# Assessment of change

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Abstract

The following describes how to carry out a statistical assessment of change in air quality based on long-term monitoring data. It presents a statistical method for quantification of change in outdoor air quality and demonstrates its use.

Key Phrases Air pollution change, air quality, change assessment, environmental monitoring.

Key Words Sulfate, acidity, monitoring, change.

Introduction

The decision if a change in a long series of data occurred is, sometimes, more important than the absolute value of the change. The ways to decide about significance of such a change are many. One possibility is to use a two-way ANOVA table, as we illustrate next on a decade of Teflon sulfate concentrations collected weekly at the Vincennes station, Indiana, USA.
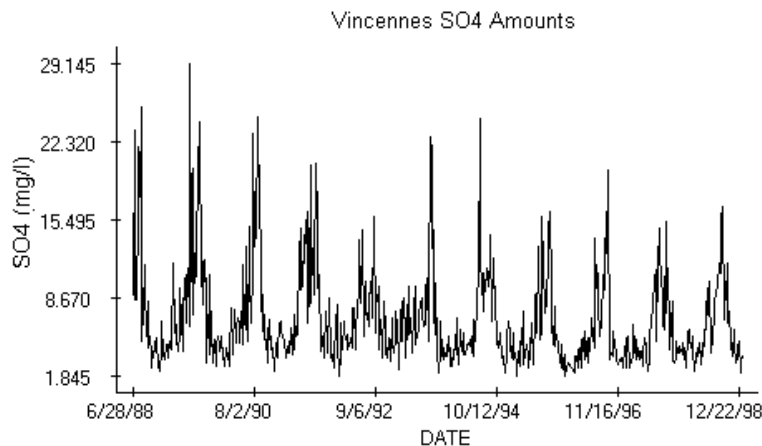
Model

The data from the station plotted against time indicate an annual periodicity with a seemingly high variability over the summer time. The Scheffe's test applied to the data in post-hoc analysis marks a significant difference between the first year of sampling, 1989, and years 1995, 1996 when a trend reversal occurred.
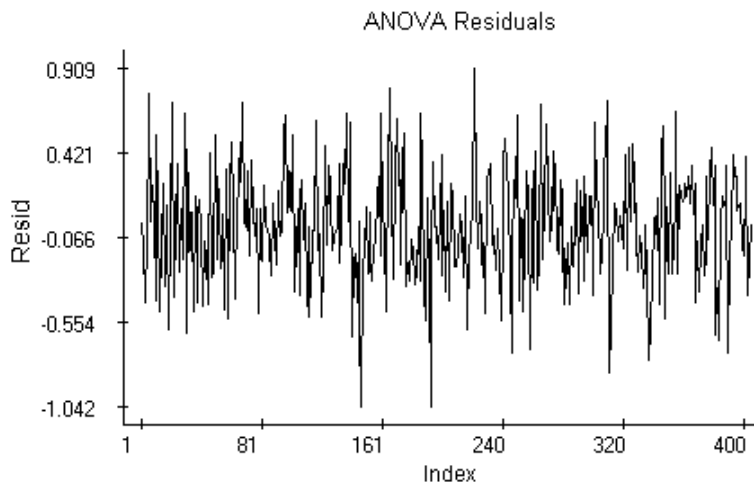

Normality

The quantile plot indicates that the same Normal distribution might generate the residuals.

Quantile Plot
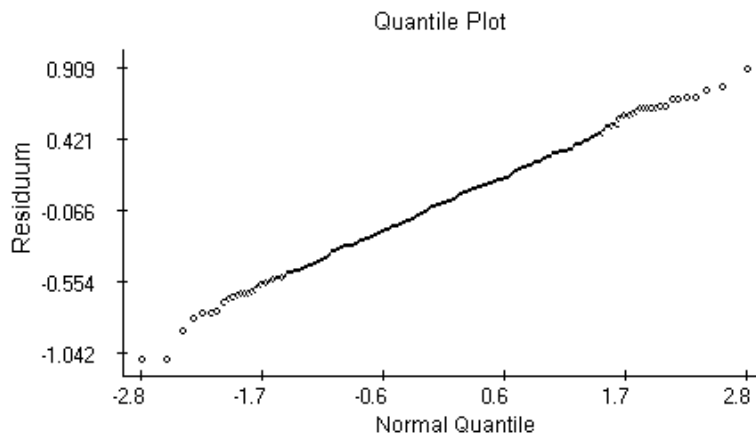
Autocorrelation

The partial autocorrelation plot admits the possibility that the data are independent. The systematically negative values in the second part of the plot could mean that the trend has not been eliminated entirely.

Partial Autocorrelation Plot

3
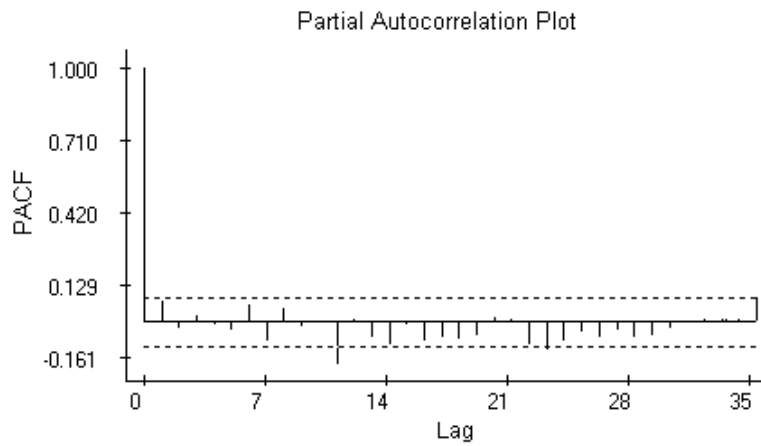
Testing

The Kolmogorov-Smirnov test does not reject the null hypothesis about Normal distribution of the residuals and the first two autocorrelations do not test as significant. Annual averages of the logarithms exhibit a decline till 1995, when the trend starts to increase again. The Scheffe's test points out the highest and lowest values in the plot as significant.
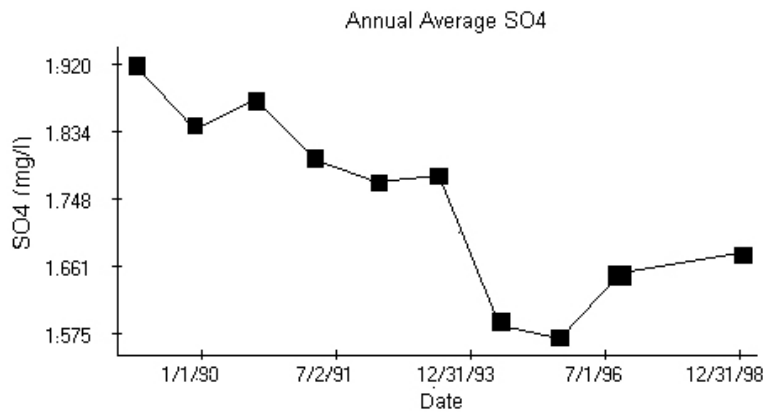
Limitations

The presented method has two serious limitations. It does not admit missing observations, something rather common for air quality data. The missing data must be thus estimated before the above analysis takes place. It cannot be applied to irregularly sampled data. That makes it of no use for assessment of changes in precipitation acidity, for example.

Data

The data used in the example are (in different units) available at the EPA's CASTNet web site http://www.epa.gov/castnet/data.

4

References

J. Mohapl: Assessment of changes in pollutant concentrations. *Environmental Monitoring & Assessment*, pp. 111-200, Handbook of Environmental Monitoring, edited by Prof. Bruce Wiersma and published by CRC Press, 2004.

J. Mohapl: A statistical assessment of changes in precipitation chemistry at CAPMoN sites, Canada. *Environmental Monitoring & Assessment*, pp. 1 - 35, 72, 2001.