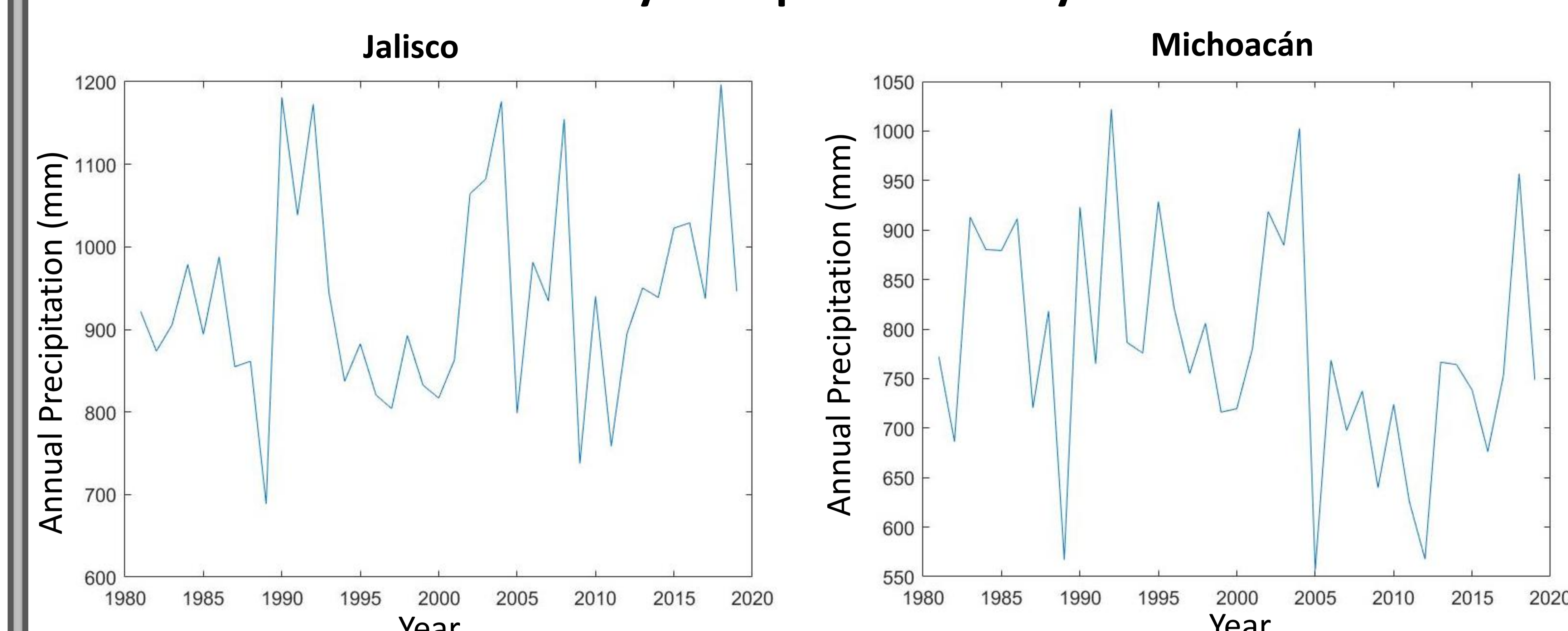



***Figure 3****: Exact density function shown in green solid line.*

- Probability of an individual's migration plotted against the exact probability density function for first instance of migration, given by:

$$f(t) = \frac{\theta}{\sqrt{2\pi\sigma_w^2 t^3}} \exp\left(-\frac{(\theta - \mu_w t)^2}{2\sigma_w^2 t}\right)$$

## Community Precipitation Analysis




***Figures 4&5:*** *Examples of precipitation analysis for communities in Jalisco and Michoacán.*

**Analysis of precipitation levels in the 170 communities surveyed by MMP**

- Interpolated community locations to the nearest location in the CHIRPS data set.
- Graphed precipitation vs. time to show trends specific to each community's geographic position

## Future Work

- Develop a $\mu_w$ term from precipitation observations that accounts for environmental changes to model the effects of climate changes on human migration patterns.
- Quantify the effects of key historical events that influenced migration as part of the $\mu_w$ term.
- Once the model is expanded to include that $\mu_w$ term, test and validate the model with precipitation and historical data.
- Employ the model to predict future human migration out of Mexico.

**Acknowledgements**

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**References**

Burkitt, A.N. A Review of the Integrate-and-fire Neuron Model: I. Homogeneous Synaptic Input. *Biol Cybern* **95,** 1–19 (2006). https://doi.org/10.1007/s00422-006-0068-6