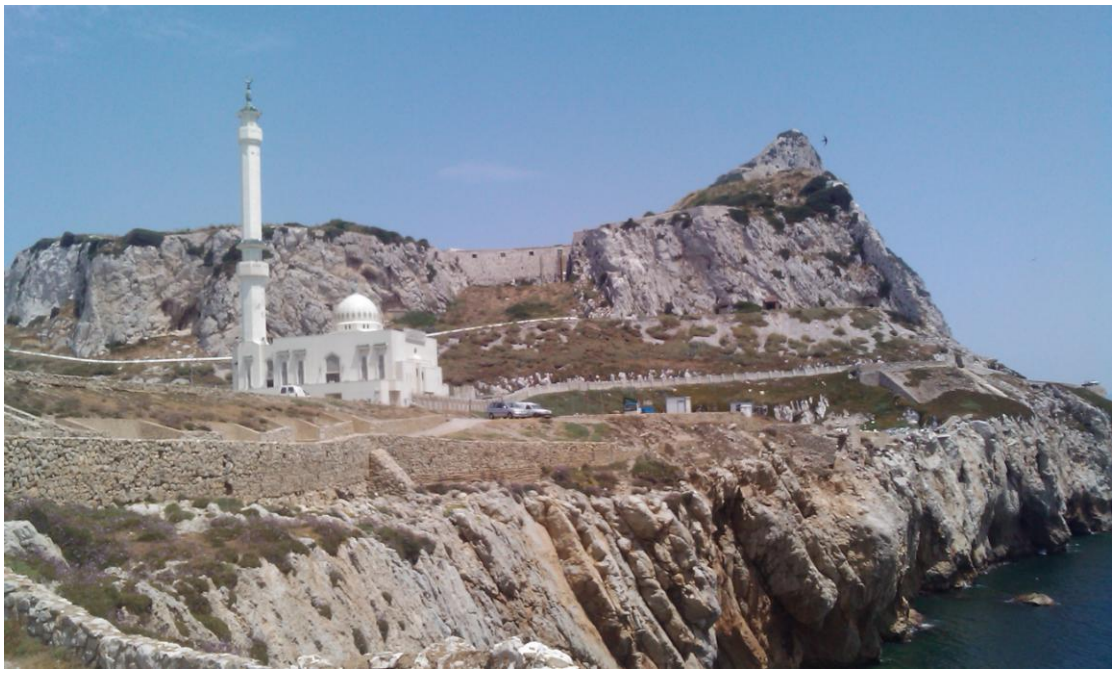
Measured PM_{10} concentrations in Gibraltar in 2008 - removal of the natural component



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A report to the Gibraltar Environmental Agency

ED48335
Issue 01
July 2009

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 (LVs) are exceeded due to causes other than natural events. The new CAFE Directive has made further provision for assessing and reporting concentrations where natural sources are a contributor. 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. The chief mechanism for reporting concentrations to the Commission is the Annual reporting questionnaire which now includes specific forms to report contributions from natural sources and corrected PM_{10} concentrations, adjusted for this natural component.

- Gibraltar's monitoring campaign in 2008 reported 63 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). This was significantly higher than the 60 reported in 2006 (reduced to 32 after African dust quantification was undertaken) but was lower than the 109 (corrected to 72) in 2007. 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 report presents analysis and details the methodology used to demonstrate a reduction from 63 daily exceedences to 36 exceedences in 2008.

Methodology

- The Spanish authorities have, for the preparation of ongoing mandatory reporting to the Commission for Spain, identified days in 2008 on which regional background sites across the Iberian Peninsula were significantly affected by African dust (Pey, J., 2009[1]), referred to here as 'African dust days', using a qualitative methodology (Querol, et al. 2007[2]).

[1] Pey, J; Querol, X; Cuevas, E; Alastuey, A; Alonso-Perez, S; Pallares, M; Salvador, P; Artiñano, B; de la Rosa, J; Gonzalez Ortiz, A; Jimenez, S; Marques, F; Ferreira, F. (April, 2009) EPISODIOS NATURALES DE PARTÍCULAS 2008 (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.

- This list of 'African dust days' has been used in conjunction with monitoring data from 5 regional background sites across the Iberian Peninsula (shown in Figure 1 below) in order to quantify the African dust increment at each site using a recommended methodology developed by researchers on the Iberian Peninsula (Escudero, et al. 2007[3]). These increments have then been used to adjust daily mean PM_{10} concentrations measured in Gibraltar (at the Rosia Road monitoring station) 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]).

Figure 1 Spanish regional background sites used in analysis

*** Alcornocales site not used**

- Of the sites shown in Figure 1, only 5 have been used in the analysis because data for 2008 from the Alcornocales site was not available. However, given the proximity of the site to Gibraltar, data from this site is expected be useful for future analysis and efforts are ongoing to obtain this data to review it's suitability for this exercise.

- A daily regional background concentration for each regional background site has been calculated on days allocated as African dust days to represent background concentrations in the absence of African dust. This is achieved by removing African dust days from the dataset and calculating a moving 30th percentile across a 30 day period centred on the day for which the calculation is being made (i.e. the day of the calculation

[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

[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)

is day 15 of the 30 day period). Occasions on which negative increments were calculated were deemed to be invalid and were omitted further calculations.

- The regional background concentration calculated above is then subtracted from the measured concentration on the African dust day (removed from the regional background calculation) to give an African dust increment for that site on that day.

- The method was used to determine an African dust increment for each of the regional background sites (excluding Alcornocales) in Figure 1. The application of these increments to the measured data from Gibraltar Rosia Road requires careful consideration. The complexity of this application stems from the fact that no single regional background site in Spain is an obvious choice to represent Gibraltar in terms of proximity. As Figure 1 shows, Spanish regional background sites available to use in this methodology are widely spread across the Iberian Peninsula. Gibraltar's position means that African dust episodes can affect it when air masses approach the Iberian Peninsula from the south east (affecting the Viznar and Nijar sites) and from the south west (affecting the Barcarrota, Sierra Norte and Alcoutim sites). We have therefore utilised increments from all 5 regional background stations in order to derive a correction factor for each African dust day to apply to measured concentrations in Gibraltar.

The use of all 5 regional background sites also affects the choice of African dust days as applied to Rosia Road in Gibraltar. Since African dust episodes are by nature regional in scale we can reasonably assume that the days which have been allocated as African dust days for each Spanish regional background site, can also be applied to Gibraltar. The allocation of African dust days by Spanish researchers has been conducted on a regional scale for south east and south western regions of the Iberian Peninsula. This regional allocation is then attributed to the sites within that those regions (i.e. Barcarrota, Sierra Norte and Alcoutin to south west, Viznar and Nijar to the south east) as shown in

- Table 1. This means that the list of African dust days provided for different sites will be slightly different depending on the region in which they are located. In reality the difference is small since most African dust episodes affect both south east and south west regions. In 2008 there were 91 African dust days allocated to the south west region compared with 108 allocated to the south east region. In order to fully capture south easterly and south westerly African dust events, the correction has been applied to Gibraltar on any day that EITHER region has been allocated as an African dust day. This has resulted in a correction for Gibraltar measured concentrations on 118 days in total in 2008.

Table 1 Regional background sites and regional classification

Site	Region
Barcarrota	South west
Sierra Norte	South west
Alcoutim	South west
Viznar	South east
Nijar	South east

- The correction applied to daily concentrations at Gibraltar Rosia Road was calculated as an average of the African dust increments from relevant regional background sites. Where a south westerly African dust episode was identified the correction was derived from an average of the increments for Barcarrota, Sierra Norte and Alcoutim (where at least 2 of the 3 sites had valid increments. Where a south eastern episode was identified the increments for Viznar and Nijar were used (where at least 1 of the 2 sites had valid increments). In the majority of circumstances, both south east and south west regions were affected and the correction was calculated as an average of African dust increments across all 5 sites.

- Occasions where there were too few sites on a regional basis (i.e. 2 of 3 in the south west or 1 of 2 in the south east) to calculate an average of the increments, no adjustment was made and the original measured concentration from Rosia Road was retained.

Results

- Results of the correction of measured Rosia Road PM_{10} concentrations are summarised below in Table 2 (daily LV) and Table 3 (annual LV). The number of days allocated as 'African dust days' refers to the total number of days for which the correction was applied and is the combination of days identified for the south east and south west regions of the Iberian Peninsula, as explained in the methodology. These do not correspond to the daily exceedences measured in Gibraltar – the aim is not just to correct exceedence days but to correct any day for which a high contribution from African dust is likely. This allows us to calculate a meaningful corrected annual mean also for comparison against the annual LV.

Table 2 Daily LV, 50 µg m^{-3} (35 permissible), 2008 summary (number of days)

	Rosia Road	Bleak House*
Measured original daily exceedences	**63**	**8**
Estimated daily exceedences AFTER removal of natural component	**36**	**3**

* The Bleak House Partisol instrument commenced operation in June 2008 and so for 2008 this site had an annual data capture of 48.4%

Table 3 Annual LV (40 µg m^{-3}), 2008 summary (µg m^{-3})

	Rosia Road	Bleak House
Annual mean BEFORE adjustment for natural sources	**40.5**	**33.7**
Annual mean AFTER adjustment for natural sources	**35.4**	**27.1**

- It should be noted that the data capture for 2008 for Bleak House was only 48.4% because it commenced operation for PM_{10} in June. The Bleak House data are presented here for comparison and will be reported along with Rosia Road Partisol data during the ongoing monitoring campaign, however since the data capture is low (and therefore not representative of the year) and because there are no exceedences to report (even before correction for natural African dust), it is unlikely that these data will be reported to the Commission for 2008.

- The corrected data set for 2008 shows a reduction in the number of daily exceedences from 63 to 36, still in excess of the 35 permissible under the Directive. It is possible that with more information on sea salt contributions to measured PM_{10}, this may bring corrected number of daily exceedences to within the 35 permissible.

- The uncorrected annual mean concentration in 2008 also just exceeded the annual LV. The removal of the natural component resulted in a corrected annual mean in 2008 of 35.4 µg m^{-3} (based on the average of corrected daily concentrations) – this represents an African dust increment

across the year of 5.1 µg m^{-3} (consistent with 5.8 µg m^{-3} in 2007) and results in compliance with the annual LV.

- After quantification and correction for natural African dust, there were 9 days which exceeded the daily LV by only a single µg m^{-3}. Therefore if only a small quantity of sea salt were found to be contributing and could be removed, it is likely that Gibraltar would achieve compliance with the Directive in 2008.

Conclusion

- Natural particulate matter from Africa is a significant contributing source to measured PM_{10} concentrations in Gibraltar and this is demonstrated in 2008 data in addition to previous years.

- For 2008, the methodology described in this report resulted in a reduction of daily exceedences from the measured number of 63 to a corrected number of 36. This remains above the 35 exceedences allowed by the Directive. Further research to identify and quantify contributions to these exceedences is ongoing with research related to emissions from the power station, emissions from shipping, transboundary contributions, natural sea salt contributions and road traffic emissions.

- Gibraltar's exposed coastal location is likely to result in a significant contribution of natural sea-salt to measured PM_{10} concentrations. No routine monitoring is currently undertaken to quantify this contribution but speciated analysis (collocated with PM_{10} analysers used for Commission reporting) on existing PM filters is being investigated as a possibility. Routine monitoring using a Delta denuder instrument at both Rosia Road and Bleak House monitoring sites is planned to provide concentrations to correct measured PM for sea salt in the future.

APPENDIX A

ADDITIONAL PM_{10} MONITORING DATA

In addition to Partisol data at Rosia Road there is Partisol data at Bleak House from June 2008 and from an FDMS instrument at Rosia Road from May. Neither of these data sets have been corrected for natural African dust. The Bleak House Partisol data will be reported with the Rosia Road data to the Commission via the annual reporting questionnaire. The FDMS data exists to satisfy Gibraltar's public information obligations and will not be reported to the Commission. Bleak House is a background location and typically records lower concentrations than the roadside Rosia Road site.

These additional data are summarised below for comparison with the Rosia Road analysis presented in this report. The data capture is comparatively low as a result of the partial year of monitoring in 2008.

Metric	Rosia Road FDMS	Bleak House Partisol
Annual mean ($\mu g\ m^{-3}$)	42	34
Exceedences of daily LV	43	8
Data capture (%)	58.6	48.4