

Analyzing Air Quality Anomalies: A Focus on PM2.5 Levels

DSAN5550

Zeju Li

Proposal

Introduction

The impact of climate change is leading to an increase in air pollution, which poses a significant threat to public health, ecosystems, and economic stability worldwide. One of the most concerning air pollutants is Particulate Matter 2.5 (PM2.5), which can penetrate deeply into the respiratory system and cause severe health issues. Our research aims to investigate the complex relationship between PM2.5 concentrations and the broader dynamics of climate change and urbanization. By linking PM2.5 emissions (often caused by the burning of fossil fuels, a primary cause of climate change) to air quality degradation, our study seeks to identify patterns of air quality anomalies. We will analyze these patterns across various climatic regions and urban settings to gain a comprehensive understanding of how global phenomena impact PM2.5 levels.

Problem Definition

The purpose of this study is to identify and classify the anomalies in air quality that are directly linked to PM2.5 concentrations in various environmental and urban settings. The study focuses on the effects of climate change on air quality. PM2.5 is a significant pollutant and a byproduct of activities that contribute to climate change, such as the burning of fossil fuels. The research aims to accurately discern and categorize the variations in air quality due to changes in PM2.5 levels. This is important for developing strategies to combat the health risks associated with PM2.5 exposure. The study is vital for guiding the development of environmentally conscious policies and urban planning initiatives that aim to improve public health outcomes in the face of climate change and urban expansion.

Data Collection and Refinement

The research will use the Global Weather Repository as the base data, which will be enhanced by adding detailed PM2.5 measurements and climatic variables gathered from various locations worldwide. Additionally, urbanization metrics from the 2023 World Country Dataset, such as population density, urban population percentage, and levels of industrial activity, will be incorporated to evaluate their impact on PM2.5 concentrations. These urban factors play a crucial role because high population densities and increased industrial activities are usually associated with higher particulate matter emissions.

The first phase of the research will involve a thorough standardization and cleaning process to ensure that the data is reliable, accurate, and consistent. This process will include

identifying and rectifying any outliers and potential anomalies, using both statistical and machine learning techniques to ensure that the dataset is robust enough for subsequent analysis.

Implementation

For predictive modeling, advanced machine learning models such as Decision Trees, Random Forests, and Neural Networks will be utilized. An innovative approach will be employed using an ensemble method, such as a stacked classifier, to combine the predictions from these models. This strategy aims to take advantage of the unique strengths of each model, improving the overall accuracy and reliability of the air quality classification, particularly in identifying the effects of climate change on PM2.5 levels.

Evaluation and Carbon Emissions Measurement

Model performance evaluation will go beyond the usual metrics like MSE values. It will include an in-depth analysis of the importance of features to understand the primary factors influencing PM2.5 concentrations. To adhere to our commitment to sustainable research practices, we will meticulously measure the carbon emissions of computational models using tools like CodeCarbon. This effort reflects our dedication to balancing methodological rigor with environmental stewardship.

This research aims to provide valuable insights into the complex relationship between PM2.5 concentrations and climate change. It will make significant contributions to the fields of environmental policy, public health, and urban planning. By clarifying the factors driving PM2.5 fluctuations and categorizing air quality in the context of climate change, the study advocates for informed and sustainable approaches to air quality management. This is especially important in an era marked by climatic and urban challenges.