Measured PM_{10} concentrations in Gibraltar in 2006 - removal of the natural component

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A report to the Gibraltar Environmental Agency

ED48335
Issue 01
September 2008

Introduction

- The first Daughter Directive (Article 5 section 4) specifies that a Member State is obliged to implement action plans *only* where the limit values are exceeded due to causes other than natural events. Where natural events result in concentrations significantly in excess of normal background levels from natural sources, Member States are required to inform the Commission, providing the necessary justification to demonstrate that these exceedences are due to natural events.

- Gibraltar's monitoring campaign in 2006 reported 60 exceedences of the daily mean limit value of 50 μg m^{-3}, of which no more than 35 exceedences are permissible, as specified in the first Daughter Directive (1999/30/EC). A significant contribution to daily exceedences measured in Gibraltar is from naturally occurring African dust due to Gibraltar's location and proximity to northern Africa, in particular to the Sahara desert.

- This document presents analysis and details the methodology used to demonstrate that, in the absence of natural African dust events in 2006, Gibraltar met the daily limit value for PM_{10}.

Methodology

- The Spanish authorities have, for the preparation of mandatory reporting to the Commission for Spain for 2006, identified days in 2006 on which regional background sites were significantly affected by African dust (Querol, X., 2007[1]), referred to here as 'African dust days', using a qualitative methodology (Querol, et al. 2007[2]).

- These selected days together with monitoring data from 5 regional background sites across the Iberian Peninsula (shown in Figure 1 below) have been used to represent the days on which Gibraltar has been affected by African dust.

- Using a recommended methodology developed by researchers on the Iberian Peninsula (Escudero, et al. 2007[3]) we have quantified the

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[1] Querol, X; Cuevas, E; Cristobal, Á; Pey, J; Escudero, M; Alastuey, A; Alonso-Perez, S; Pallares, M; Salvador, P; Artiñano, B; de la Rosa, J; Marques, F; Ferreira, F. (March, 2007) EPISODIOS NATURALES DE PARTÍCULAS 2006 (CSIC, INM, CIEMAT, Ministerio de Medio Ambiente Dirección General de Calidad y Evaluación Ambiental)

[2] Querol, X; Alastuey, A; Escudero, M; Pey, J; Castillo, S; Perez, N; Ferreira, F; Franco, N; Marques, F; Cuevas, E; Alonso, S; Artinano, B; Salvador, P; de la Rosa, J; Jimenez, S; Cristobal, A; Pallares, M and Gonzalez A (2007) Methodology for the indentification of natural African dust episodes in PM10 and PM2.5, and justification with regards to the exceedences of the PM10 daily limit value. For Ministerio de Medio Ambiente-Spain and Ministerio do Ambiente, Ordenamento do Territorio e Desenvolvimento Regional – Portugal.

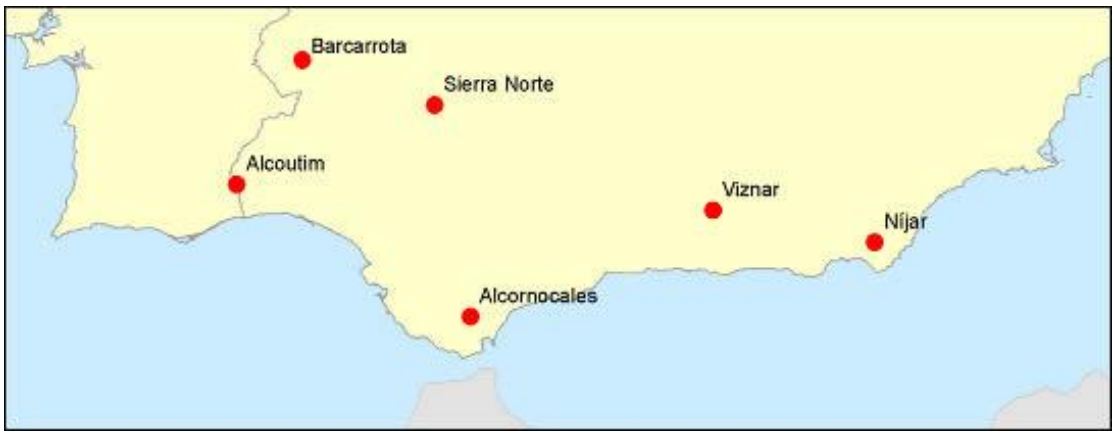
[3] Escudero, M; Querol, X; Alastuey, A; Perez, N; Ferreira, F; Alonso, S; Rodriguez, S and Cuevas, E (2007b) A methodology for the quantification of the net African dust load in air quality monitoring networks. Atmospheric Environment 41 (2007) 5516-5524

contribution to daily PM_{10} concentrations from natural African dust events and used this to adjust daily mean PM_{10} concentrations measured in Gibraltar to compare against the daily limit value.

- This method is developed and used by Spain and therefore adoption of this method by Gibraltar has the advantage of being consistent with neighbouring Member States. The method was discussed at the workshop 'Contribution of natural sources to PM levels in Europe' organized by the JRC in Ispra in October 2006 and has been reviewed in the subsequent workshop report (Marelli, 2007[4]).

- A daily regional background concentration for each regional background site has been calculated for those days allocated as African dust days. This regional background concentration is used in conjunction with the measured daily concentration at the regional background site to produce an increment that represents the influence of African dust at each regional background site. This increment has then been subtracted from the daily mean PM_{10}concentration at the Rosia Road site in Gibraltar to calculate the adjusted daily mean PM_{10} concentration excluding the influence of African dust. The number of daily mean PM_{10} exceedences of the limit value have then been recalculated using the daily data excluding this natural component.

Figure 1 Regional background sites used in this analysis



- Of the sites shown in Figure 1, only 5 have been used in the analysis because data for 2006 from the Alcornocales site was not available. However, given the proximity of the site to Gibraltar, data from this site will be useful for future analysis and efforts are being made to obtain this data.

- As Figure 1 shows, Spanish regional background sites available to use in this methodology are widely spread across the Iberian Peninsula. It was

[4] Marelli, L (2007) Contribution of natural sources to air pollution levels in the EU - a technical basis for the development of guidance for the Member States (post workshop report from 'Contribution of natural sources to PM levels in Europe' workshop organized by JRC, Ispra, October 2006. EUR 22779 EN)

considered that for a conservative approach, the days where the quantification was applied would be those days where the Spanish authorities had allocated *ALL* regional background sites as having African dust influence. However, due to the geographic range of the regional background sites, it was found that this approach considerably underestimated the number of days on which African dust was an influence on ambient concentrations in Gibraltar. For example, African dust episodes influencing Gibraltar from the south east would be captured in the daily concentrations at Viznar and Nijar but not necessarily at the remaining 3 Spanish regional background sites (Alcoutim, Barcarrota, Sierre Norte) and so this genuine episode would not be represented in the quantification.

- Therefore a different methodology was employed using days on which *ANY* regional background site was allocated as an African dust day. This results in a greater number of days to which the quantification has been applied. Therefore, in order to ensure that no unreasonable over-correction occurs, an average increment was calculated for *ALL* sites on those days irrespective of whether they reflected African dust influence. As a result, the average increment calculated for days on which not all sites were identified as African dust days includes the increments calculated at sites that did not reflect a significant African dust influence and for which the increments would be very low or even zero. On some of these occasions the calculated increment was negative (and therefore set to zero) and were included in the average of the increments to avoid an unreasonably high correction.

- Occasions occurred where 1 or more sites were identified as African dust influenced days but where data from some sites were absent. A condition was therefore applied to calculate the average increment *ONLY* where 3 or more of the 5 sites had a valid calculated increment. On those occasions where 2 or fewer sites had valid increments available for calculation of the average, the original uncorrected daily concentration from Rosia Road was retained.

Results

The tables below present the results of the correction for natural sources for both the daily and annual LVs. The number of days allocated as 'African dust days' refers to the dates on which the Spanish authorities identified a significant contribution to PM_{10} from natural African dust. These do not directly correspond to the daily exceedences measured in Gibraltar (i.e. some of these dates reflect a high contribution from African dust to daily PM_{10} on days where measured exceedences did not exceed the daily LV. However it has been necessary to apply the correction methodology to all days in 2006 rather than restricting it to the days of exceedence in Gibraltar so that a representative corrected annual mean can be calculated for comparison with the annual LV.

Daily LV, 50 µg m^{-3} (35 permissible)

Measured original daily exceedences	**60**
Estimated daily exceedences AFTER removal of natural component	**32**
Number of days allocated as 'African dust days' *	111
Number of allocated African dust days for which there were 3 or more valid increments calculated	105

* this is the number of days on which the Spanish authorities identified a significant contribution to PM_{10} from African dust in 2006 - these are the days for which the natural correction has been undertaken but do not necessarily correspond to the days of measured daily exceedence in Gibraltar.

Annual LV (40 µg m^{-3})

Annual mean BEFORE adjustment for natural sources	**39.2**
Annual mean AFTER adjustment for natural sources	**35.6**

- When the final data set of corrected daily concentrations was obtained, the number of daily exceedences of the LV was calculated as 32.The average increment used in the correction was 14 ug m^{-3} and the maximum increment was 39 µg m^{-3}.

- The uncorrected annual mean concentration did not exceed the LV in 2006 (although it was close to 40 µg m^{-3}). The removal of the natural component in 2006 produced an annual mean in 2006 of 35.6 µg m^{-3} (based on the corrected daily concentrations) – this represents an African dust increment across the year of 3.4 µg m^{-3}.

Conclusion

- Natural particulate matter from Africa is a significant contributing source to measured PM_{10} concentrations in Gibraltar.

- For 2006, the methodology described in this report resulted in a reduction of daily exceedences from the measured number of 60 to a corrected number of 32, below the 35 permissible exceedences for compliance with the Directive.

- Gibraltar's exposed coastal location is likely to result in a significant contribution of natural sea-salt to measured PM_{10} concentrations. No monitoring is currently undertaken to quantify this contribution but speciated chloride monitoring (collocated with PM_{10} analysers used for Commission reporting) is recommended for consideration as this would provide an additional natural increment to remove from daily measured PM_{10} concentrations.