10.2. Monitoring of atmospheric pollutans

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Abstract

The monitoring results of SO_2, O_3, and NO_2 concentrations in Sierra Nevada are presented in comparison with data from the urban station of the city of Granada (Granada-Norte) available on EIONET. For the data collected in Sierra Nevada, a downward trend for NH_3, O_3 and SO_2 was detected, whereas a stabilization of NO2 was observed. Great differences are measured in NO_2 and SO_2 between Granada and Sierra Nevada. Following the concentration modelling of each contaminant, a projection was made. In general, although with the available data it is difficult to make a reliable prediction over the long term, the concentration of contaminants will foreseeably continue within the detected trend.

Aims and methodology

In the light of potential negative effects of certain pollutants on natural ecosystems, a protocol has been put into practice to monitor air quality in Sierra Nevada.

The concentrations of four atmospheric pollutants were recorded from 2008 to 2013 at three different points by passive dosimeters. Previous data are available for the period 2001-2004 as well as data on the concentrations of three pollutants at a station in the city of Granada (accesible at: www.eionet.europa.eu). Prior to the analysis, the series were homogenised. The collector was replaced every 14 and 15 days for the period 2001-2004 and 2008-2013 respectively. The station in Granada city registered the concentration measurements every hour.

After the data homogenisation, the averages of the concentrations in the city of Granada were calculated for the same time interval in which the collectors were installed in Sierra Nevada.

When the two data series (2001-2004 and 2008-2013) were defined, several analysis methods were used: linear regression, simple smoothing, double smoothing, Stl (*Seasonal and Trend decomposition using Loess*), Holt-Winters smoothing, and ARIMA. All these techniques are available in TSA packages [5], tseries [6], and forecast [7] of the statistical program R.

Results

The comparative analysis of the distribution of the concentrations (Figure 2) shows high concentrations of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) in the city of Granada in relation to any point in Sierra Nevada, while the concentrations of ozone (O_3) show an inverse pattern, with minimal differences between the city and Sierra Nevada. The European normative considers ozone concentrations higher than 40 ppb (parts per billion) to be harmful to plants, this known as the AOT index [8-9].

Ammonia (NH_3) concentrations are similar in the three points analysed in Sierra Nevada (Figure 2). This gas is related to primary human activities (livestock and agriculture). There are no data available for this gas in the city of Granada.

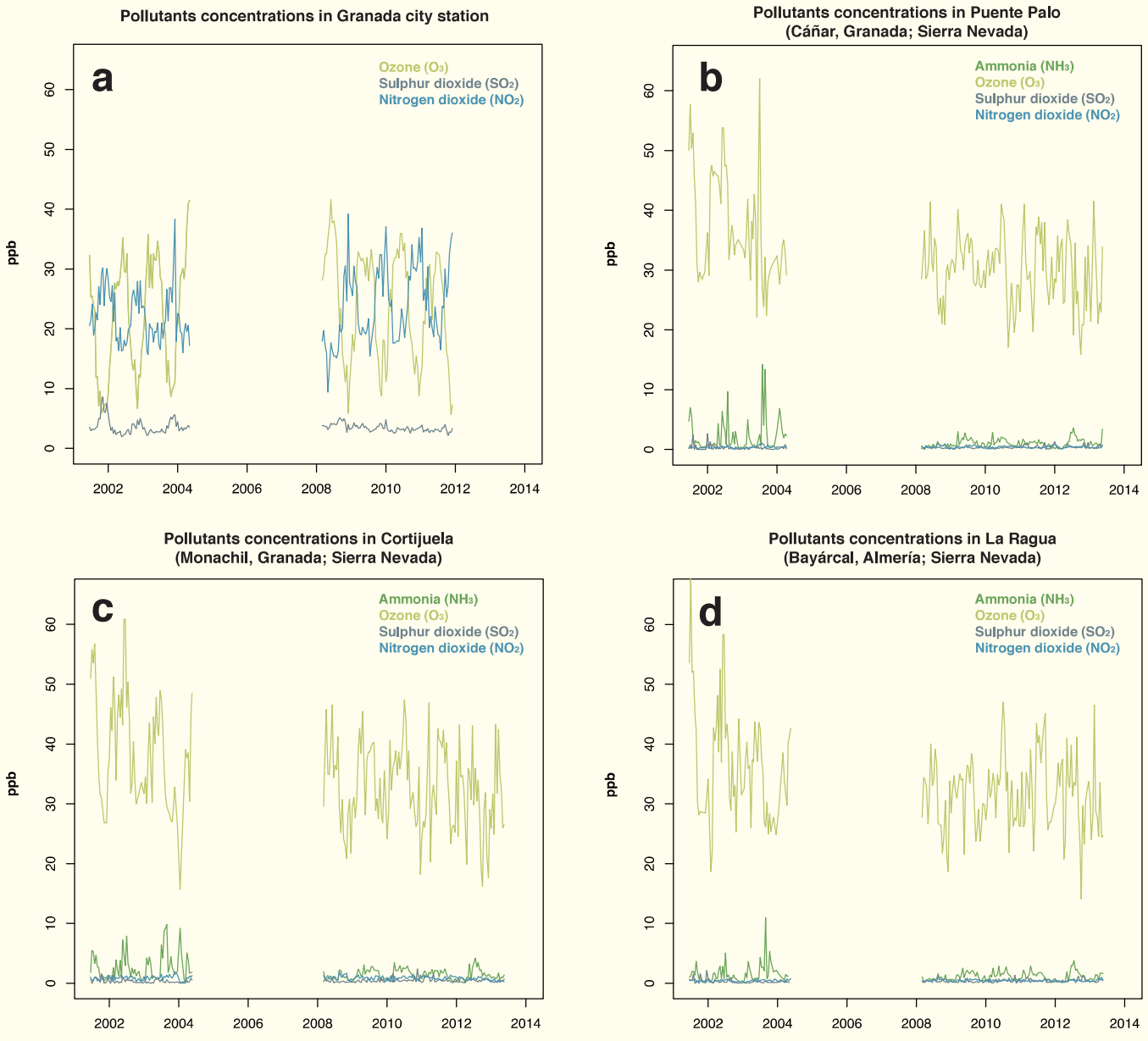
The difference between the two series (Figure 3) indicates some temporal changes. In general, the concentrations decreased but the relative differencesamong measuring points remain. Concretely, NO_2 concentration slightly increased in the city of Granada, but did not significantly change in Sierra Nevada.

Ammonia, as well as ozone concentration, decreased in Sierra Nevada. Nevertheless, ozone remained relatively stable in Granada.

Finally, the SO_2 concentration rose slightly at the three points in Sierra Nevada, but kept the same range of values in Granada.

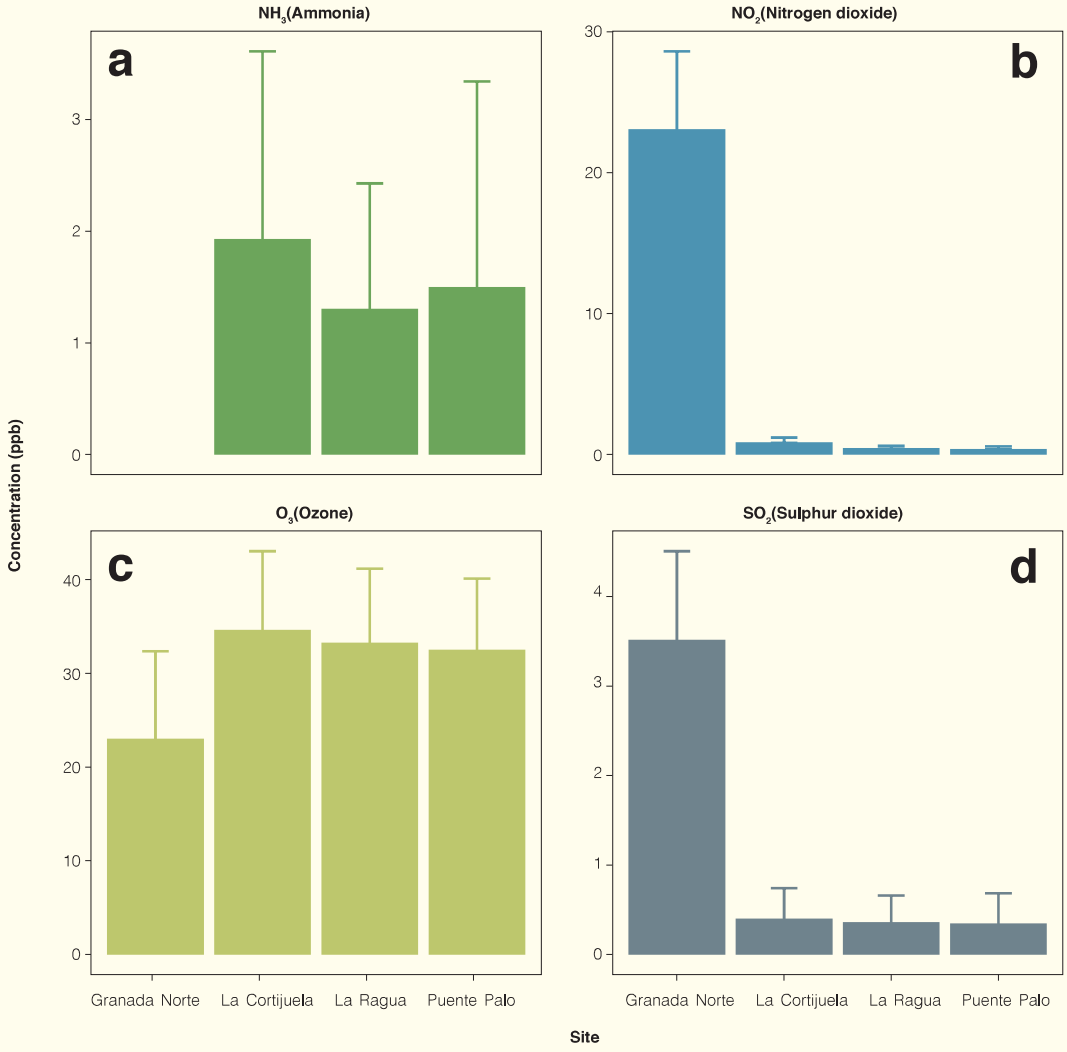
The available data are not sufficient to reliably predict future trends in the pollutants concentrations, especially without knowing the emission rate of the sources of each contaminant. Nevertheless, the results of the projections indicate (Figure 4) that most have remained stationary, with a certain trend to decline in recent years (2012 and 2013).

Figure 1



Concentrations (in ppb) of each contaminant at 4 sites through time. a) Urban station of Granada; b) Puente Palo (Cáñar, Granada), pine and oak forests; c) La Cortijuela Botanic Garden, pine forest; d) La Ragua, pine forests and spiny broom thickets.

Figure 2



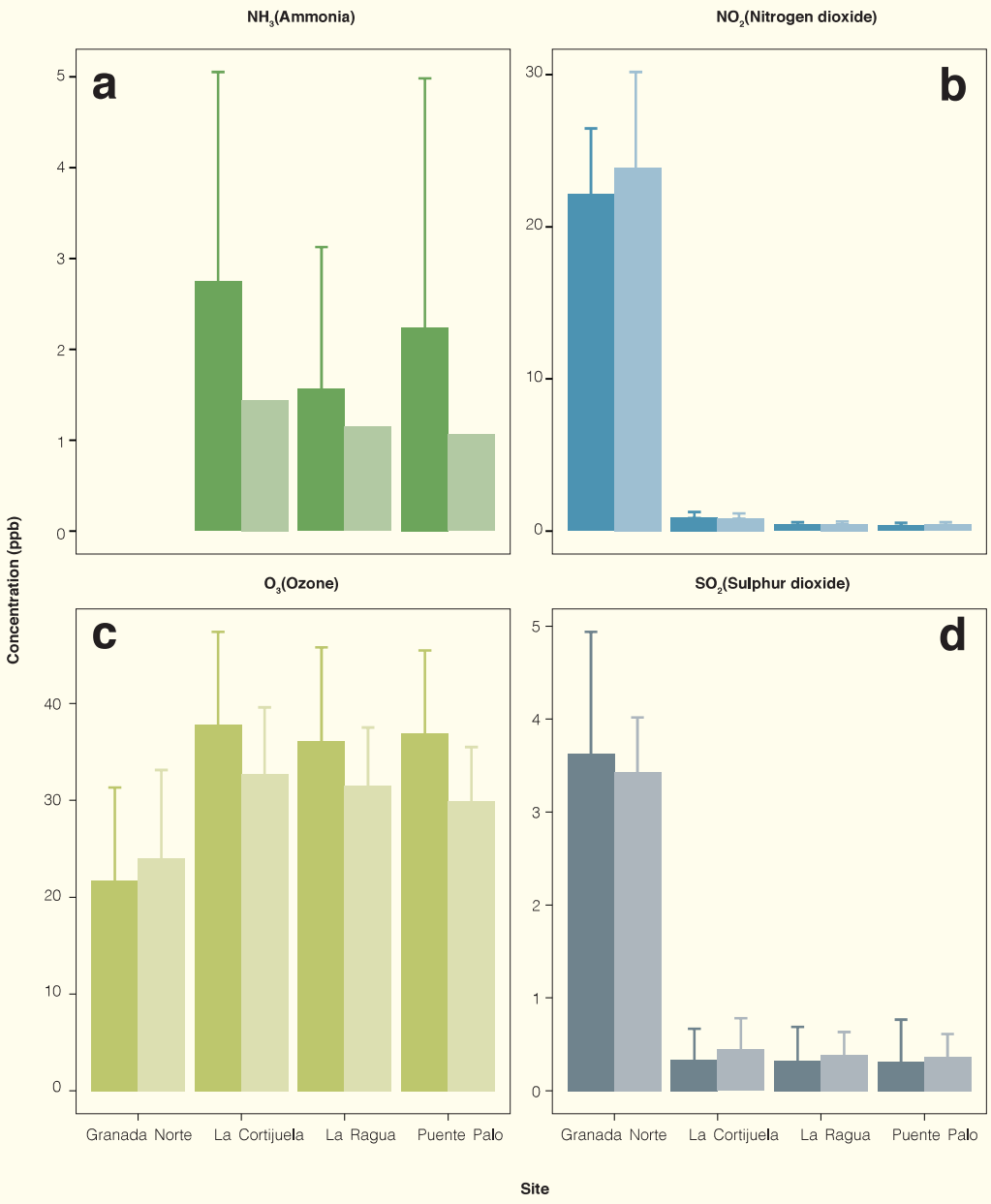
Distribution of concentrations (in ppb) of each contaminant during the period 2001-2013. a) Ammonia gas. No data are available for the city of Granada; b) Sulphur dioxide; c) ozone; and d) nitrogen dioxide.

Discussion and conclusions

The comparative analysis confirmed that there is a great difference in contamination levels between Sierra Nevada Protected Area and the urban agglomeration of Granada, mainly in SO_2 and NO_2 concentrations.

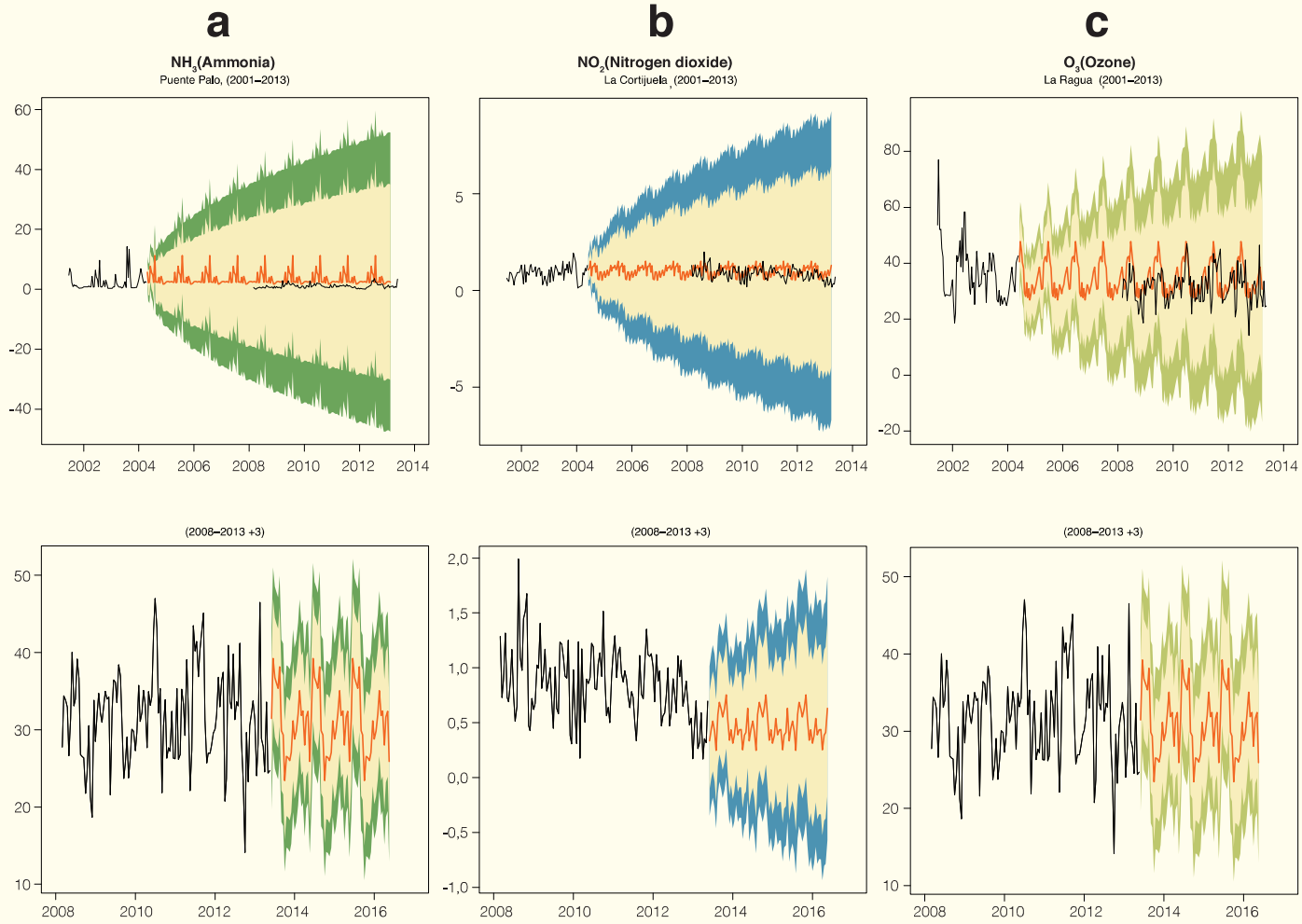
A decline was detected in the NH_3 and O_3 concentrations as well as a rise in the SO_2 and NO_2 concentrations in Sierra Nevada. There are not yet enough data to make a reliable forecast, although most pollutants seem to follow a stationary trend with a slight tendency to diminish at present.

Figure 3



Comparison of the distribution of concentrations (in ppb) of each contaminant for the 2 time series (2001-2004 and 2008-2013).

Figure 4



Three examples of superposition between the real values and the forecast for the next following years according to the current time course of the concentrations of ammonia (a), nitrogen dioxide (b), and ozone (c).