

## **Abstract**

Typical air quality time series consist of consecutive hourly averages of concentrations of gaseous pollutants or composition of airborne particles. More often time series of concentrations of particulate species are 24-hour averages observed every third or sixth day. Time series may give us important information about sources of pollutants. For instance, seven-day and monthly cycles are mostly associated with anthropogenic sources and can be analyzed to study the anthropogenic cycles and their variation within time. Moreover, species with the same periodicity might be related to the same sources and can be characterized based on their periodic behavior.

The fast Fourier transform (FFT) is an efficient means to computationally calculate the discrete Fourier transform (DFT). However, the FFT requires equally spaced data, which means there can be no missing observations. A few isolated missing points can be filled in by interpolation, but, air quality data often has long runs of missing data that cannot be replaced by interpolated values in any reasonable manner. Thus, the FFT cannot usually be applied to air quality data, and that perhaps explains why there have been very few reports in the literature of Fourier methods applied to air quality time series.

It is well known that air quality time series exhibit seasonal, weekly, and daily periodicities; therefore, identifying the periodicities is not the main goal of this study. The primary purpose of this research is to show how the Fourier transform and the periodogram can be used to quantitatively characterize and classify the periodicities in time series of air pollutants.

In this research several methods of addressing the problem of missing or irregularly spaced data are developed and applied to analyze air quality data such as Lomb periodogram, least square fitting, Schuster periodogram mean-gapping, sliding window Fourier transform, and Lomb estimation of the discrete Fourier transform.

As the conclusion, the Lomb periodogram is an appropriate tool when there are many missing values and long gaps in the data, and when the sampling time is irregular or random; otherwise, the Schuster periodogram mean-gapping would be a reasonable method to apply, and would provide the same result as Lomb method. It has to be emphasized that detecting peaks in spectral analysis of unequally spaced data requires cautious concern, and for this reason several procedures are discussed and a modified computer code is developed, which could be applied for our specific needs in air quality analysis.