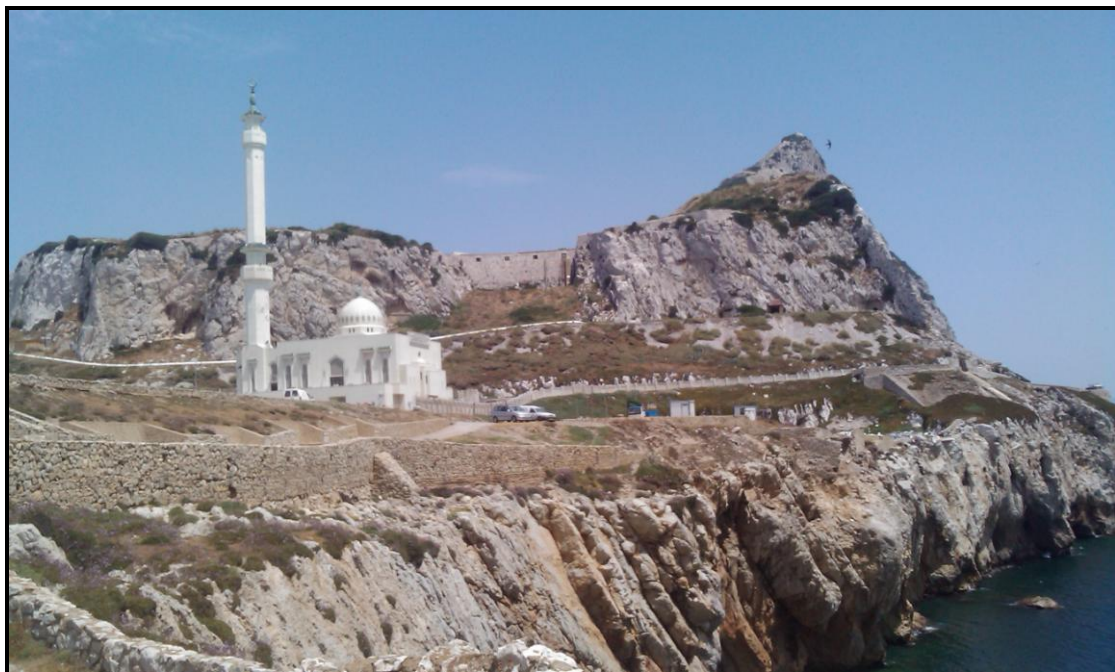


Measured PM₁₀ concentrations in Gibraltar in 2009 - removal of the natural component



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Introduction

- European air quality directives¹ specify that a Member State is obliged to implement action plans where the limit values (LVs) are exceeded due to causes other than natural events. The new air quality directive on Clean Air for Europe (CAFE)² came fully into force in July 2010 and further guidance has been provided 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 exceedances are due to natural events. The chief mechanism for reporting concentrations to the Commission is the annual reporting questionnaire which includes specific forms to report contributions from natural sources and corrected PM₁₀ concentrations, adjusted for this natural component.
- The Gibraltar Air Quality Monitoring Network in 2009 recorded 37 exceedances (Rosia Road monitoring site) of the daily mean limit value of 50 µg m⁻³, of which no more than 35 exceedances are permissible, as specified in the air quality Directive (CAFE).
- A significant contribution to daily exceedances 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 37 daily exceedances to 15 exceedances in 2009 due to the quantification of PM₁₀ from natural sources (African dust only). This quantification for 2009 represents the difference between exceedance and compliance with the Directives. The annual mean LV at Rosia Road and the annual mean and daily LVs at Bleak House were not exceeded in 2009 prior to the African dust correction.

Methodology

- The Spanish authorities have, for the preparation of ongoing mandatory reporting to the Commission for Spain, identified days in 2009 on which regional background sites across the Iberian Peninsula were significantly affected by African dust (Pey, J., 2009³), referred to here as 'African dust days', using a qualitative methodology (Querol, et al. 2007⁴).

¹ Directive 1999/30/EC (the first Daughter Directive): Article 5, section 4

² Directive 2008/50/EC (CAFE Directive)

³ 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)

⁴ 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 identification of natural

- This list of 'African dust days' has been used in conjunction with monitoring data from regional background sites across the Iberian Peninsula (shown in Figure 1 below) in order to quantify the African dust increment using a recommended methodology developed by Spanish researchers (Escudero, et al. 2007⁵). These increments have then been used to adjust daily mean PM₁₀ concentrations measured in Gibraltar (at the Rosia Road monitoring station) to compare against the daily limit value. Historically, the absence of a single regional background site to be paired with Gibraltar has meant that a combination of regional background sites from Spain has been used. The methodology employed to incorporate multiple sites has been explained in previous studies^{6,7,8}. For 2009, regional background monitoring data from Alcornocales has been made available for this quantification. Given that this regional background site is so much closer to Gibraltar than other regional background sites in Spain and it provides a much more certain representation of regional background sites in Gibraltar, it would make no sense to use a combination of sites to establish the African dust increment. For this reason, only Alcornocales has been used for the correction of PM₁₀ concentrations in Gibraltar for 2009.
- The number of days allocated as 'African dust days' refers to the total number of days for which the correction was applied. These do not necessarily 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.
- This method has been 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, 2007⁹). The methodology has

African dust episodes in PM₁₀ and PM_{2.5}, 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.

⁵ 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

⁶ 2006 African dust quantification

http://www.gibraltairquality.gi/documents/Gib_natural_quantification_2006_v2.pdf

⁷ 2007 African dust quantification

http://www.gibraltairquality.gi/documents/Gib_natural_quantification_2007_v1.pdf

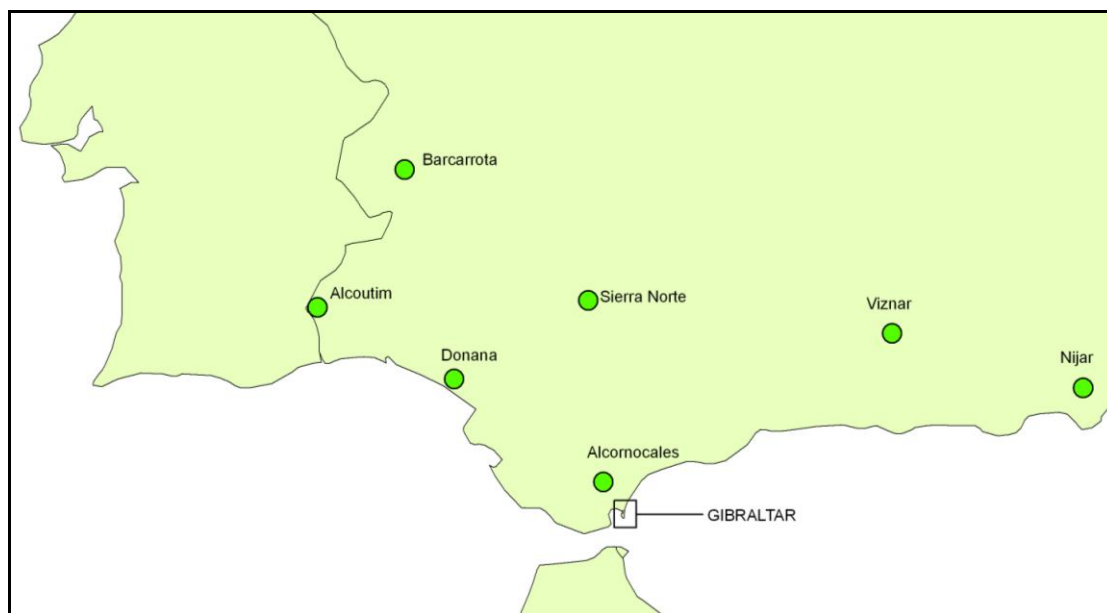
⁸ 2008 African dust quantification

http://www.gibraltairquality.gi/documents/Gib_natural_quantification_2008_v1.pdf

⁹ 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)

been incorporated into the Commission's guidance on quantifying natural contributions of particulate matter.

Figure 1 Spanish regional background sites used in analysis



* site locations are approximated

- A daily regional background concentration for Alcornocales has been calculated 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 is day 15 of the 30 day period). This provides an indication of the regional background concentration in the absence of African dust contributions.
- The regional background concentration calculated above was subtracted from the measured concentration on the African dust day to give an African dust increment for that site on that day. Occasions on which negative increments were calculated were deemed to be invalid and were omitted further calculations.
- The method was used to determine an African dust increment for Alcornocales which is then used as a proxy indication of the African dust contribution to Gibraltar monitoring sites. The African dust contribution was then subtracted from the daily measured concentrations from Gibraltar on days allocated as African dust days. This results in a new series of 'corrected' daily concentrations of PM₁₀ from which the number of daily exceedances and annual mean can be recalculated for assessment against the legislative LVs.
- Data from Alcornocales regional background monitoring site makes the application of this methodology much simpler and more robust for Gibraltar than having to establish a robust combination of several distant regional background sites. It is not certain that Alcornocales data will be available

in future years and so reverting to the more complex methodology employed in previous years may be required in future years.

- A brief comparison of results using the previous methodology (combining all regional background sites) with those using just Alcornocales was undertaken and is presented in the results section. The regional background monitoring data supplied by Spanish authorities for this exercise for 2009 included some changes from previous years (see Figure 1 for approximate locations):
 - Alcoutim was not provided.
 - Donana was provided
 - Nijar was not provided
 - Alcornocales was provided

Results

- Results of the correction of measured Rosia Road and Bleak House PM₁₀ concentrations are summarised below in Table 1 (daily LV) and Table 2 (annual LV).

Table 1 Daily LV, 50 µg m⁻³ (35 permissible), 2009 summary (number of days)

	Rosia Road	Bleak House*
Measured original daily exceedances	37	3
Estimated daily exceedances AFTER removal of African dust	15	0

Table 2 Annual LV (40 µg m⁻³), 2009 summary (µg m⁻³)

	Rosia Road	Bleak House
Annual mean BEFORE adjustment for natural sources	38.2	27.2
Annual mean AFTER adjustment for African dust	34.8	23.9

- The data set for 2009 with African dust contribution removed demonstrates a reduction in the number of daily exceedances from 37 to 15 at Rosia Road – i.e. compliance with the Directive. It is likely that with more information on sea salt contributions to measured PM₁₀, there would be a larger amount of ‘headroom’ between the LV and the measured concentrations.
- The uncorrected annual mean concentration in 2009 achieved the annual LV before African dust had been accounted for. The removal of the natural African dust component resulted in an annual mean in 2009 of 34.8 µg m⁻³ at Rosia Road (based on the average of corrected daily concentrations) –

this represents an African dust increment across the year at Rosia Road of $3.4 \mu\text{g m}^{-3}$.

- There was no exceedance of daily LV or annual LV in 2009 at Bleak House prior to African dust correction.
- Using the combination of all available regional background sites (as the methodology employed in previous years in the absence of Alcornocales data - though with different sites in 2009 as explained above - there were 13 daily exceedances and an annual mean of $34 \mu\text{g m}^{-3}$. However, it was considered most appropriate to use the Alcornocales site given its availability and proximity to Gibraltar rather than a combination of several regional background sites a greater distance away.
- Figure 2 below shows how daily exceedances including and excluding African dust in Gibraltar have varied from 2005 and places these in the context of compliance – the red dashed line represents the number of permissible daily exceedances according to the Directive (35). Data from Rosia Road only are presented in the plot as this site importantly affects the zone's exceedance status whereas Bleak House has never been close to exceeding in the past. Figure 2 shows how concentrations have been declining since 2007 and in 2009, compliance was achieved after accounting for African dust.
- Figure 3 shows annual mean data for Rosia Road including and excluding African dust. The green line demonstrates that after accounting for African dust, the annual LV has never been exceeded in Gibraltar.

Figure 2 Daily PM₁₀ exceedances at Rosia Road over time (including and excluding African dust contributions)

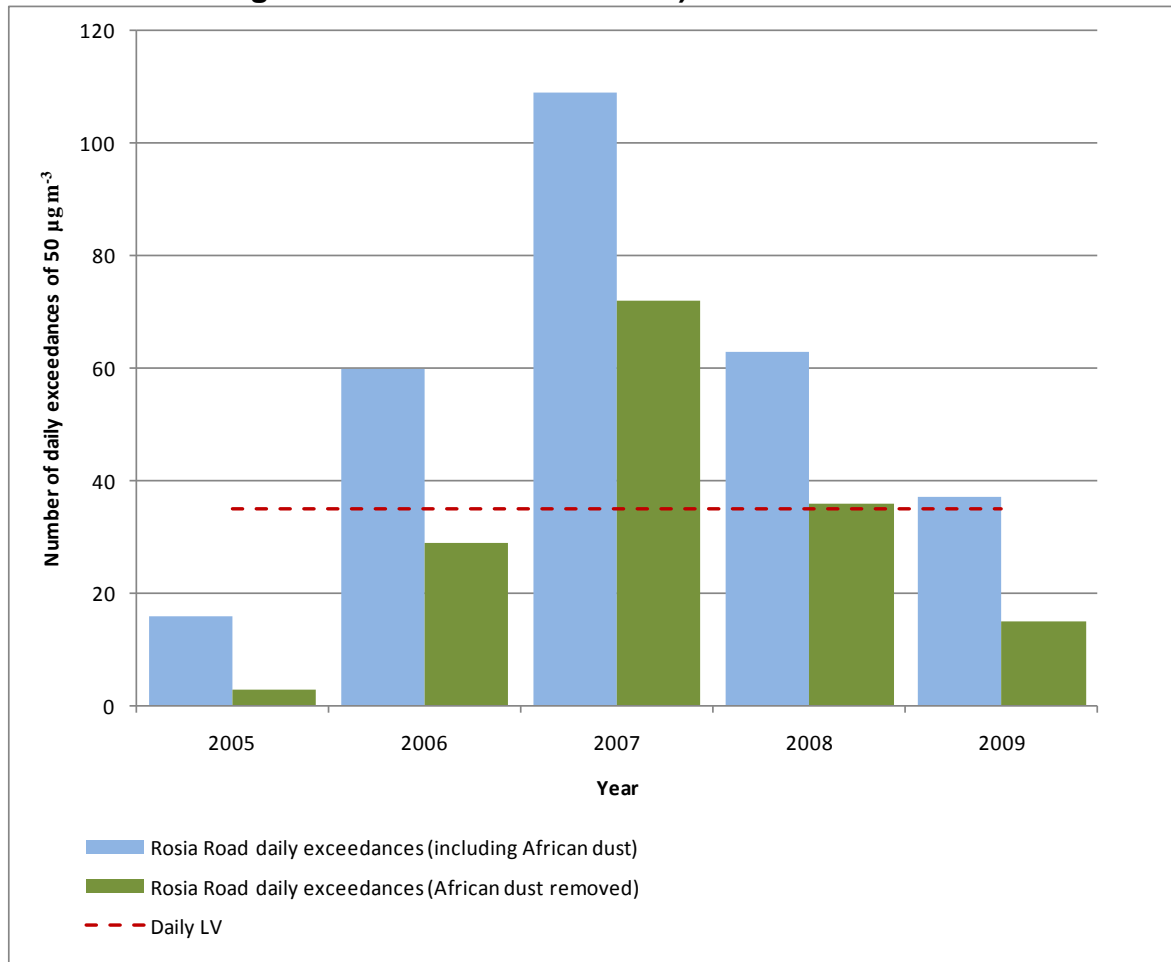
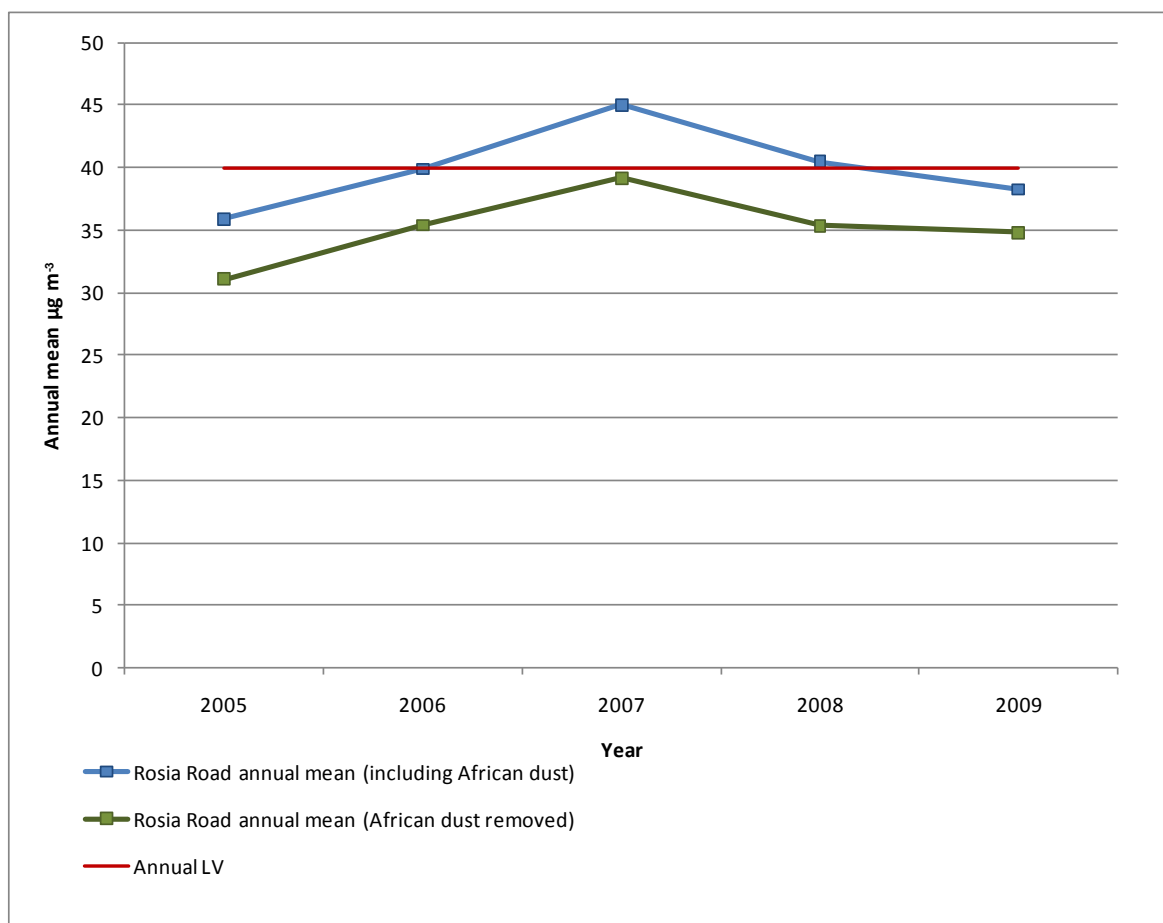


Figure 3 Annual mean PM₁₀ at Rosia Road over time (including and excluding African dust contributions)



Conclusion

- Natural particulate matter from Africa is a significant contributing source to measured PM₁₀ concentrations in Gibraltar and this is demonstrated in 2009 data in addition to previous years.
- For 2009, the methodology described in this report resulted in a reduction of daily exceedances from 37 to a corrected number of 15. Therefore, Gibraltar achieves compliance with both the daily LV and annual LV in 2009 when African dust is taken into account.
- Gibraltar's exposed coastal location is likely to result in a significant contribution of natural sea-salt to measured PM₁₀ concentrations. Monitoring by denuder sampler during will allow further analysis and possible corrections for the outstanding natural component of PM₁₀ by sea spray.