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Spatial and temporal variations of an atmospheric pollutant in an urban area

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Air quality is a major concern in big cities. This problem has lead administrations to introduce plans and regulations to reduce pollutants emissions. The analysis of long-term variations in pollutants concentration is useful to evaluate if these plans are effective. This analysis can not be done however with standard statistical techniques as atmospheric pollutants concentrations often exhibit lack of normality and are autocorrelated. The application of a linear model to transformed data is considered. To take into account the serial dependence of the residuals of this model, the generalized least-squares estimation method is proposed. The use of the model is illustrated with monthly carbon monoxide (CO) concentrations observed by a ground level monitoring network in an urban area. The sampling sites are located in street intersections in downtown Valencia (Spain) or close to motorways access. The estimation of the linear model yields a significant decrease every twelve months over the average monthly CO concentration. The seasonal cycle also results significant. This cycle depends on the emission rate and meteorological variations. There are not differences in trends across months. The spatial random component is estimated from the appropriately de-trended data. Geostatistical techniques are used to analyze this component. The spatial variation is described using a semivariogram. A exponential model was chosen by visual inspection of the empirical semivariogram versus geographical distance. The application of a kriging interpolation technique provides estimation of the spatial stochastic component at any monitored or potentially monitored location. The temporal and spatial components can be used to predict CO concentrations. The accuracy of the prediction is estimated using the variance of the temporal and spatial interpolation. This technique captures the main features of the empirical field and is satisfactory in terms of the prediction error.