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Nonlinear dynamics of the atmospheric pollutants in Mexico City

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The atmospheric pollution in the Metropolitan Zone of Mexico City (MZMC) is a serious problem with social, economical and political consequences, in virtue that it is the region which concentrates both the greatest country population and a great part of commercial and industrial activities. According to the World Health Organization, maximum permissible concentrations of atmospheric pollutants are exceeded frequently. In the MZMC, the environmental monitoring has been limited to criteria pollutants, named in this way due to when their levels are measured in the atmosphere, they indicate in a precise way the air quality. The Automatic Atmospheric Monitoring Network monitors and registers the values of pollutants concentration in air in the MZMC. Actually, it is integrated by approximately 35 automatic-equipped remote stations, which report an every-hour register.
Local and global invariant quantities have been widely used to describe the fractal properties of diverse time series. In the study of certain time series, many times it is assumed that they are monofractal, which means that they can be described only with one fractal dimension. But this hypothesis is unrealistic because a lot of time series are heterogeneous and non stationary, so their scaling properties are not the same throughout time and therefore they may require more fractal dimensions for their description.
Complexity of the atmospheric pollutants dynamics suggests us to analyze its time series of hourly concentration registers with the multifractal formalism. So, in this work, air concentration time series of MZMC criteria pollutants were studied with the proposed method. The chosen pollutants to perform this analysis are ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide and PM10 (particles less than 10 micrometers). We found that pollutants air concentration time series are multifractal. When we calculate the degree of multifractality for each time series we know that while more multifractal are the time series, there is more complexity both in the time series and in the system from which the measurements were obtained. We studied the variation of the degree of multifractality over time, by calculating the multifractal spectra of the time series for each year; we see the variation in each monitoring station from 1990 until 2013. Multifractal analysis can tell us what kinds of correlations are present in the time series, and it is interesting to consider how these correlations vary over time. Our results show that for all the pollutants and all the monitoring stations the time series have long range correlations and they are highly persistent.