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Variability of NO, NO_2, O_3, SO_2 and toluene measured with a DOAS system at Puertollano (Spain).

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During the period of February 2002 to August 2003, NO, NO_2, O_3, SO_2 and toluene concentrations were measured in the industrial city of Puertollano (in central Spain) using the differential optical absorption spectroscopy technique (DOAS). A commercial DOAS system (OPSIS, model AR 500) was employed to simultaneously monitor the gas concentration of the above mentioned gases, integrated along a light path of 200 m. The system used in this study consists of an emitter (EM 150) and receiver (RE 150) in combination with the AR 500 analyzer. The emitter was located on the flat roof of the Sta. Bárbara Hospital, about 17 m height above the ground, and the receiver system was installed 16 m above street level, all this situated in the north of town.

Puertollano is a very important industrial area with some 51,000 inhabitants and is located in the heart of La-Mancha region in central-southern Spain (38˚42'N 04˚07'W, at approximately 543m above sea level) in a fairly flat area, 240 km south of Madrid. The presence of a petrochemical pole, situated about 5 km southeast from the center of town, would be an important source of air pollution in this city. The existent industry include refinery, chemical industry, two power plants and coal minery. Meteorologically, it has very hot and sunny weather during summer, dry and cold winters, with very low wind speed throughout the year in addition to frequent temperature in-

versions. These conditions will play a crucial role in the evolution and transformation of the polluting agents. From hourly data have been analysed the levels that shows these pollutants and the monthly and daily evolution.

The maximum hourly concentration are high in the case of NO_2, ozone, SO_2 and toluene with maximum higher 65 μg m^{-3}, 200 μg m^{-3}, 150 μg m^{-3} and 22 μg m^{-3} respectively. While the mean value of these pollutants series are: 11.1$\pm$0.2 μg m^{-3} for NO, 19.9$\pm$0.2 μg m^{-3} for NO_2, 109.9$\pm$0.3 μg m^{-3} for O_3, 24.1$\pm$0.7 μg m^{-3} for SO_2 and 11.2$\pm$0.1 μg m^{-3} for toluene (the σ indicate the mean standard deviation).

The five pollutants measured present both monthly and daily evolutions but with different characteristics. The primary pollutants such as NO and NO_2 show higher monthly levels in winter months (December and January) while the lower concentrations are registered in summertime (June and July). The cause of this behaviour could be in the meteorological conditions, high atmospheric stability in winter favours the accumulation in the lower troposphere, however in summer the concentrations are lower due mainly to a major participation in the photochemical mechanism. The monthly ozone concentrations present high levels in summer, due to meteorological conditions that favour their formation (anticyclonic conditions, high level radiation and temperature, formation of residual layers, among others). In addition, the monthly ozone cycle is not very marked, with levels high during all year. The SO_2 and toluene do not present a clear seasonal cycle. The higher SO_2 concentrations were measured during the early months, but from May it shows a decrease trend, since is also a primary pollutant could be favour this behaviour for the meteorological conditions characterised for atmospheric stability and no so much dispersion. Similar behaviour shows the toluene, but with lower values and a less marked monthly evolution.

Respect to daily evolution has been studied the seasonal daily cycles of the five air pollutants. In the nocturnal period, in general the concentrations remain constants or with decrease tendency as the ozone concentration. From the 7:00 h (local time) the NO, NO_2 and toluene concentrations start to increase, reach the daily maximum to 8:00-9:00 h, which coincide with a daily minimum of ozone.

While the studied area is a typical industrial zone and the traffic emissions is not the main source of emissions, the behaviour that presents the pollutants will be due to the atmospheric conditions. Thus, the rupture of the inversion layer could favour the vertical mixed and the possible down of the pollutants from residual layers.

The NO removes the ozone causing the minimum daily. With a major solar radiation is increasing the mixed layer depth and the photochemical activity. The ozone maximum occurs between 12:00 to 19:00 h and coincide with the NO, NO_2 and toluene minimum.

From 20:00 h there is a decrease in the ozone concentration and a secondary maximum of NO, NO_2, while the toluene remains with constant levels. The SO_2 since no participate in the photochemical cycle present higher concentrations to 11:00-12:00 h.

At current, the observations with the DOAS system continue in this zone with the aim to determinate the causes that originate the pollutants events or the high ozone concentrations measured during all the year.