



Quantifying Heat Wave Cost and Mortality

Roger Yang, Dr. Jingjing Peng, Dr. Peng Yu
August, 2024

Background

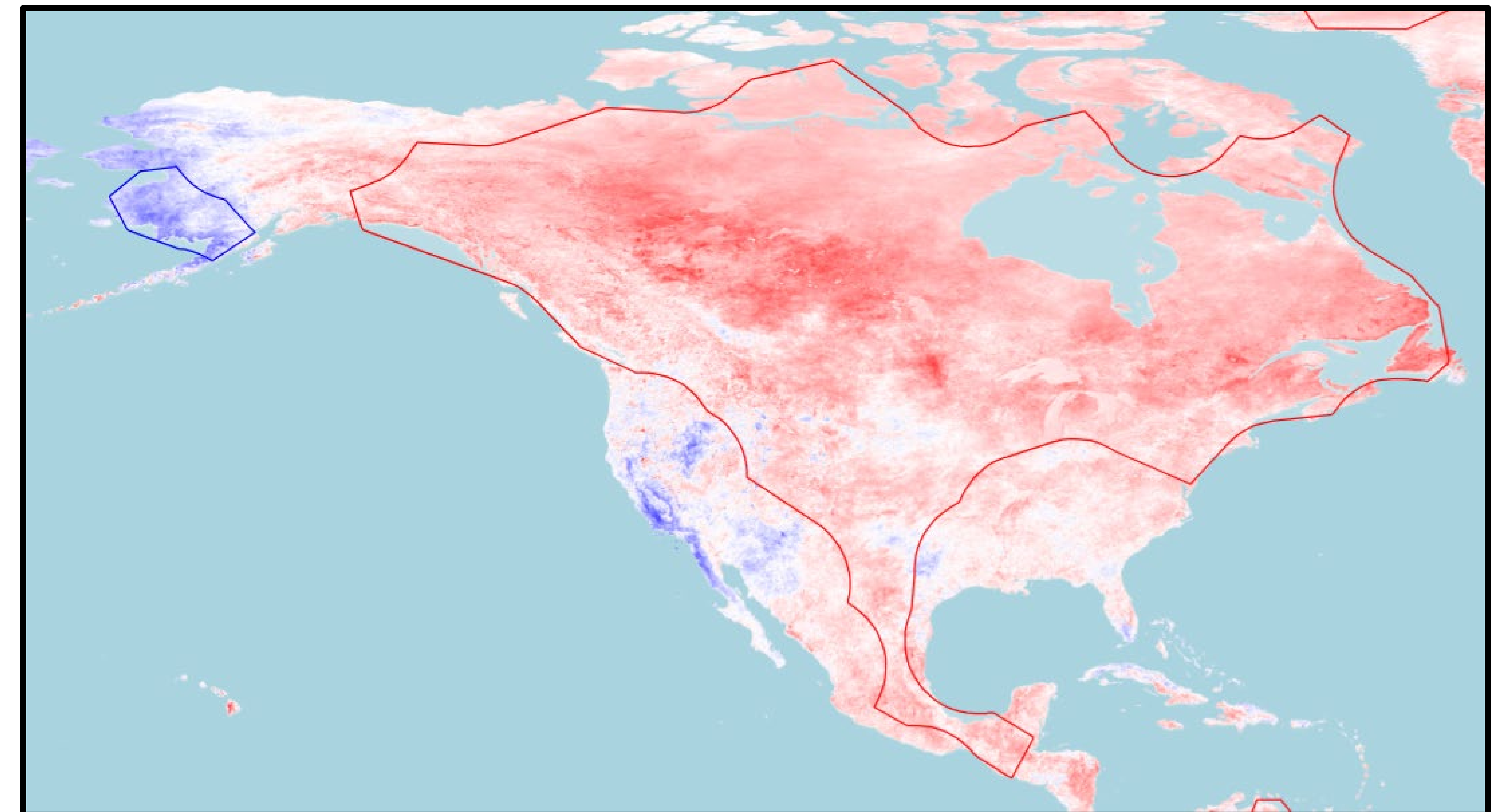
- ★ Due to climate change, **extreme heat events** are growing increasingly prevalent. Heat waves present myriad challenges to human health and infrastructure. Regions of positive temperature anomaly have been assoc. with increased risk of certain cardiovascular diseases, suggesting that general mortality is correlated with heat waves
- ★ Heat waves stifle economic output through a variety of modes, such as reduced worker productivity, supply shocks to fisheries and higher maintenance costs
- ★ We can precisely quantify the presence of heat waves by measuring the variation of land surface temperature WRT the mean, or LST anomaly. The LST anomaly can be graphed for specific regions and dates, as shown right

Research goals

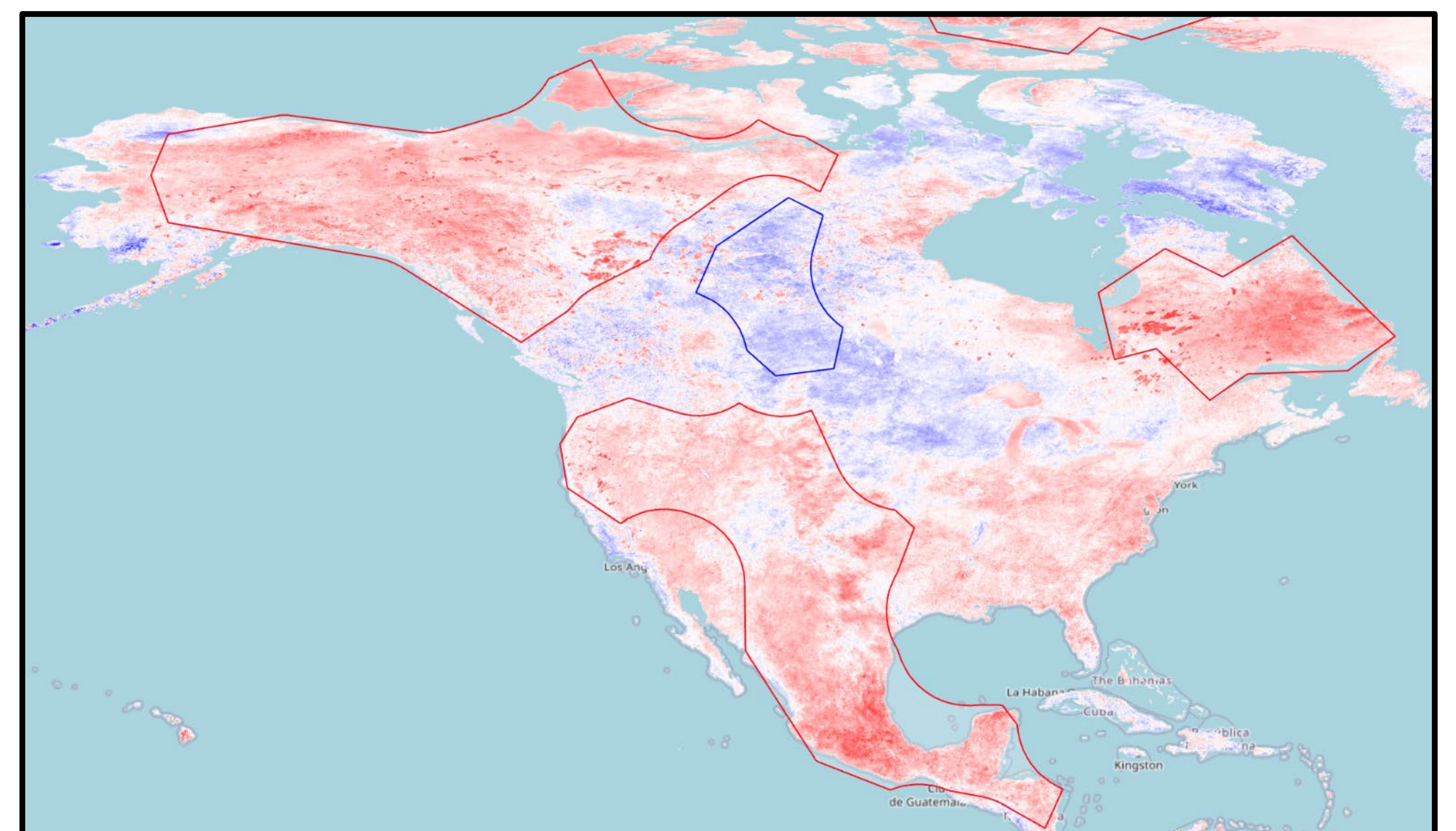
We aim to achieve the following goals:

1. Derive a meaningful relationship betw. mortality & LST anomaly using a predictive ML - based regressor
2. Obtain a rough estimate of the annual financial cost of heat waves (in terms of nom. GDP)

April, 2024



June, 2024





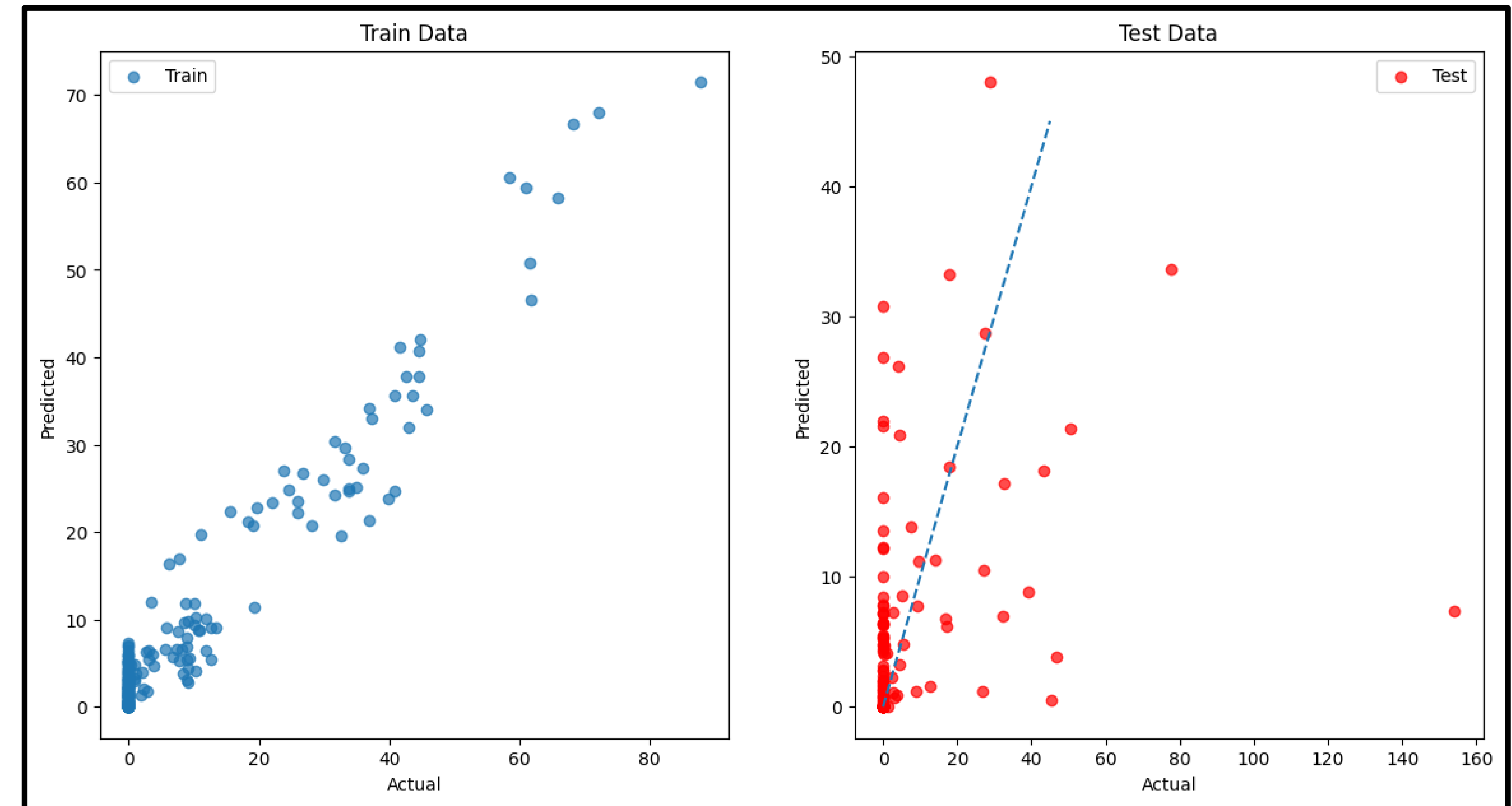
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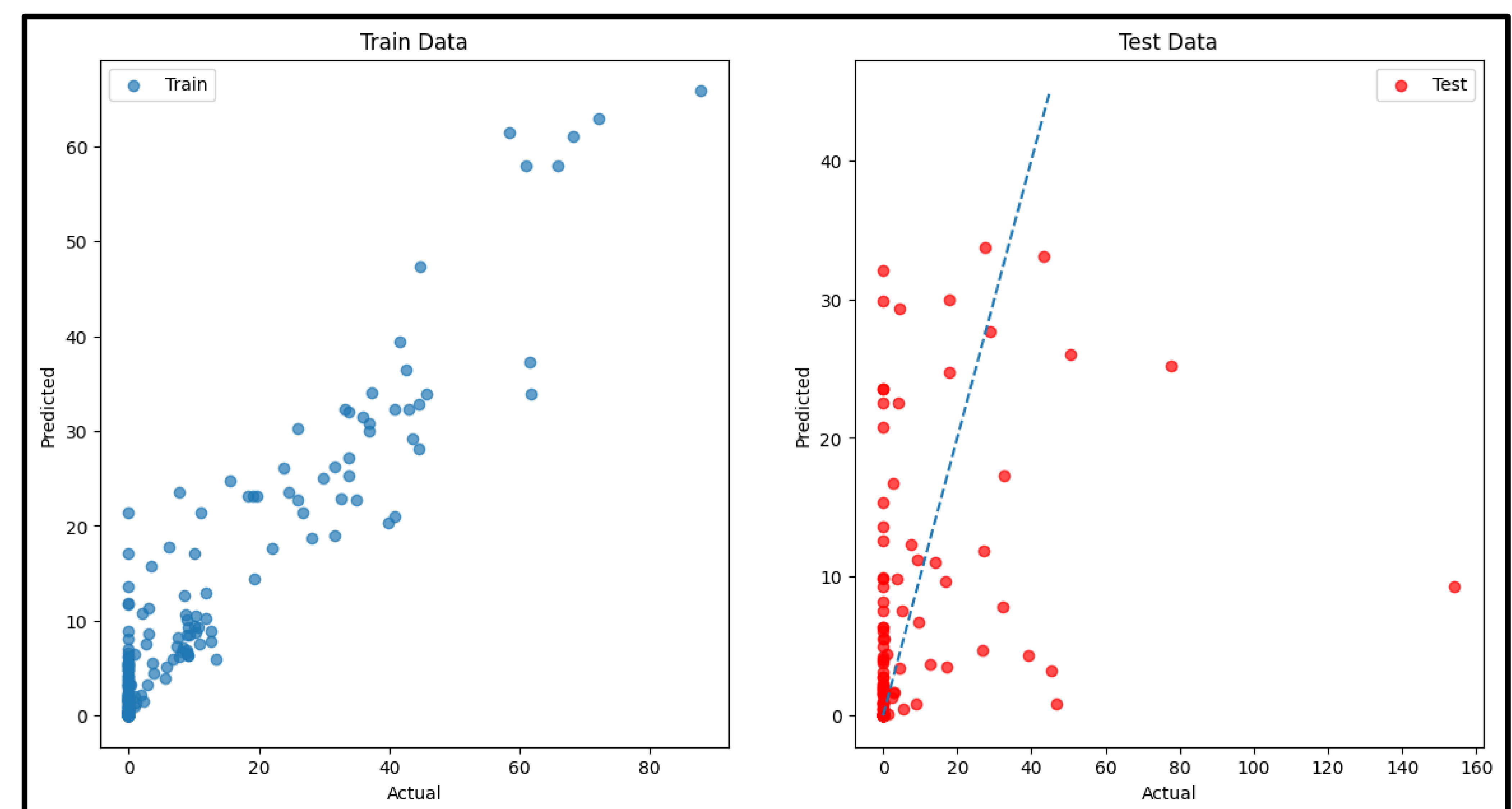
Regression Results

- ★ In previous implementations a **Random Forest Regressor** (RF) was used. We tested an ensemble of 27 different regressors to determine the most accurate and consistent one
- ★ The **Gradient - Boosting Regressor** (GBR) performed the best. Though the model achieves a respectable 8.73 test MAE, it still shows signs of overfitting - > unfortunately inherent to the sparse nature of our dataset; however, the GB model overfits less than prior RF implementations
- ★ Compared to the plots for the RF regressor, the GBR performs better with the test data while maintaining a consistent structure with the train data. Unlike other model candidates tested like **Gaussian - Process Regression** (GPR), the GBR does not perfectly predict the train data either (overfits less)

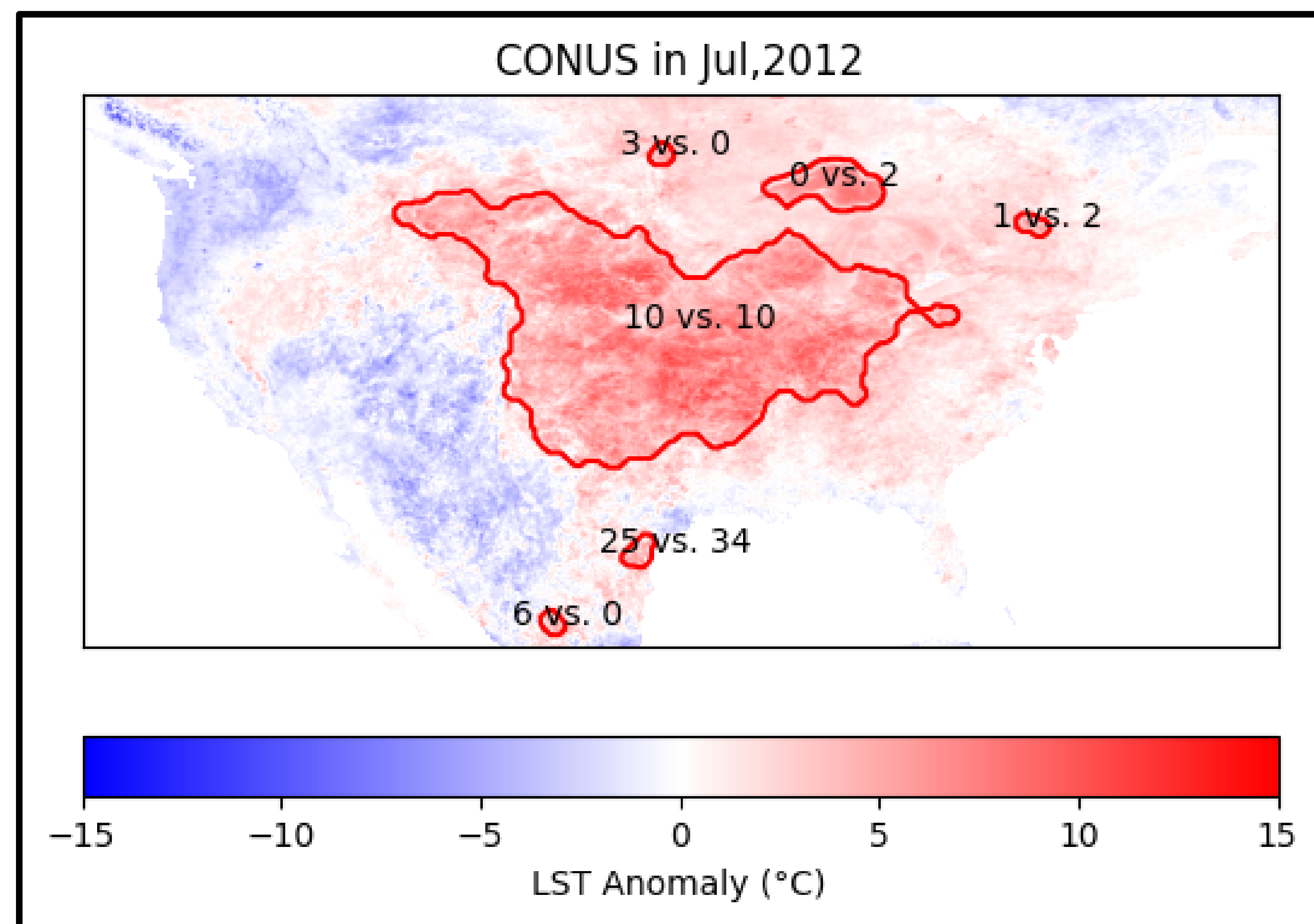
GBR (test 8.73, train 2.83)



RF (test 8.82, train 3.35)



GBR predicted vs. actual events



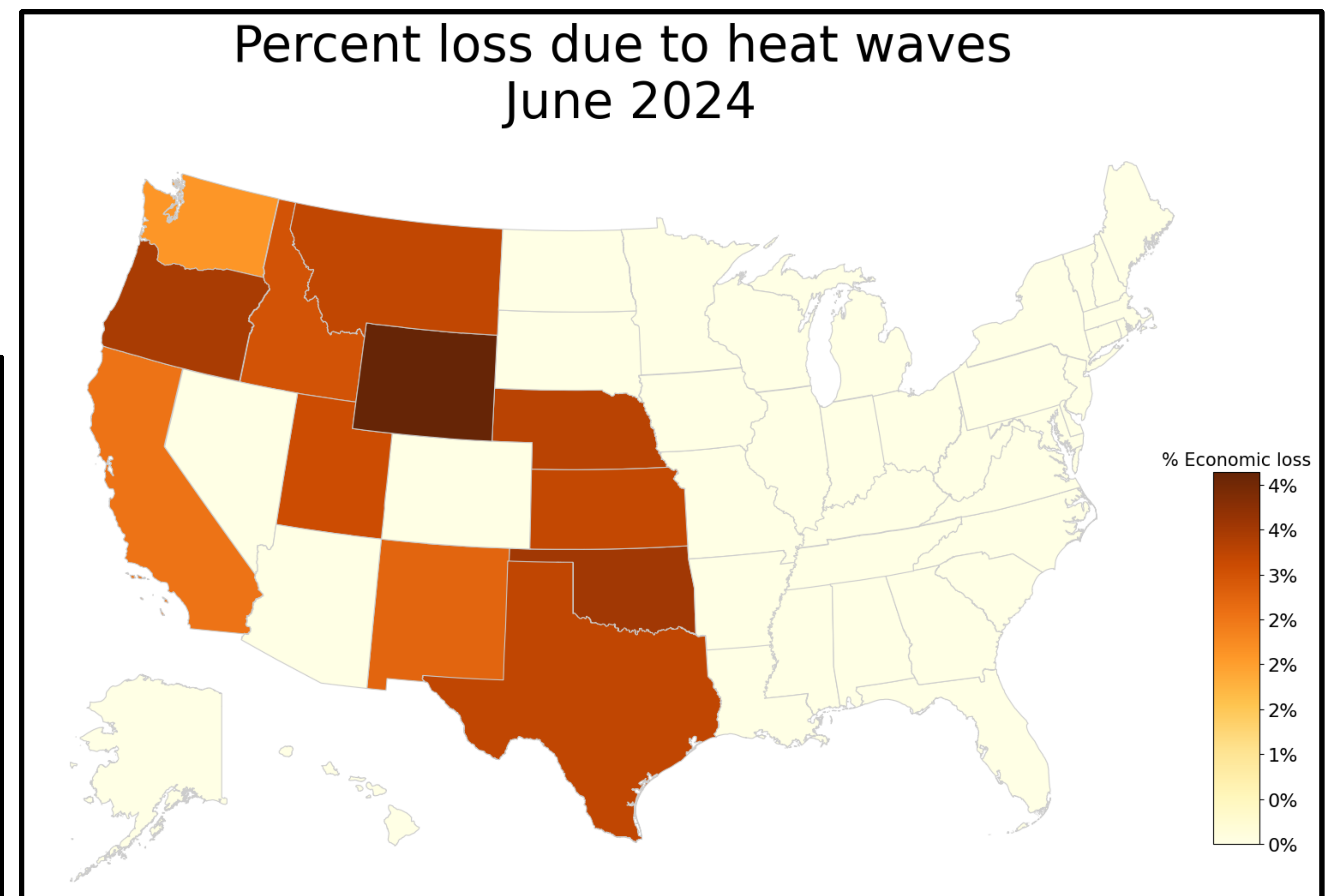
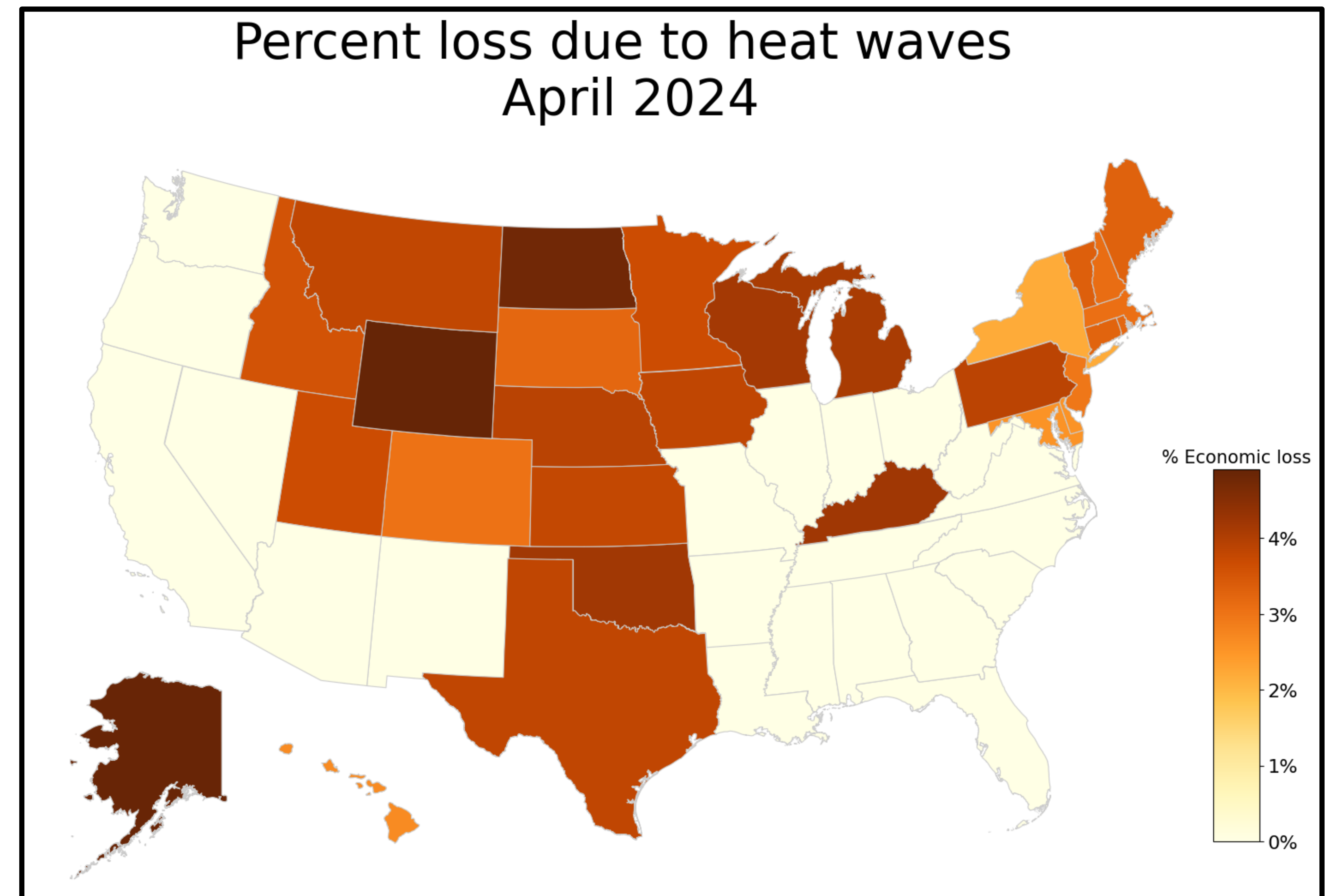


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Economic cost estimate

- ★Using a linear temp. heuristic given in **Lai et al. (2023)** , heat wave data from NOAA’s STAR climatology database and public data on the GDP breakdowns of each state, we can roughly estimate the costs incurred by each state due to decreased production
 - This method gives an estimate of **\$44 billion** lost annually due to “heat- exposed industries,” with southern and northeastern states being particularly affected. NE was more affected in Apr. compared to Jun. The “Great Plains” states also consistently seem to be affected
- ★Using statistical estimates from **Cheung et al. (2021)** coupled with public fiscal information about said fisheries, we can estimate the economic costs due to fishery unemployment
 - Approx. **\$26 - 32 billion** lost annually - however, subject to flux
- ★Total cost: **~\$70 - 76 billion.** Somewhat lower than **\$100 B.** figure reported by [Congress](#) for 2020 (lower bound)



Bottom left: MHWs are characterized by abnormally high sea surface temperature. Shown adjacent is a plot of the famous 2014 “Blob” MHW that devastated Pacific ecosystems and aquaculture ([NASA, 2019](#))

