Lab 2: Climate Trend Analysis

Regional Climate Trends Project

Learning Statistical Analysis in R

EA030

January 23, 2026 v. 0.07

Contents

1 Introduction

In Lab 2, you will learn statistical analysis of climate trends. Building on Lab 1's data preparation, we focus on:

- Descriptive statistics in R
- Histograms and distributions
- Linear regression for trend analysis
- Interpreting p-values and significance
- Comparing groups (seasons, regions)

2 Setup

```
##
## ============================================================
##  Climate Narratives Functions v7.0 Loaded Successfully!
## ============================================================
##  Run check_packages() to verify dependencies
## ============================================================
##
##  QUICK START:
##  1. setup_project('CA')
##  2. select_stations_for_analysis(n_stations = 50)
##  3. download_stations()
##  4. load_and_save_stations(cleanup = TRUE)
##  5. process_all_stations_for_spatial()
##  6. create_spatial_objects(all_station_trends)
##
##  NEW IN v7.0:
##  - Fixed figuresfolder variable handling
##  - Improved error messages
##  - Better documentation for teaching
##
## ============================================================
```

```
setwd("/path/to/your/project/folder/")
source("ClimateNarrativesFunctions_v07.R")
check_packages()
```

3 Load Data from Lab 1

```
## [OK] Loaded data for CA : 50 stations
```

```
my.state <- "CA"
datafolder <- "Data/"
figuresfolder <- "Figures/"

rdata_file <- paste0(datafolder, "spatial_trends_", my.state, ".RData")
load(rdata_file)
```

4 Learning R: Summary Statistics

4.1 Basic Summary Functions

```
## Statistics for Annual TMAX Trend (C/century):
## ========================================
## Mean:     0.56
## Median:   0.4
## Std Dev:  1.02
## Min:      -1.68
## Max:      2.59
```

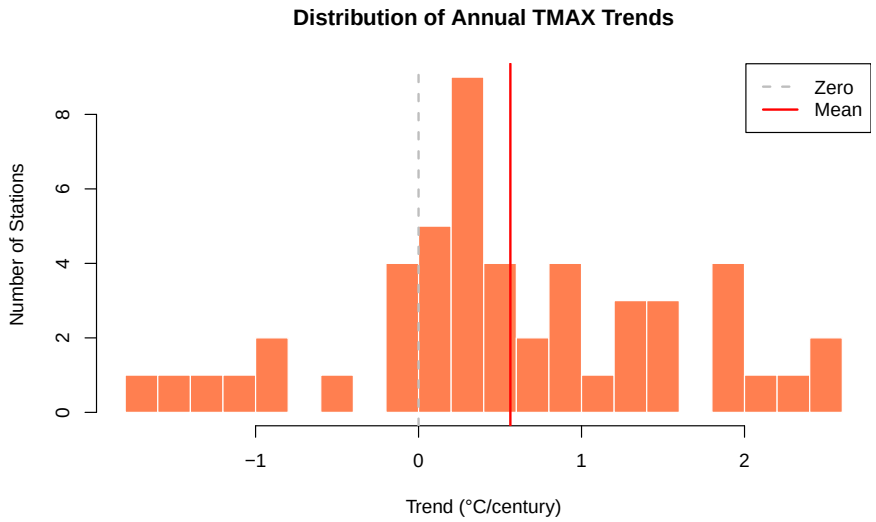
```
tmax_trends <- all_station_trends$annual_trend_TMAX

mean(tmax_trends, na.rm = TRUE)     # Average
median(tmax_trends, na.rm = TRUE)   # Middle value
sd(tmax_trends, na.rm = TRUE)       # Standard deviation
min(tmax_trends, na.rm = TRUE)      # Minimum
max(tmax_trends, na.rm = TRUE)      # Maximum
```

R Concept: na.rm = TRUE

Many R functions return `NA` if any values are missing. Adding `na.rm = TRUE` removes missing values before calculating.

5 Learning R: Histograms

Histograms show the distribution of data.




```
hist(tmax_trends, breaks = 20, col = "coral",
     main = "Distribution of Annual TMAX Trends",
     xlab = "Trend (C/century)")
abline(v = 0, col = "gray", lty = 2)
abline(v = mean(tmax_trends, na.rm = TRUE), col = "red", lwd = 2)
```

6 Learning R: Linear Regression

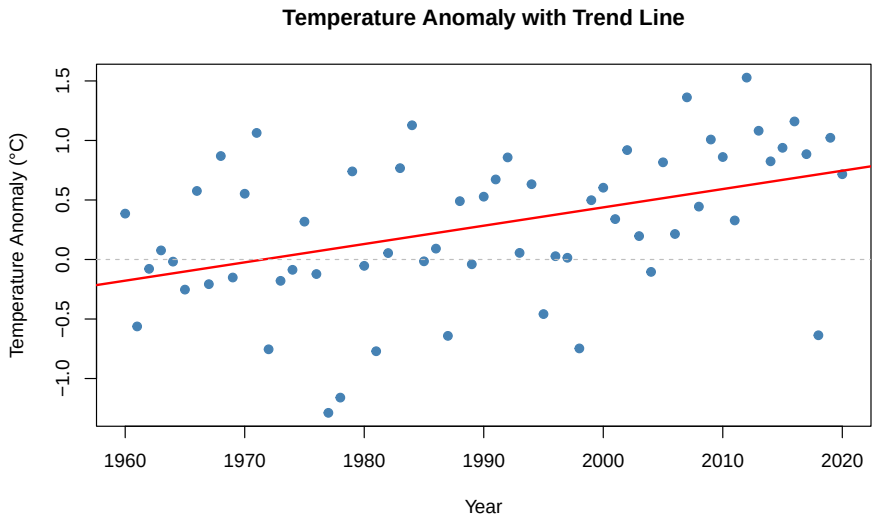
Linear regression finds the best-fit line: $y = a + bx$

```
## Linear Regression Results:
##                 Estimate  Std. Error   t value     Pr(>|t|)
## (Intercept) -30.35504722 8.250718385 -3.679079 0.0005083376
## YEAR          0.01539644 0.004145927  3.713631 0.0004552597
##
## Trend: 1.54 C/century
## p-value: 0.000455
## R-squared: 0.189
```

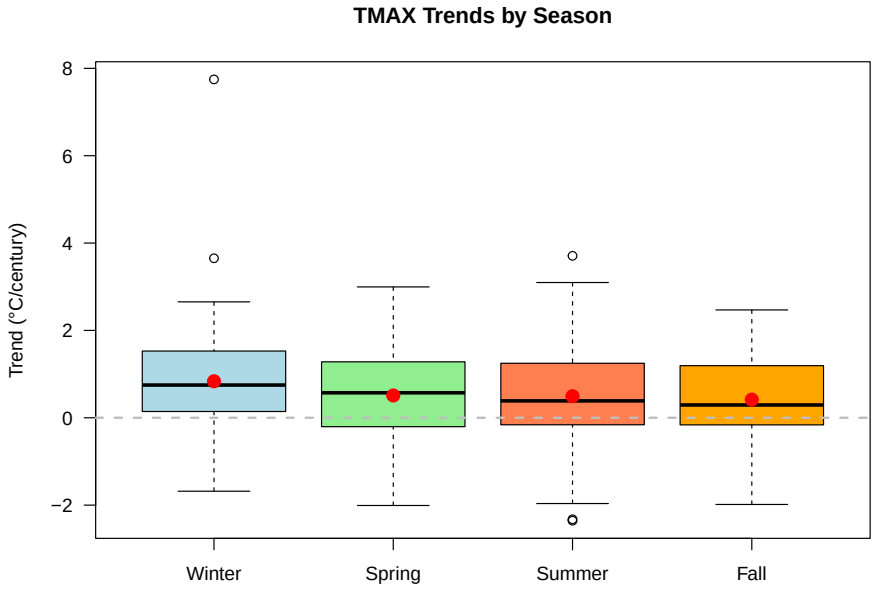
```
# Fit linear model
model <- lm(ANOMALY ~ YEAR, data = demo_data)

# Get summary
summary(model)

# Extract slope (trend per year)
coef(model)[2]

# Convert to per century
coef(model)[2] * 100
```

Understanding p-values:

- $p < 0.05$: Statistically significant
- $p < 0.01$: Highly significant
- $p < 0.001$: Very highly significant

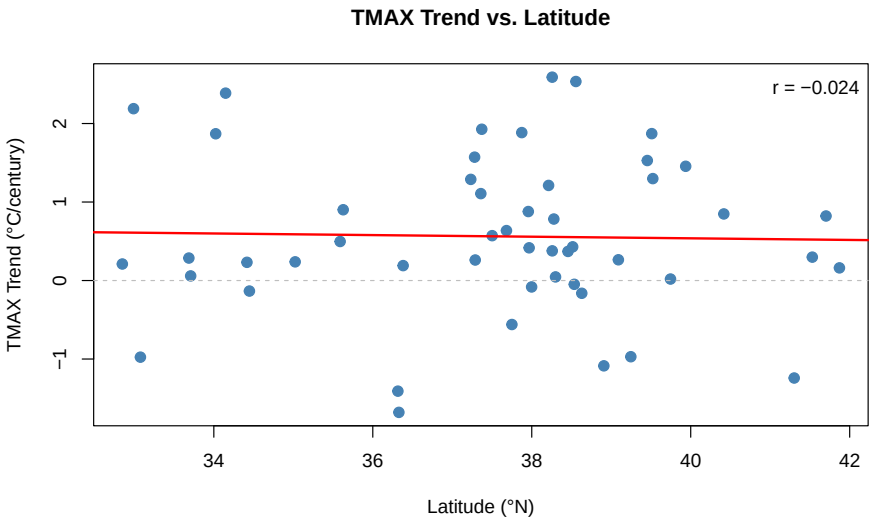


7 Seasonal Comparison

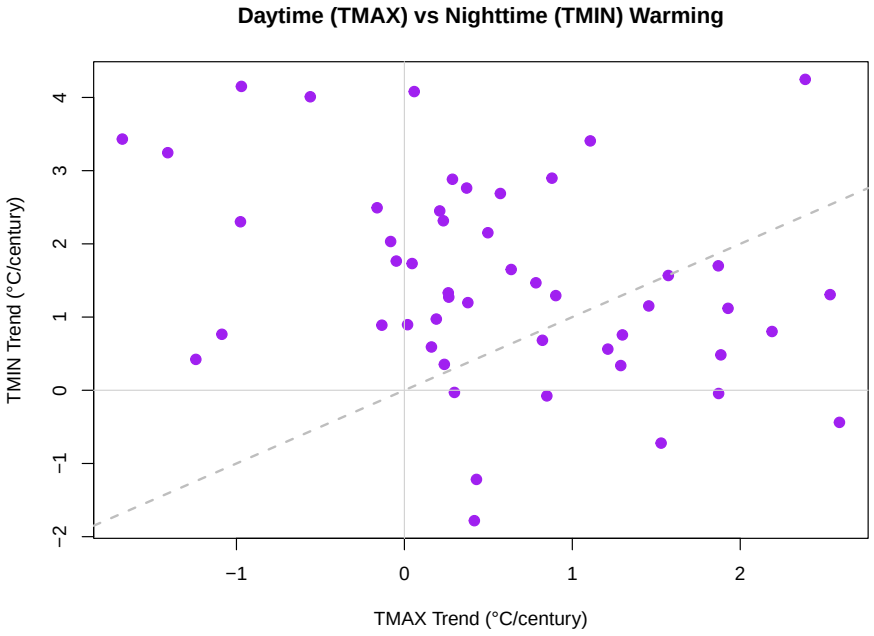



```
seasonal_data <- data.frame(
  Winter = all_station_trends$winter_trend_TMAX,
  Spring = all_station_trends$spring_trend_TMAX,
  Summer = all_station_trends$summer_trend_TMAX,
  Fall = all_station_trends$fall_trend_TMAX
)

boxplot(seasonal_data, col = c("lightblue", "lightgreen", "coral", "orange"),
        main = "TMAX Trends by Season", ylab = "Trend (C/century)")
```

8 Geographic Patterns



9 TMAX vs TMIN Comparison



```
##
## ============================================================
## DAYTIME vs NIGHTTIME WARMING
## ============================================================
## Mean TMAX trend: 0.56 C/century
## Mean TMIN trend: 1.49 C/century
## Correlation:     -0.309
## ============================================================
```

10 Key Findings Summary

```
## ============================================================
##               KEY FINDINGS SUMMARY
## ============================================================
## State: CA | Stations: 50
## ------------------------------------------------------------
## ANNUAL TRENDS:
##   TMAX: +0.56 C/century
##   TMIN: +1.49 C/century
##   PRCP: -3.3 mm/century
## ------------------------------------------------------------
## Stations warming: 39 / 50 (78%)
## ============================================================
```

11 Lab 2 Summary: R Concepts Learned

1. **Summary Statistics:** `mean()`, `median()`, `sd()`, `summary()`
2. **Histograms:** `hist()`, `breaks`, `abline()`
3. **Linear Regression:** `lm()`, `coef()`, `summary()`
4. **Statistical Concepts:** p-value, R, correlation
5. **Boxplots:** Comparing distributions across groups

12 Next Steps

Lab 3: Create spatial heat maps, visualize regional patterns, generate publication-quality figures.