# Lesson Plan: Analyzing Trends and Calculating Uncertainty using Hurricane Data Records

As an **undergraduate Statistics** teacher, you can use this set of computer-based tools to help you in teaching statistical analysis topics such as **trends**, **uncertainty**, **confidence interval**, and **student's t-distribution**.

As an **undergraduate Geography** or **Earth Sciences** teacher, you can use this set of computer-based tools to help you in teaching **disasters**, **hurricanes**, **the possible impact of climate change on hurricanes**, and the analysis of **trends in hurricane intensity**.

This lesson plan allows your students to perform statistical analysis and interpretation of data (specifically, analyzing trends and determining uncertainty) by using hurricane data records. In the activity, students will explore possible trends in hurricane intensity and number over the past 40 years, and will investigate a possible link between climate change and hurricane strength.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in Statistics, Geography, or Earth Sciences.

Use this lesson plan to help your students find answers to:

- *Is there an increase in the frequency of major hurricanes over the past few decades?*
- *Calculate the trend and determine the confidence interval for the frequency of hurricanes in the Atlantic Ocean from past records.*
- *Calculate the trend and evaluate the uncertainty for the intensity of hurricanes.*
- *What are the possible effects of climate change on the intensity and number of tropical cyclones/hurricanes?*

## About the Lesson Plan

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| **Grade Level** | Undergraduate |
| **Discipline** | Statistics, Geography, Earth Sciences |
| **Topic(s) in Discipline** | Statistics: Inferential Statistics, Trend Analysis, Uncertainty, Confidence Interval, Student's t-Distribution<br><br>Geography, Earth Sciences: Disasters, Hazards, Hurricanes, Storms, Oceanography, Trends in Hurricane Intensity |
| **Climate Topic** | Disasters and Hazards |
| **Location** | Global (data in the activity is for the Atlantic Ocean) |
| **Access** | Online, Offline |
| **Language(s)** | English |
| **Approximate Time Required** | 100 min |

# 1 Contents

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| **1. Micro-lecture (video) (~9 min)** | A micro-lecture (video) that introduces the topic of confidence interval.<br><br>https://www.coursera.org/learn/hypothesis-testing-confidence-intervals/lecture/cpecc/introducing-confidence-interval |
| **2. Micro-lecture (video) (~8 min)** | A micro-lecture (video) that introduces the topic of t-distribution.<br><br>https://www.coursera.org/learn/inferential-statistics-intro/lecture/FlRrd/t-distribution |
| **3. Classroom/Laboratory activity (~60 min)** | A classroom/laboratory activity to calculate trends and uncertainties in hurricane intensity by analyzing hurricane data records over 40 years.<br><br>https://serc.carleton.edu/NAGTWorkshops/hurricanes/activities/28276.html |
| **4. Reading (~10 min)** | A reading on changes in hurricane activity.<br><br>https://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes |
| **5. Suggested questions/assignments for learning evaluation** | • *Is there an increase in the frequency of major hurricanes over the past few decades?*<br>• *Calculate the trend and determine the confidence interval for the frequency of hurricanes in the Atlantic Ocean from past records.*<br>• *Calculate the trend and evaluate the uncertainty for the intensity of hurricanes.*<br>• *What are the possible effects of climate change on the intensity and number of tropical cyclones/hurricanes?* |

# 2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

**1. Introduce the topics through micro-lectures (videos)**

- Introduce the topic of trends and confidence intervals.
- Play this micro-lecture (video) (approx. 9 min), "Introducing Confidence Interval", to explain confidence intervals.

  The micro-lecture "Introducing Confidence Interval", from Rice University on Coursera, is available at https://www.coursera.org/learn/hypothesis-testing-confidence-intervals/lecture/cpecc/introducing-confidence-interval.

- Explain t-distribution with the help of another micro-lecture (video) (approx. 8 min), "t-distribution".

  The micro-lecture "t-distribution", from Duke University on Coursera, is available at https://www.coursera.org/learn/inferential-statistics-intro/lecture/FlRrd/t-distribution.

**2. Conduct a classroom/laboratory activity**

Next, explore the topics in more detail through a hands-on classroom/laboratory activity, "Is There a Trend in Hurricane Intensity?"

This activity will help your students determine trends, uncertainties, and confidence intervals by analyzing actual hurricane data records for the Atlantic Ocean over a period of 40 years. They will also discuss the potential link between climate change and hurricane intensity.

- Download the documents (teaching material and tips) for the activity from https://serc.carleton.edu/NAGTWorkshops/hurricanes/activities/28276.html.

- Conduct the activities and assignments described in the teaching material (analysis and interpretation of actual data by using MS Excel).

**3. Discuss using a reading**

Then, read the article, "Changes in Hurricanes", to discuss the changes in hurricane activity and climate-related factors that may affect hurricane development.

The article "Changes in Hurricanes" from GlobalChange.gov, is available at https://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes.

**4. Questions/Assignments**

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- *Is there an increase in the frequency of major hurricanes over the past few decades?*
- *Calculate the trend and determine the confidence interval for the frequency of hurricanes in the Atlantic Ocean from past records.*
- *Calculate the trend and evaluate the uncertainty for the intensity of hurricanes.*
- *What are the possible effects of climate change on the intensity and number of tropical cyclones/hurricanes?*

# 3 Learning Outcomes

The tools in this lesson plan will enable students to:

- calculate trends in data
- determine uncertainty and evaluate confidence in trends
- discuss the possible impacts of climate change on the intensity and number of hurricanes

# 4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. **Reading**

A reading, “Hurricanes and Climate Change”, from the Center for Climate and Energy Solutions:

https://www.c2es.org/content/hurricanes-and-climate-change/

# 5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

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| **1. Micro-lecture (video), "Introducing Confidence Interval"** | "Business Applications of Hypothesis Testing and Confidence Interval Estimation" course by Rice University on Coursera |
| **2. Micro-lecture (video), "t-distribution"** | "Inferential Statistics" course by Duke University on Coursera |
| **3. Classroom/Laboratory activity, "Is There a Trend in Hurricane Intensity?"** | Teach the Earth portal at SERC Carleton |
| **4. Reading, "Changes in Hurricanes"** | GlobalChange.gov |
| **5. Additional Resources** | The Center for Climate and Energy Solutions (C2ES) |