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Assessment of contributions from natural sources, winter sanding and salting and compliance with existing available guidelines

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ASSESSMENT OF CONTRIBUTIONS FROM NATURAL SOURCES, WINTER SANDING AND SALTING AND COMPLIANCE WITH EXISTING AVAILABLE GUIDELINES

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ABBREVIATIONS AND DEFINITIONS

Abbreviation or key term	Definition
ADMS	Atmospheric Dispersion Modelling System, used for calculating concentrations of pollutants emitted from point, line volume and area sources
CAMS	Copernicus Atmosphere Monitoring Service. Available at: https://atmosphere.copernicus.eu/about-us
Coarse PM fraction	Particulate matter with a diameter between 2.5 and 10 µm. Calculated as the difference between measured concentrations of PM_{10} and $PM_{2.5}$ (PM_{10} – $PM_{2.5}$)
DfG	Dataflow G
ECMWF	European Centre for Medium-Range Weather Forecasts, a 24/7 operational service, producing and distributing numerical weather predictions for Member States. Available at: https://www.ecmwf.int/en/about/who-we-are
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme, a co-operative programme for the monitoring and evaluation of long-range transmission of air pollutants in Europe. Available at: https://emep.int
HIRLAM	High Resolution Limited Area Model, a numerical weather prediction forecast system used to create short-range limited area forecasts
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory, a model system used for computing the trajectories of discrete air parcels. Frequently used to determine back trajectories. Available at: https://www.arl.noaa.gov/hysplit/
IMGW-PIB	A Polish research and development unit, whose acronym translates to "Institute of Meteorology and Water Management – National Research Institute", who provide weather forecasts for Poland. Available at: https://www.imgw.pl/instytut/imgw-pib
NAAPS	Naval Aerosol Analysis and Predictive Systems, an aerosol forecast model used to determine the surface concentration of windblown dust and biomass smoke. Available at: https://www.nrlmry.navy.mil/aerosol/
NMMB-BSC	A daily dust forecasting model provided by the Barcelona Supercomputing Centre (BSC), intended to provide short to medium range dust forecasts for regional and global domains. Available at: https://ess.bsc.es/bsc-dust-daily-forecast
"SR3 contract"	Deliverables completed by Ricardo under Task 3 of the specific contract No. 070201/2018/791820/SFRA/ENV.C.3, implementing framework contract No. ENV.C.3/FRA/2017/0012.
Voivodeships	The area governed by an administrative district in Poland, and other countries in eastern Europe. Similar to a province in many other countries.

1. INTRODUCTION

This report forms the deliverable for Task 2 under the Service Request 14 Services to technically assess compliance and monitor the implementation of EU air quality policy. This report provides a cross cutting overview of all Member States reporting contributions from natural sources or winter-sanding and salting of roads to concentrations of relevant air pollutants on the basis of Article 20 and 21 of Directive 2008/50/EC respectively, for the years 2018, 2019 and 2020. The report for France (Martinique) had previously been assessed and has therefore not been reviewed as part of this assessment.

In addition, for those Member States that have made adjustments to pollutant concentrations based on contributions from natural sources or winter sanding or salting this report assesses the evidence provided by Member States compared to the European Commission guidelines (SEC (2011) 208 final document and SEC (2011) 207 final document, respectively).

This report first outlines the requirements under the existing guidelines. In Section 1.1 an overview of the Commission's natural source guidelines (SEC (2011) 208 final document) is provided and in Section 1.2 an overview of the winter sanding and salting guidelines SEC (2011) 207 winter sanding and salting guidelines are detailed. In Section 2 the methodology followed to identify the Member States that relied upon Article 20 and/or 21 of Directive 2008/50/EC and applied natural source or winter sanding and salting corrections has been outlined. Section 3 details the corrections applied by Member States, and Section 4 provides an overview of the methodologies the Member States have applied and recommendations. In Section 5 we have concluded where Member States have followed the guidelines and where improvements in the methodologies have been demonstrated.

Appendices 1-9 of this report provide detailed assessments of the Member States' methodology against the relevant guidelines for each individual country. These include Bulgaria, Cyprus, Greece, Latvia, Lithuania, Malta, Poland, Slovenia, and Spain.

1.1 SUMMARY OF THE COMMISSION'S SEC (2011) 208 FINAL DOCUMENT – NATURAL SOURCE GUIDELINES

Commission Staff Working Paper SEC (2011) 208 final document "establishing guidelines for demonstration and subtraction of exceedances attributable to natural sources under the Directive 2008/50/EC on ambient air quality and cleaner air for Europe" provides Member States with guidelines for identifying, quantifying, and subtracting the contribution of natural sources before comparing the ambient air pollution concentration to the relevant limit values. This document is hereafter referred to as "SEC (2011) 208 final document" and "the Commission's natural source guidelines".

In this section we have provided a brief description of the Commission's natural source guidelines, particularly those used in our assessment of Member States' approach.

Section 1 of the Commission's natural source guidelines provides a general introduction of air quality limit value exceedances set in the EU, and the scope for providing evidence for and subtracting the contributions from natural sources. The first section also includes a description of how the guidelines was formulated, and a glossary of terms used. Section 1 is divided as follows: 1.1, General; 1.2, Legal provisions; 1.3, Aim and scope; 1.4, Process of developing the guidelines; and 1.5, Terms, definitions and abbreviations.

Section 2 describes the "key principles" which outline the minimum requirements that a Member State must meet in order to subtract natural source contributions. These key principles are detailed further in Section 1.1.1 of this report.

Section 3 describes what natural sources are eligible for deduction. The section is divided into three sections: 3.1 defines the concept of an eligible contribution, while 3.2 and 3.3 provide non-exhaustive lists of eligible, and non-eligible sources, respectively. Natural contributions eligible for subtraction, include "Transport of natural particles from dry regions" (such as Saharan dust), "Sea Spray", "Volcanic eruptions, seismic and geothermal activity" and "Wild-land fires", and are further described in Section 3.2 of the Commission's natural source guidelines. Non-eligible natural contributions specified in Section 3.3 include "Re-suspension" (such as dust on roads), "Primary Biological Aerosol Particles" (such as pollen) and "Secondary Organic Biogenic Aerosols".

Section 4 outlines existing approved methodologies that Member States should follow for the identification and quantification of the contribution of natural sources. The methodologies provided are not mandatory but are detailed as examples which should be adapted to the conditions of each specific Member State. This section of the Commission's natural source guidelines document is divided into 4 sub-sections that each provide methodologies for determining the contribution of eligible natural sources:

- 4.1: Re-suspended and transported Saharan dust
- 4.2: Sea salt contribution to PM
- 4.3: Volcanic eruptions, geothermal and seismic activities
- 4.4: Wild-land fires

Section 5 outlines further considerations which must be accounted for when model calculations are used in assessing exceedances of ambient air quality standards. This includes guidelines that subtraction can only occur if the model accounts for the specific natural source contribution in its calculation. For example, a module is used to reproduce the sea salt aerosol source and is in turn used in calculating the total amount of PM_{10}. Where modelling is used to support measurements, it is preferred that the subtraction is based on the measurement results.

Section 6 details the requirements for Member States to document and report the determination of natural source contributions, which should be uploaded annually onto EIONET CDR. There are no specific guidelines for structure, but the required content is specified, including a description of methodology and identification and quantification information with supporting evidence.

1.1.1 Natural source contribution assessment criteria

As indicated above, Section 2 of the Commission's natural source guidelines describes the key principles for the assessment of natural contributions to the concentrations. These are:

1. The natural contribution must not be caused by direct or indirect human activities.
2. The quantification of the natural contribution must be sufficiently precise.
3. The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered.
4. The quantification of the natural sources must be spatially described.
5. The contributions must be demonstrated in a process of systematic assessment.
6. The quantification of the natural sources must be demonstrated for each pollutant separately.

The application of all key principles set out in Section 2 of the Commission's natural source guidelines document has to be identifiable in the methodology applied by the Member State. Table 1 provides a summary of the criteria required under each key principle, which will be used in this report to assess whether each Member States correction methodology provides adequate evidence in the determination of natural source contributions.

Table 1 Summary of the criteria detailed in the Commission's natural source guidelines – SEC (2011) 208 final document

Key principle		Summary of description	Reference[1]
1	Natural contribution must not be caused by direct or indirect human activities	The following evidence should be provided in the description of the method: • The "identified contribution" has natural origin • The "identified contribution" does not derive from interactions between natural component and anthropogenic components	Section 2.1, pages 10-11.

[1] All reference locations refer to the Commissions natural source guidelines, SEC (2011) 208 final document.

Key principle		Summary of description	Reference[1]
		• That human action could not prevent or significantly reduce the "identified contribution" As such, agriculture cannot be considered a natural source.	
2	The quantification of the natural contribution must be sufficiently precise.	The contribution from the natural event or natural background contribution needs to be expressed in numerical terms to make it possible to distinguish from anthropogenic components of observed concentrations. These should be expressed as best estimates, as opposed to low or high estimates. Member States are required to remove all bias from results, in particular any artefacts introduced by anthropogenic contributions. Natural source contributions should be identified individually (and added if necessary). The successive elimination of known anthropogenic contributions is not accepted. Uncertainties regarding the quantification must be provided.	Section 2.2, page 11
3	The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered.	The limit values set for pollutants respective averaging periods in the Annex XI and XIV of Directive 2008/50/EC (summarised in Table 3 of the Commission's natural source guidelines; SEC (2011) 208 final document) should be used as the averaging period for measured concentrations. For PM_{10} these averaging periods are 1 day, and 1 calendar year. Relevant natural contributions can be divided into two subgroups: • Events which occur on an occasional basis, and last for limited short-term periods (e.g., a couple of days). These include Saharan dust and wildfire. Satellite images are usually satisfactory for the visualisation of these periods. • Events which occur continuously with varying intensity, such as sea spray. These can significantly affect the short-term limit values as well as annual. Each short-term event must be recognised and evaluated independently. Use of an annual average amount to quantify short-term contributions is discouraged. If used it must be demonstrated to be representative in each instance. It is acceptable practice to use the short-term "subtracted concentration" for the calculation of the "long term" subtracted concentration.	Section 2.3, pages 11-13
4	The quantification of the natural sources must be spatially described.	The natural contribution should be shown to be present at each location where an exceedance occurs. A proven occurrence at one site cannot be extrapolated to another. Representativeness of the measuring station and modelling plays an important role, as natural contributions exhibit significant spatial variation.	Section 2.4, page 13
5	The contributions must be demonstrated in a process of	The occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. A natural contribution should cause distinct features in the results of the monitoring process, compared to the rest of the series of	Section 2.5, page 13

Key principle		Summary of description	Reference[1]
	systematic assessment.	measured concentrations. This can be in the form of temporal features, or a distinct chemical signature.	
6	The quantification of the natural sources must be demonstrated for each pollutant separately.	A demonstrated occurrence for a given pollutant does not necessarily mean the conclusion can be extrapolated to another (e.g., PM_{10} and $PM_{2.5}$). A natural source subtraction therefore should be separately demonstrated for each pollutant.	Section 2.6, page 13

1.1.2 Recommended methods for the subtraction of the contribution from natural sources

As indicated above, Section 4 of the Commission's natural source guidelines, SEC (2011) 208 final document outlines the recommended methodologies for the subtraction of eligible contributions from four different natural sources:

- Re-suspended and transported Saharan dust
- Sea salt contribution to PM
- Volcanic eruptions, geothermal and seismic activities
- Wild-land fires

In this section of this report, we have provided a brief description of each sub-section of Section 4 from the Commission's natural source guidelines.

Section 4.1 of the Commission's natural source guidelines regards the **determination of re-suspended and transported Saharan dust**. The recommended procedure is based on a method developed and demonstrated for use in both Spain and Portugal,[2] which has since been validated and published,[3] and applied across a larger geographical area.[4] This method allows the identification and quantification of contributions of re-suspended and transported natural Saharan dust episodes on a daily basis, which may then be used to adjust the annual mean value. It is stated in the guidelines that Saharan dust outbreak episodes should be identified using a mixture of modelling and observations (Section 4.1.1). This includes interpretation of 5-day back trajectories of air masses using the HYSPLIT model (Hybrid Single-Particles Lagrangian Integrated Trajectories) validated by the inspection of relevant meteorological charts (e.g., from ECMWF), consultation of aerosol index maps (e.g., from the Ozone Monitoring Instrument; OMI) as well as daily results of aerosol models (e.g., SKIRON, BSC-DREAM or NAAPs), and studying measured PM_{10} levels at appropriate regional background stations for rapid increases in concentrations which may indicate the occurrence of a dust outbreak. It is noted that the residence time of dust episodes in the atmosphere can last between 1-3 days.

The recommended method for quantification of Saharan dust outbreak episodes (Section 4.1.2) requires the calculation of PM_{10} background levels for each day excluding those identified as part of an episode, using a monthly moving 40th percentile. This should be determined using PM_{10} measurements at an appropriate regional background site, which should be selected considering their spatial representativeness in relation to the site being deducted (Section 4.1.3). The difference between the daily background concentration determined and the measured concentration on the same day during an identified episode can be attributed to Saharan dust. The Commission's natural source guidelines discusses that this statistical indicator has been recommended based on the evidence, but if evidence is missing a more conservative indicator (e.g., average or 50th percentile) is preferred (Section 4.1.2). Section 4.1.4 provides an example of implementation of the method, while Section 4.1.5 suggests possible validation measures. The Commission's natural source guidelines states that for each calendar year the contribution of Saharan dust has been deducted, the Member State should provide justification and descriptions of the episodes in a report (Section 4.1.6). Section 4.1.7

[2] Querol *et al.* (2006), Spain and Portugal Methodology for the identification of natural African dust episodes in PM_{10} and $PM_{2.5}$, and justification with regards to the exceedances of the PM_{10} daily limit value, modified version from November 2009. Ministero de Medio Ambiente, y Medio Rural y Marino–Spain S.G. de Calidad del Aire y Medio Ambiente Industrial (Dirección General de Calidad y Evaluación Ambiental, DGCEA) and Ministerio do Ambiente, Ordenamento do Territorio e Desenvolvimento Regional – Portugal Agência Portuguesa do Ambiente, 32 pp.

[3] Escudero *et al.* (2007), *Atmospheric Environment,* 41, 26, 5516-5524.

[4] Querol *et al.* (2009), *Atmospheric Environment*, 43, 28, 4266-4277.

provides a critical discussion for this method, acknowledging systematic biases, in this case for instance that an underestimation in background conditions may lead to an overestimation in the natural contribution determined. The procedure in Section 4.1 has been used in the form of a checklist throughout this report as basis for the assessment of the methodology used by each Member State when reporting Saharan dust corrections.

Section 4.2 outlines the methodology for the **determination of sea salt contributions to PM**, highlighting that daily contributions of sea salt may be present through the year. However, these will be episodic, varying in intensity due to changeable meteorological factors like wind speed and direction. The recommended method is based on chemical analysis of 24-hour PM_{10} samples to determine exceedances as a result of sea salt, at a specific measurement point. Section 4.2.1 suggests that these contributions should be identified and quantified through analysis of at least one major component in sea salt (e.g., inorganic ions in Table 4 of the Commission's natural source guidelines).[5] However, chloride (Cl^-) alone is not recommended due to large margins of uncertainty in Cl^- observations. A simpler parameterisation is also accepted. It assumes that sea salt is made up of only sodium chloride (NaCl) and uses measurements of only sodium (Na^+) and/or Cl^- ions as tracers to determine overall sea salt concentrations. The concentration calculated can be attributed to the sea salt contribution and deducted. Section 4.2.2 states that the methodology presented in the guidelines is only applicable in the area that the spatial representativeness of the measurement is determined. Section 4.2.3 provides a critical discussion for this method, including:

- considerations of the time coverage of chemical composition measurements (to account for the episodic nature of this sea salt contributions);
- avoiding methodologies based on determining contribution from other days, or scaled down from annual mean estimates unless these are demonstrated to be representative on each specific day;
- justifying spatial extrapolation from the point of assessment to a wider area through representative analysis or validated modelling; and
- addressing potential overestimations, such as the possible artefacts from winter salting (contributions of which should be determined separately to avoid double counting).

Section 4.3 provides an overview for the determination of volcanic eruptions, geothermal, and seismic activities. However, this was not used in this assessment of any Member States methodologies.

Finally, Section 4.4 of the Commission's natural source guidelines provides an overview for the **determination of wild-land fires**. Since wild-land fires are typically of anthropogenic origin and may be prevented or controlled with appropriate action, Member States should only identify and subtract this contribution if emissions are transported from outside the Member State and provisions of Directive 2008/50/EC related to transboundary pollution have been applied. Despite several good examples that highlight how this natural contribution can lead to an exceedance in PM_{10}, no exhaustive method for the identification and quantification of wild-land fire had been developed and communicated to the Commission in the framework of the annual report on air quality assessment at the time of writing of the guidelines. A suggested method that meets each of the key principles is provided in Section 4.4.1, using satellite images, back trajectories and further dispersion modelling to determine the wild-land fire event, cross-referenced with peaks in measured PM_{10} time series, and using the 30-day average PM_{10} concentration (excluding episode days) to determine the background concentration. This is deducted in a similar way to the Saharan dust contribution, while justifying the spatial extent to which it has been applied. Section 4.4.2 discusses developments to this method at the time of writing the Commission's natural source guidelines.

1.2 SUMMARY OF THE COMMISSION'S SEC (2011) 207 FINAL DOCUMENT – WINTER SANDING AND SALTING GUIDELINES

Commission Staff Working Paper SEC (2011) 207 final "establishing guidelines for determination of contributions from re-suspension of particulates following sanding or salting of roads under the Directive 2008/50/EC on ambient air quality and cleaner air for Europe" provides Member States with guidelines on when they are able to subtract the contribution from re-suspension of particles following winter sanding or salting of roads before comparing the ambient air pollution concentration to the limit values. This document is

[5] SEC (2011) 208 final document, Table 4, pages 25-26.

hereafter referred to as the “SEC (2011) 207 final document” and “the Commission’s winter sanding and salting guidelines”.

In this section we provide a brief description of the Commission’s winter sanding and salting guidelines (SEC (2011) 207 final document) and contents of each section, particularly those used in our assessment of Member States approach, is detailed below.

Section 1 of the Commission’s winter sanding and salting guidelines provides a general introduction of the legal provisions for air quality limit value exceedances set in the EU, and the aim and scope for providing evidence for identifying and quantifying the impact of winter sanding or salting. This chapter also includes definitions of winter sanding and salting.

Section 2 describes the key principles which outline the criteria which a Member State must meet in order to subtract the contributions to PM_{10} limit value exceedances attributable to winter sanding or salting. These key principles are detailed further in Section 1.2.1 of this document, below.

Section 3 of the Commission’s winter sanding and salting guidelines provides an overview of the guidelines for the identification of the influence of winter sanding or salting on PM_{10} levels, by detailing the influence these sources have on chemical composition and particle size.

Section 4 details the recommended methodology for quantifying the fraction of PM_{10} which is attributable to winter sanding and salting. This includes detail on three different methodologies, provided in three sections:

- 4.1 quantifying winter sanding, by identifying the difference between measured $PM_{2.5}$ and PM_{10};
- 4.2 quantifying winter salting by chemical composition (using chloride);
- 4.3 quantifying winter sanding by chemical composition (using mineral dust).

Each includes any conditions or requirements which must be met for this methodology to be used, as well as suggested procedures and previous examples of its application. This excludes Section 4.3, which states no preferred method could be recommended at the time of writing the Commission’s winter sanding and salting guidelines.

Section 5 outlines the requirement for the Member States to document and report the determination of winter sanding or salting contributions, which should be uploaded annually onto EIONET CDR. There are no specific guidelines for structure but required content is specified, including a description of methodology and the subsequent results including identification and quantification information.

Annexes in the SEC (2011) final document outline existing procedures used to identify and quantify the impact of winter sanding or salting, as well as an example report outline for Member States to populate.

1.2.1 Winter sanding and salting source contribution assessment criteria

Section 2 of the Commission’s winter sanding and salting guidelines (SEC (2011) 207 final document) describes the key principles that outline the minimum requirements to determine the actual contributions of winter sanding or salting to total PM_{10} concentrations. These are reproduced as follows:

1. Contributions must be attributed unequivocally to winter sanding or salting activities;
2. Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value;
3. Representativeness of the measuring stations at which contribution is determined;
4. The contribution of winter sanding or salting to the measured PM_{10} concentration has to be quantified in $\mu g\ m^{-3}$ for each exceedance day under consideration;
5. The method to determine this contribution has to be documented.

The application of all key principles set out in Section 2 of the Commission’s winter sanding and salting guidelines has to be identifiable in the methodology applied by the Member State in the document. Table 2 below provides a summary of the criteria required Commission’s winter sanding and salting guidelines (SEC (2011) 207 final document) against which we will assess Member States correction methodology for winter sanding and salting contributions.

Table 2 Summary of the criteria detailed in the Commission's winter sanding and salting guidelines – SEC (2011) 207 final document.

Key principle		Summary of description	Reference[6]
1	Contributions must be attributed unequivocally to winter sanding or salting activities	Recommended methods (where possible) to identify winter sanding and salting contributions are outlined in Section 4 of the Commission's winter sanding and salting guidelines. These include the identification of winter sanding by assessing the size fractions of PM (difference between $PM_{2.5}$ and PM_{10}) or chemical composition of PM_{10} (using mineral dust), as well as identifying the contribution of winter salting by chemical composition (using chloride). Sources that may have a similar influence on PM_{10} levels have to be excluded, such as sea spray or salt from industrial sources when using a method based on chloride analysis. In the case of using a method based on coarse fraction quantification (PM_{10} – $PM_{2.5}$) emissions from road abrasion, tyre and break wear, construction activities, agriculture, natural sources, and re-suspension of material from such sources should be excluded.	Section 2, pages 7-8
2	Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value	Quantification must be as precise as possible, and the best estimate must always be used. Uncertainties related to the quantification must be documented in the reporting. Quantification of the contributions from winter sanding and salting can be applied as a first step to days exceeding the PM_{10} concentration of 50 µg m^{-3}. For other days, quantification of winter sanding or salting contributions are also deemed relevant where the subtraction is to be applied to the annual mean limit value; a 'reduced' annual mean value may be calculated from the 'reduced' daily mean values.	Section 2, page 8
3	Representativeness of the measuring stations at which contribution is determined	Concentrations at roadside monitoring stations near to the identified winter sanding or salting events should be corrected for each measurement station separately. When the results are to be applied at a wider spatial scale, a representative area of the affected monitoring site should be used. This should be restricted where appropriate to account for the specificity of the source and the different dispersion characteristics of the winter sanding and salting component.	Section 2, page 8
4	The contribution of winter sanding or salting to the measured PM_{10} concentration has to be quantified in µg m-3 for each exceedance day under consideration	For each day that a reduction due to winter sanding or salting is applied, this reduction must be quantified as a concentration. The daily PM_{10} value should not be subtracted from exceedance statistics after identifying an influence of winter sanding for this day.	Section 2, page 8

[6] All reference locations refer to the SEC (2011) 207 final document.

Key principle		Summary of description	Reference[6]
5	The method to determine this contribution has to be documented	Must be documented as a reference to a report or a publication, which gives information about the input data used and the assumptions on which estimates are based. Accepted methods are outlined in Section 4 of guidelines.	Section 2, page 8

1.2.2 Recommended methods for the subtraction of the contribution from winter sanding and salting

As indicated above, Section 4 of the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) outline the recommended methodologies for the subtraction of eligible contributions from winter sanding and salting.

The size fraction of particulate matter (PM) can be used to determine the contribution of winter sanding at traffic measurements stations. PM_{10} contributions from winter sanding are predominantly in the "coarse" size fraction (defined as the difference between PM_{10} and $PM_{2.5}$; PM_{10}–$PM_{2.5}$), generated by the mechanical grinding of larger sand grains on road surfaces. As such it is expected that the contribution of winter sanding to the $PM_{2.5}$ fraction is low. Therefore, the ratio of the coarse fraction to total PM_{10}, or $PM_{2.5}/PM_{10}$, may therefore be a suitable indicator for the impact of winter sanding, in comparison to sites known not to be affected. At the time of writing the Commission's winter sanding and salting guidelines, no standardised methods were proposed to identify or quantify the contribution of winter sanding based on its chemical composition (e.g., mineral dust). For winter salting events, however, the dispersion of salt or a salt solution (e.g., NaCl, $CaCl_2$, or $MgCl_2$) may be easily detected by chemical analysis. A recommended method for this is therefore outlined in the Commission's guidelines, including considerations to discern the influence of sea spray, where spatially relevant.

Three different methods are discussed:

- Winter sanding – difference between $PM_{2.5}$ and PM_{10}
- Winter salting – chemical composition (chloride)
- Winter sanding – chemical composition (mineral dust)

In this section of this report, we have provided a brief description of each.

Section 4.1 of the Commission's winter sanding and salting guidelines detail a method that attributes a fixed percentage (50%) of the coarse fraction (PM_{10}–$PM_{2.5}$) to winter sanding, based on modelling studies in Finland. This percentage is considered preliminary until further research is conducted to increase its robustness. The suggested procedure for this method (Section 4.1.2) provides a list of conditions that must apply for this method to be used for the deduction of each individual day, including: proving winter sanding activities have taken place and that the remains were on the road or adjacent footpaths, demonstrating that the road surface was dry, and showing that the measured $PM_{2.5}/PM_{10}$ ratio at the site is less than or equal to 0.5. Each of these criteria are discussed in further detail in Sections 4.1.2.1 to 4.1.2.3, including acceptable evidence for each, such as the acceptable parallel monitoring situations for PM_{10} and $PM_{2.5}$ to determine the ratio. Section 4.1.2.4 states that the contribution from long-range transport should be inspected for each day, to ensure this does not affect the measured size fraction ratio. The final sections outline the location of examples of this method (Section 4.1.3) and critical discussions of its use (Section 4.1.4).

Section 4.2 provides an outline of a method used to quantify the contribution of winter salting to PM_{10} using chemical analysis of 24-hour PM_{10} samples, to quantify chloride (Cl^-) ions. The requirements for use of this method (Section 4.2.1) include daily chemical analysis of PM_{10} for the days affected by winter road salting, evidence that the salt used contains chloride, and ensuring that no other sources of salt (e.g., sea spray) caused the increased PM_{10} concentration. The suggested procedure (Section 4.2.1) includes collecting evidence for the requirements, chemical analysis of chloride (or other relevant chemical constituent of the dispersed salt used) in PM_{10}, and subtracting the derived fraction attributed to salt from the measured PM_{10} concentrations. Again, the final sections outline examples of this method (Section 4.2.3) and critical discussions of its use (Section 4.2.4), noting that the contributions of sea spray and winter salting should be clearly distinguished.

Section 4.3 states that no preferred method based on the chemical analysis of mineral dust in PM_{10} samples can be recommended to determine the contribution of winter sanding, at the time of writing the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document). This is because quantification of emissions of mineral material and attribution of PM_{10} fractions to specific sources is complex. The chemical composition of sanding materials is diverse, and many other sources have similar compositions (e.g., road abrasion). Some principles and pre-requisites for using a method based on this procedure, however these are not applicable in this report as it is not used.

The recommended procedures in the Section 4 of the Commission's winter sanding and salting guidelines have been used in the form of a checklist throughout this report as basis for the assessment of the methodology used by each Member State when reporting winter sanding and salting contributions.

2. METHODOLOGY

In both of the Commission's winter sanding and salting (SEC (2011) 207 final document) and natural source guidelines (SEC (2011) 208 final document) there is a requirement for Member States to report their contributions from these sources to the Commission and to the public (online or in EIONET CDR). This section of the report outlines the methodology followed to identify those Member States that relied upon Article 20 and or 21 of Directive 2008/50/EC and applied a correction to their data for natural source or winter salting/sanding contributions. The European Environment Agency (EEA) have harvested the data from the EIONET Central Data repository and collated the data in user tables.[7] It was agreed with the European Commission in the inception meeting that utilising the collated European Environment Agencies attainment table G was the most efficient way to identify Member States that had applied a correction. The methodology that was followed has been detailed in Section 2.1 below.

2.1 METHODOLOGY FOR IDENTIFICATION OF MEMBER STATES THAT APPLIED A CORRECTION FOR NATURAL SOURCES OR WINTER SALTING OR SANDING

Member States that corrected reported measurements of PM_{10}, as a result of the influence of natural sources or winter sanding or salting of roads, were initially identified in the "Air Quality Attainments (data flow G)" table on the EEA European Air Quality Portal "Users' Corner" between 2013 and 2020.[8] This data was not filtered on the website, and downloaded as a CSV (22nd February 2022), and will hereafter be referred to as the "dataflow G summary document".

It was clear from analysis of this dataflow G summary document that there were discrepancies in how Member States had reported the required information (see Figure 1 and Figure 2 for example EEA attainment table G download). [9,10] This included, but was not limited to:

- "Exceedance Type Id" (column K) – completed with a mixture of "adjustment" and "final" where corrections had been used. Some Member States, such as Poland, provided multiple entries for the same calendar year to detail the adjustment and final concentration, whereas other countries only presented one (e.g., Bulgaria presented only "adjustment").
- "Adjustment Type" (column X) – consistently completed by Member States, with either "Natural source correction", "Winter-sanding or -salting correction" or "Fully corrected". The latter was used if "Exceedance Type Id" was "final" (See Figure 1 line 677).

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[7] EEA European Air Quality Portal, Users' Corner, https://aqportal.discomap.eea.europa.eu/index.php/users-corner/ (last accessed 17th June 2022).

[8] EEA, Air Quality Attainments (dataflow G), https://eeadmz1-cws-wp-air02.azurewebsites.net/index.php/users-corner/attainment-g-table/ (last downloaded 22nd February 2022).

[9] The code lists we were directed to by the European Commission were at: European Air Quality Portal, Reporters' Corner, Code lists, https://eeadmz1-cws-wp-air02.azurewebsites.net/index.php/reporters%20corner/code-lists/ (last access attempt 24th June 2022). However, we were unable to access these as the website "refused to connect" on every attempt so alternative sources of the same information were found.

[10] Code lists used to format submission of xml lead to a broken webpage in the European Air Quality Portal Reporters' Corner ("dd.eionet.europa.eu refused to connect."). As such, definitions of column names from an alternative source were found in the EIONET Data Description Vocabularies, at https://dd.eionet.europa.eu/vocabularies?expand=true&expanded=&folderId=1#folder-1 (last accessed 17th June 2022).

- "Adjustment Source" (column Y) – occasionally completed by the Member States to detail the specific source deducted from the relevant measurement metric (number of days in exceedance in a calendar year or annual mean). This column was completed if the "Exceedance Type Id" and "Adjustment Source" were "final" and "Fully corrected" (e.g., Slovenia, Portugal, or UK), or "adjustment" and "Natural source correction" (e.g., Cyprus or Spain). On some occasions, this information was missing (e.g., Germany in 2016). Spain also has a discrepancy in their data reported for zone ES1219 in 2019 and 2020. The reported "Adjustment Type" is "Winter-sanding or -salting correction" but the corresponding "Adjustment Source" is "Sea spray" (2020 example shown on line 31699 of Figure 3). This is discussed further in Appendix 9.
- "Description of Assessment Type" (column AA) – occasionally completed by the Member State to provide information contrary to the "Adjustment Source". For example, Greece stated an "Adjustment Source" of sea spray for 2018, 2019 and 2020, but the "Description of Assessment Type" specifies a "methodology for subtraction of natural contribution of Saharan dust" for all and makes no mention of sea spray. A screenshot of this is shown in Figure 4.

Figure 1 Screenshot of EEA attainment table G illustrating the different reporting terms in Exceedance Type ID (column K) and Adjustment Type (column X)*

	A	B	C	F	G	I	J	K	L	M	N	X	Y	
1	Country	B-G Namespace	Year	AQ Zone Id	Air Polluta	Objective Type	Reporting Metric	Exceedance Type Id	Is Exceedance	Numerical	Number Of Exceedances	Adjustment Type	Adjustment Source	A
664	Cyprus	CY.DLI-MLSI.AQ	2017	ZON_CY001A	As in PM1(	Target Value (TV)	Annual mean / average	final	No	0				
665	Cyprus	CY.DLI-MLSI.AQ	2017	ZON_CY001A	BaP in PM:	Target Value (TV)	Annual mean / average	final	No	0				
666	Cyprus	CY.DLI-MLSI.AQ	2017	ZON_CY001A	PM2.5	Exposure concentrati	Average Exposure Indicator	final	No	16				
667	Cyprus	CY.DLI-MLSI.AQ	2017	ZON_CY001A	PM2.5	Limit Value (LV)	Annual mean / average	final	No	14.5				
668	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	SO2	Critical level (CL)	Annual mean / average	final	No	0		None applied		
669	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	SO2	Critical level (CL)	Winter Mean	final	No	0				
670	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	SO2	Limit Value (LV)	Days in exceedance in a calendar y	final	No		0			
671	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	SO2	Limit Value (LV)	Hours in exceedance in a calendar	final	No		0			
672	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Annual mean / average	adjustment	Yes	45.2		Natural source correcti	High wind event outsi	Fi
673	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Annual mean / average	base	Yes	45.2		None applied		
674	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Annual mean / average	final	No	31.5		Natural source correction		
675	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Days in exceedance in a calendar y	adjustment	Yes		90	Natural source correcti	High wind event inside	In
676	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Days in exceedance in a calendar y	base	Yes		90	None applied		
677	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	PM10	Limit Value (LV)	Days in exceedance in a calendar y	final	No		21	Fully corrected		
678	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	O3	Long term objective (	AOT40 vegetation protection	final	Yes	29006				
679	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	O3	Long term objective (	Days in exceedance in a calendar y	final	Yes		66			
680	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	O3	Target Value (TV)	AOT40 vegetation protection avera	final	Yes	29565				
681	Cyprus	CY.DLI-MLSI.AQ	2018	ZON_CY001A	O3	Target Value (TV)	Days in exceedance averaged over	final	Yes		55			

** It should be noted some columns have been hidden to be able to fit all relevant columns into the Figure.*

Figure 2 Screenshot of EEA attainment table G illustrating the reporting terms in Adjustment Source (column Y) and Description of Assessment Type (column AA)*

J	K	L	M	N	X	Y	Z	AA	AB	AC	
Reporting Metric	Exceedance Type Id	Is Exceeda	Numeri	Number Of Exceedance	Adjustment Type	Adjustment Source	Assessment Ty	Description Of Assessment Type	Reason	Reason	Ad
Annual mean / average	final	No		0	No corrections applicable						
Days in exceedance in a calendar y	final	No		0	No corrections applicable						
Annual mean / average	final	No	4.58		No corrections applicable						
Annual mean / average	final	No	0.005		No corrections applicable						
Annual mean / average	final	No	0.12		No corrections applicable						
Annual mean / average	final	No	0.95		No corrections applicable						
Annual mean / average	final	No	0.85		No corrections applicable						
Annual mean / average	final	No	0.47		No corrections applicable						
Annual mean / average	final	No	13.38		No corrections applicable						
Average Exposure Indicator	final	No	12.27		No corrections applicable						
Three consecutive hours in exceed	final	No		0	No corrections applicable						
Days in exceedance in a calendar y	final	No		0	No corrections applicable						
Hours in exceedance in a calendar	final	No		0	No corrections applicable						
Annual mean / average	final	No	39.3		No corrections applicable						
Days in exceedance in a calendar y	adjustment	No		35	Winter-sanding or -salti	Atmospheric resuspension inside the	Fixed measureme	PM2.5 data used from urban station :Report on QuantIfication			
Days in exceedance in a calendar y	adjustment	No		34	Natural source correcti	Sea spray	Fixed measureme	NaCl measurements for the quantification of Sea Spray :Repor			
Days in exceedance in a calendar y	adjustment	No		32	Natural source correcti	Wild-land fire outside the Member S	Fixed measureme	PM10 data used from rural station: Report on QuantIfication c			
Days in exceedance in a calendar y	base	Yes		66	None applied						
Days in exceedance in a calendar y	final	No		32	Fully corrected						

** It should be noted some columns have been hidden to be able to fit all relevant columns into the Figure.*

Figure 3 Screenshot of a subset of EEA attainment table G, focussing on PM_{10} data reported by Spain in 2020, to illustrate the discrepancy between Adjustment Type (column X) and Adjustment Source (column Y)*

	A	C	F	G	J	K	L	M	N	X	Y
1	Countr	Year	AQ Zone Id	Air Pollutar	Reporting Metric	Exceedance Type Id	Is Excee	Numer	Numbe	Adjustment Type	Adjustment Source
30159	Spain	2020	ZON_ES0128	PM10	Days in exceedance in a calendar year	adjustment	No		11	Natural source correction	Transport of natural particles from dry regions outside the Member State
30262	Spain	2020	ZON_ES0307	PM10	Days in exceedance in a calendar year	adjustment	Yes		68	Natural source correction	Transport of natural particles from dry regions outside the Member State
30484	Spain	2020	ZON_ES0501	PM10	Annual mean / average	adjustment	No	27		Natural source correction	Transport of natural particles from dry regions outside the Member State
30487	Spain	2020	ZON_ES0501	PM10	Days in exceedance in a calendar year	adjustment	No		9	Natural source correction	Transport of natural particles from dry regions outside the Member State
30499	Spain	2020	ZON_ES0504	PM10	Days in exceedance in a calendar year	adjustment	No		11	Natural source correction	Transport of natural particles from dry regions outside the Member State
30515	Spain	2020	ZON_ES0508	PM10	Days in exceedance in a calendar year	adjustment	No		6	Natural source correction	Transport of natural particles from dry regions outside the Member State
30543	Spain	2020	ZON_ES0510	PM10	Annual mean / average	adjustment	No	32		Natural source correction	Transport of natural particles from dry regions outside the Member State
30546	Spain	2020	ZON_ES0510	PM10	Days in exceedance in a calendar year	adjustment	No		32	Natural source correction	Transport of natural particles from dry regions outside the Member State
30561	Spain	2020	ZON_ES0511	PM10	Days in exceedance in a calendar year	adjustment	No		9	Natural source correction	Transport of natural particles from dry regions outside the Member State
30589	Spain	2020	ZON_ES0513	PM10	Annual mean / average	adjustment	No	26		Natural source correction	Transport of natural particles from dry regions outside the Member State
30592	Spain	2020	ZON_ES0513	PM10	Days in exceedance in a calendar year	adjustment	No		21	Natural source correction	Transport of natural particles from dry regions outside the Member State
31699	Spain	2020	ZON_ES1219	PM10	Days in exceedance in a calendar year	adjustment	No		16	Winter-sanding or -salting correction	Sea spray

** It should be noted some columns have been hidden to be able to fit all relevant columns into the Figure.*

Figure 4 Screenshot of a subset of EEA attainment table G, focussing on PM_{10} data reported by Greece in 2018–2020, to illustrate the discrepancy between Adjustment Source (column Y) and Description of Assessment Type (column AA)*

	A	C	F	G	J	K	X	Y	AA	AH	AI	AJ	AK
1	Countr	Year	AQ Zone Id	Air Pollutar	Reporting Metric	Exceedance Type Id	Adjustment Type	Adjustment Source	Description Of Assessment Type				
50884	Greece	2018	ZON-EL0001	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
50924	Greece	2018	ZON-EL0003	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
50941	Greece	2018	ZON-EL0004	PM10	Annual mean / average	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
50944	Greece	2018	ZON-EL0004	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51003	Greece	2019	ZON-EL0003	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51020	Greece	2019	ZON-EL0004	PM10	Annual mean / average	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51023	Greece	2019	ZON-EL0004	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51043	Greece	2020	ZON-EL0001	PM10	Annual mean / average	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51046	Greece	2020	ZON-EL0001	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				
51102	Greece	2020	ZON-EL0004	PM10	Days in exceedance in a calendar year	adjustment	Natural source correction	Sea spray	A methodology for subtraction of natural contribution of Saharan dust in PM10 is applied implementing the Commission S				

** It should be noted some columns have been hidden to be able to fit all relevant columns into the Figure.*

The unfiltered dataflow G summary document (84,485 rows) was too long to manually search. Since the filters used were not consistent for each Member State, an alternative method was used to avoid missing potential corrections. The first step was to use R language programming[11] to search and identify key terms in the unfiltered dataflow G summary document. The columns searched in this CSV, as well as the key terms specifically included and excluded from the search have been provided in Box 1, below. The method was structured to avoid excluding any corrections, but still capture the discrepancies between Member States. This includes:

- Searching for every key term in all columns specified.
- Searches returning both partial and full matches to the terms. For example, the key term "correct" identified entries of both "correction" and "corrected".
- Searches were not case sensitive, e.g., "NaCl" would return "nacl" if found.

Since this search was intentionally broad and incorporated many columns of pre-defined entries to choose from in English, key terms in other languages were not specifically considered.

Box 1 Summary of the columns searched within the full dataflow G summary document downloaded from the European Air Quality Portal,[12] alongside the key terms included and excluded within the search criteria to identify reporting of natural source or winter sanding and salting corrections. Every key term was searched for in all columns specified.

Columns searched (column position in csv):	Key terms included:	Key terms excluded:
"Air Pollutant" (column G)	"adjustment"	"no correction"
"Exceedance Type Id" (column K)	"correct"	"none applied"
"Is Exceedance" (column L)	"dry region"	
"Adjustment Type" (column X)	"dust"	
"Adjustment Source" (column Y)	"fire"	
"Assessment Type" (column Z)	"NaCl"	
"Description of Assessment Type" (column AA)	"natural"	
"Reason" (column AB)	"PM10"	
"Reason Other" (column AC)	"Sahara"	
"Comment" (column AE)	"sea"	
"Source Data URL" (column AF)	"salt"	
	"sand"	
	"volcan"	
	"wind event"	
	"winter"	

The results of this search were then manually examined to obtain a final list of the corrections declared. This step included examining the context of each row, with particular note of the "Exceedance Type Id", "Adjustment Type" and "Adjustment Source" columns as described above. Incorrectly identified rows of the filtered dataflow G summary document (such as Luxembourg where the only indication of a correction was the key term "correction" in the "Source Data URL") were ignored.

It should be noted here that the extensive list of search terms that were necessary to use to identify all Member States that applied a correction due to natural sources or winter sanding or salting illustrates the inconsistent approach of submitting the data to EIONET by different countries. This has been identified as an area that could be improved in future guidelines to help Member States complete their submissions in a more consistent way.

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[11] R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[12] EEA, Air Quality Attainments (dataflow G), https://eeadmz1-cws-wp-air02.azurewebsites.net/index.php/users-corner/attainment-g-table/ (last downloaded 22nd February 2022).

When the list of Member States that applied a correction was shared with the European Commission, it was highlighted that the adjustment applied by France (Martinique, FR02ZAR01) in 2018 was not identified. An assessment of the correction methodology used had been assessed under the previous "SR3 contract".[13] This led the European Commission to request that the xml files in Dataflow G were checked to ensure no other adjustments were missed.

After discussion with the European Commission, it was decided that this study would focus on the Member States which had made adjustments to their data during the period 2018 to 2020. Ricardo undertook a manual search for all Member States for years 2018, 2019 and 2020 for any further corrections applied. No other countries were identified in this search. Therefore, the final list of countries identified as having a correction applied is limited to this period in the results table. For completeness, the following list of corrections identified during our initial investigation have been excluded from further assessment as part of this project:

- France (2013) – natural source correction ("Adjustment Type") from a high wind event outside the Member State ("Adjustment Source"). Excluded due to year of adjustment outside the study period.
- France (2018) – natural source correction (Saharan dust). This correction had previously been assessed against the guidelines under the previous contract (SR3) and is not included in this assessment.
- Iceland (2013) – natural source correction ("Adjustment Type") from a high wind event inside the Member State ("Adjustment Source"), and a winter-sanding or -salting correction ("Adjustment Type"). Excluded as not part of the European Union.
- Portugal (2015 and 2017) – natural source correction ("Adjustment Type") from transport of natural particles from dry regions outside the Member State ("Adjustment Source"). Excluded due to years of adjustment outside the study period. The correction methodology presented by Portugal for 2017 has been assessed against the guidelines under the previous "SR3 contract".[14]
- An assessment of the methodology provided by Portugal in 2016, 2017 and 2018
- United Kingdom (2013, 2014 and 2015) – natural source correction ("Adjustment Type") from sea spray ("Adjustment Source"). Excluded as no longer part of the European Union.
- Austria (2018) – no declared "Adjustment Type" or "Adjustment Source" in the dataflow G summary document. Although in the XML file uploaded to Austria's "Attainment 2018" envelope on Dataflow G,[15] the "BaseExceedanceDescription" sheet has reported an exceedance (column E) as "true" for zone "AT.0008.20. AQ/Zon-AT_60" for the number of days in exceedance of the daily limit value. The same entry in the "FinalExceedanceSituations" sheet (column E) is reported as "false" and the "valueAfterAdjustment" (column K) also reports "false". No further information could be found on what adjustments had been made to the data and therefore this country was not investigated any further in this assessment.
- Germany (2018 and 2019) – winter-sanding or -salting correction "AdjustmentType" (column X). The same is stated in the "Adjustment Type" (column L) the XML files uploaded to Germany's "2018_v3" and "2019_v4" envelopes on Dataflow G.[16,17] of the "FinalExceedanceSituations" sheet. All of these sites have reported "false" in the "Exceedance" column (E) of the "BaseExceedanceDescription" sheet, and no methodology documents were provided for any correction applied in Germany. Therefore, this was not investigated further in this assessment

The results of this stage of the assessment are presented in Table 3 and Table 4 below. These Member States correction methodologies were then assessed against the Commission's natural source guidelines (SEC (2011) 208 final document) and/or the winter sanding and salting guidelines (SEC (2011) 207 final document) following the methodology outlined in Section 3 of this report.

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[13] Technical assessment of the attribution of exceedances of natural sources in Martinique, France in 2017, delivered on 28th October 2021 under the previous "SR3 contract" outlined in the table of abbreviations.

[14] Technical assessment of the attribution of PM_{10} exceedances to natural sources in Portugal, delivered on 20th December 2019 under the previous "SR3 contract" outlined in the table of abbreviations.

[15] AT Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/at/eu/aqd/g/envxyswyg/AQD_Dataset_G_2018_AT.xml/manage_document

[16] DE Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/de/eu/aqd/g/colxwtzeq/envxdjuqa/DE_G_Attainment_2018.xml/manage_document

[17] DE Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/de/eu/aqd/g/colxx6vla/envx2mdcq/DE_G_Attainment_2019.xml/manage_document

Table 3 Summary of the information available through the e-Reporting tool and confirmed through Dataflow G for 2018–2020.

Country	Correction type stated	Correction applied	Years	Adjustment reason
Bulgaria	Winter sanding or salting	Winter salting	2020	Not available
Cyprus	Natural source	Sea spray and Saharan dust	2018, 2019, 2020	High wind event inside the Member State
Greece	Natural source	Saharan dust	2018, 2019, 2020	Transport of natural particles from dry regions outside the Member State
	Natural source	Sea spray	2018, 2019, 2020	Sea spray
Latvia	Winter sanding or salting	Winter sanding	2018, 2020	Atmospheric resuspension inside the Member State
	Natural source	Sea spray and wild-land fire	2020	Wild-land fire outside the Member State Sea spray
Lithuania	Winter sanding or salting	Winter sanding	2018, 2019	Atmospheric resuspension inside the Member State
Malta	Natural source	Sea spray and Saharan dust	2018, 2019	Transport of natural particles from dry regions outside the Member State Sea spray
Poland	Natural source	Saharan dust	2018, 2019, 2020	Transport of natural particles from dry regions outside the Member State
	Natural Source	Wild-land fire	2020	Wild-land fire outside the Member State
	Winter sanding or salting	Winter sanding	2018, 2019, 2020	Atmospheric resuspension inside the Member State
Slovenia	Natural source	Saharan dust	2018, 2019	Transport of natural particles from dry regions outside the Member State
Spain	Natural source	Saharan dust	2018, 2019, 2020	Transport of natural particles from dry regions outside the Member State
	Winter sanding	Sea spray	2019, 2020	Sea spray*

** See screenshot of this discrepancy provided in Figure 3. This would require additional investigation through dataflow G.*

3. ASSESSMENT OF CORRECTION METHODOLOGIES REPORTED BY MEMBER STATES

The list of Member States obtained from Section 2.1 were then examined to identify which corrections were applied by each Member State, excluding those no longer considered part of the scope for assessment.

For each Member State, the reported XML file for each year between 2018 and 2020 were downloaded from the relevant envelopes on Dataflow G, at the EIONET Central Data Repository. If a resubmission folder was present for any of these years (e.g., Spain), the file was taken from that folder instead. To identify the correction type stated by each of the Member States the "FinalExceedanceSituations" sheet, column L "Adjustment Type" of each XML file was examined. The "Correction type stated" in the Member States XML files are presented in the second columns of Table 3 and Table 4 in this report. Similarly, the "Correction applied" column in Table 3 and Table 4 was populated using the "AdjustmentDescription" (column M) in each XML file. Since this was a free text field, the information provided here was not consistent for all Member States. As such, the correction applied (and subsequently assessed in the Appendices of this report) were cross-referenced against the methodology reports found for each Member State.

Methodology reports were often included in the same folder uploaded to the relevant year of the Member State envelope on Dataflow G. For Bulgaria's 2020 envelope, the report was restricted from public view at the time of the assessment, and we were provided with a copy from the European Commission via email (Table 4). Where reports were missing entirely, other reasonable sources were consulted. This included the respective government and specific environmental department or agency websites within the Member State, or within the "zone" provided in the XML file (column D) if it could be identified. Both specific correction methodology reports, and annual air quality reports were searched for. If the latter was identified, it was examined for the relevant methodology presented and ignored if not present. Reports were only assessed for the most recent year that a correction had been identified in that Member State, however previous years' methodologies were checked to ensure the same process had been applied.

3.1.1 Summary of Member State documents reviewed

This section provides a brief summary of the methodology documents used in the assessment of each Member State, the name referenced in relevant footnotes, and the location they were obtained from. This includes the methodology presented, as well as any type of additional documents the Member States have provided or referenced as evidence of how they have applied their corrections. A summary of the reports identified, and their sources, is provided in Table 4.

Table 4 Summary of methodology documents used in the assessment of natural sources or winter sanding and salting corrections reported by Member States (presented in the Appendices).

Country	Correction type stated	Correction applied	Source, referenced name of document, URL	Data downloaded
Bulgaria	Winter sanding or salting	Winter salting	Source: "Data Flow G 2020 BG" envelope on Dataflow G for Bulgaria Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020) https://cdr.eionet.europa.eu/bg/eu/aqd/g/envyucyhq/ Access to this report in the Bulgaria envelope on DfG was restricted from public view at the time of assessment, so a copy of the report and an English translation were provided by the European Commission via email.[18]	01/04/2022

[18] Email correspondence between the Commission and Ricardo, "RE: SR14 Task 2 templates", received 1st April 2022.

Cyprus	Natural sources	Sea spray and Saharan dust	Source: "Information on the attainment of environmental objectives 2020 V.1" envelope on Dataflow G for Cyprus Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020 https://cdr.eionet.europa.eu/cy/eu/aqd/g/envyubnwg/Report_2020.doc/manage_document	08/02/2022
Greece	Natural sources	Saharan dust*	Source: "G-Reporting year 2020" envelope on Dataflow G Finokalias Dust Methodology https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyvsqiw/Finokalias_Dust_methodology.pdf	10/02/2022
			Source: "G-Reporting year 2020" envelope on Dataflow G Finokalia PM_{10} 2020 [Data] https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyvsqiw/Finokalia_PM10_2020.xlsx/manage_document	10/02/2022
			Source: "Adjustments_dust_2020.zip" file uploaded to "G-Reporting year 2020" envelope on Dataflow G Greece [Data]: Dust Adjustments EL0001 (2020) https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyvsqiw/Adjustments_dust_2020.zip/manage_document	10/02/2022
			Source: "Adjustments_dust_2020.zip" file uploaded to "G-Reporting year 2020" envelope on Dataflow G Greece [Data]: Dust Adjustments EL0004 (2020) https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyvsqiw/Adjustments_dust_2020.zip/manage_document	10/02/2022
			Source: Air quality reports page of the Greek Ministry of Environment and Energy website Greece: Annual Atmosphere Quality Report 2020 https://ypen.gov.gr/perivallon/poiotita-tis-atmosfairas/ektheseis/	10/02/2022
Latvia	Winter sanding or salting Natural sources	Winter sanding, sea spray and wild-land fire	Source: "dataflow G_2020" envelope on Dataflow G for Latvia Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances (2008/50/EC Article 21) https://cdr.eionet.europa.eu/lv/eu/aqd/g/envyuh8zw/Report_on_Quantification_of_Winter_sanding__Sea_spray_and_Wild-land_fires_of__Contribution_to_2020_Exceedances.pdf	10/02/2022

Lithuania	Winter sanding or salting	Winter sanding	Source: “Reference year 2019” envelope on Dataflow G for Lithuania Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21) https://cdr.eionet.europa.eu/lt/eu/aqd/g/envx2nj4g/REPORT_ON_QUANTIFICATION_OF_WINTER_SANDING_CONTRIBUTION_2019.pdf	11/02/2022
Malta	Natural sources	Sea spray and Saharan dust	Source: “AQD_REP_MT_ERA_G-002_2019” envelope on Dataflow G for Malta Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019 https://cdr.eionet.europa.eu/mt/eu/aqd/g/envx38ahq/Justification_report_2019.pdf	10/02/2022
Poland	Winter sanding or salting Natural sources	Winter sanding, Saharan dust, and wild-land fire	Source: Voivodeship’s annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1444	14/02/2022
		Saharan dust and wild-land fire	Source: Voivodeship’s annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Łódzkie Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1441	01/03/2022
		Winter sanding, Saharan dust, and wild-land fire	Source: Voivodeship’s annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1421	01/03/2022
		Saharan dust	Source: Voivodeship’s annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Opolskie Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1425	01/03/2022
		Saharan dust	Source: Voivodeship’s annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Podkarpackie Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1423	01/03/2022

		Saharan dust	Source: Voivodeship's annual assessment of air quality on the Polish Chief Inspectorate for Environmental Protection website Annual Air Quality Assessment in Silesian Voivodeship for 2020, Annex 2 https://powietrze.gios.gov.pl/pjp/rwms/publications/card/1445	01/03/2022
Slovenia	Natural sources	Saharan dust	Source: Air quality annual reports, on the Republic of Slovenia, Ministry of the Environment and Spatial Planning departmental website Air quality in Slovenia in 2019 Annual Report (Kakovost zraka v Sloveniji v letu 2019) https://www.arso.gov.si/zrak/kakovost%20zraka/poro%c4%8dila%20in%20publikacije/Letno_Porocilo_2019_Za_Splet.pdf	18/02/2022
Spain	Natural sources	Saharan dust	Source: "Spain 2020_v1" envelope on Dataflow G Spanish adjustment of natural contribution of Saharan dust in PM_{10} https://cdr.eionet.europa.eu/es/eu/aqd/g/envyxfmyq/Spanish_adjustment_natural_contribution_2020.pdf	10/02/2022
			Source: Spanish adjustment of natural contribution of Saharan dust in PM_{10} document Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013 (Procedimiento para la Identificación de Episodios Naturales de PM_{10} y $PM_{2.5}$) https://www.miteco.gob.es/images/es/metodologiaparaepisodiosnaturales-revabril2013_tcm30-186522.pdf	23/03/2022
			Source: Spanish adjustment of natural contribution of Saharan dust in PM_{10} document Spain: Natural Particulate Matter Episodes 2020 (Episodios Naturales de Partículas 2020) https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/atmosfera-y-calidad-del-aire/episodiosnaturales2020_tcm30-529865.pdf	23/03/2022
			Source: Spanish adjustment of natural contribution of Saharan dust in PM_{10} document Spain [Data]: PM_{10} – Discounts to all stations 2020 (PM_{10} - Descuentos todas estaciones 2020) https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.miteco.gob.es%2Fes%2Fcalidad-y-evaluacion-ambiental%2Ftemas%2Fatmosfera-y-calidad-del-aire%2FPM10-descuentos_todas_estaciones_2020_tcm30-529863.xlsx&wdOrigin=BROWSELINK	17/02/2022

	Winter salting or sanding**	Sea spray	Source: "Spain 2020_v1" envelope on Dataflow G Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020 (Influencia del aerosol marino en la concentración de PM_{10} en A Coruña en 2020) https://cdr.eionet.europa.eu/es/eu/aqd/g/envyxfmyq/ES1219_Seasalt_2020.pdf	10/02/2022

** Sea spray is not an "Adjustment type" reported by Greece (GR) in the Dataflow G envelope for 2020, and the method is not outlined in attached information. This follows on from Greece's reporting discrepancy in the dataflow G summary document, presented in Figure 4.*

*** "Adjustment type" declared in Spain (ES) Dataflow G envelope for 2020 as winter salting or sanding, but correction calculated and applied for sea spray. This discrepancy is also seen in the dataflow G summary document (Figure 3).*

3.1.2 Critical assessment methodology

For each Member State identified as having made a correction for natural sources or winter sanding or salting a critical assessment of the methodology they applied has been undertaken comparing their methodology to the Commission's guideline documents. All assessments are presented in the Appendices and follow the same format.

Firstly, a general introduction outlines the corrections that a Member State has applied, and any important information specific to that Member States assessment.

Secondly, a summary table of the corrections reported in Dataflow G are presented. These utilise the XML files previously downloaded from Dataflow G for 2018, 2019 and 2020 (Section 3 introduction), where Member States have provided the baseline and final data for zones where corrections have been applied. All exceedances for the Member State are listed by zone, and only years where corrections have been made are included in the tables (links to Dataflow G XML files that were checked have been provided in footnotes for all three years).

A critical review of the assessment methodology applied by the Member State against the criteria outlined in the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) and/or the Commission's natural source guidelines (SEC (2011) 208 final document) has been undertaken.

Within each section assessing a Member States methodology for subtracting a natural source contribution, the six principles outlined in Section 1.1.1 have been critically discussed under correspondingly named sub-headings. Each natural source subtraction (e.g., sea spray or transport of natural particles from dry regions, such as Saharan dust) has been assessed against the same criteria. These sections have been separated if the methodology for each natural source correction has been presented in a separate document. Where the natural source corrections follow the Commission's guidelines, the methodology has been assessed against the recommended steps in the relevant section of the Commission's guidelines and presented in a summary table. If a new or different methodology has been utilised by the Member State, a more general assessment has been conducted. Each assessment has included recommendations to improve the reported methodology. Similarly, within each section assessing a Member States methodology for subtracting a winter sanding or salting contribution, the five principles outlined in Section 1.2.1 have been discussed under correspondingly named sub-headings. For each correction applied due to winter salting or sanding, the methodology reported has been assessed against the relevant recommended methodology outlined in the Commission's winter salting and sanding guidelines SEC (2011) 207 document and presented in a summary table.

Finally, an overall summary of the assessment conducted on Member States' reported application of the correction methodology, and any deviations from the Commission's guidelines, are presented in a summary section.

4. SUMMARY OF MEMBER STATE METHODOLOGY ASSESSMENTS AND RECOMMENDATIONS

The in-depth, systematic, and critical assessment for each Member State that applied either a natural source or winter sanding or salting correction has been provided in Appendices 1-9. This section of the report provides an overview of the Member States' correction reports evaluated, to evidence the correction(s) applied to measured PM_{10} concentrations in the year assessed. This has been divided into three sub-sections: a summary of correction assessments for natural sources (Section 4.1), a summary of correction assessments for winter salting or sanding (Section 4.2) and a recommendations section to highlight areas where Member States could improve the information provided (Section 4.3).

4.1 SUMMARY OF NATURAL SOURCE CORRECTION ASSESSMENTS

Table 5 presents a summary of our assessment of the Member States' methodologies applied for natural source corrections, compared to the Commission's natural source guidelines (SEC (2011) 208 final document). This table includes detail of the correction applied, year assessed, methodology used, as well as our overall assessment of the methodology reported by the Member States. It also includes highlights of where Member States have followed the guidelines or used new methodologies, omissions from the evidence presented by the Member State and recommendations for improvements to the information supplied. The rest of the section summarises all the natural source correction methodologies assessed, as well as examples of good practice which could be highlighted by the Commission or adopted into future recommendations and guidelines.

Table 5 Summary of notes on methodology assessed, and recommendations made for natural source corrections applied by Member States, compared to the recommendations from the Commission's natural source guidelines (SEC (2011) 208 final document). Comprehensive assessments for each Member State are presented in individual Appendices Sections 1-9.

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
Cyprus	Sea spray, Saharan dust	2020	Assumed to be the natural source guidelines, SEC (2011) 208 final document	**Not enough information provided to assess methodology used**	The report presents and discusses the results of a good quantification of sea spray and Saharan dust, but not of the methodology they followed to reach them. As such, not enough information is provided for the method used to be independently verified during this assessment. It is concluded from what has been presented, that the Commission's guidelines have been followed, but the steps taken, and subsequent evidence obtained have not been sufficiently presented. We recommend that the report is revised to present the information identified as missing.
Greece	Saharan dust	2020	The natural source guidelines, SEC (2011) 208 final document	**Follows Commission guidelines, but does not provide enough evidence to**	The daily PM_{10} data provided by Greece is clearly presented and shows the influence of each step of the methodology used. However, the number of days in exceedance do not match that submitted to DfG, and the method presented does not feature enough evidence or relevant

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
				support results	discussion (e.g., HYSPLIT results or satellite images for the identification of dust events, or discussion of possible sources of uncertainty to meet the criteria of the first key principle). We recommend that the report is revised to present the information identified as missing. It would be preferable if Greece would also address the difference between the data reported to Dataflow G and presented alongside their methods.
Latvia	Sea spray, wild-land fire	2020	The natural source guidelines, SEC (2011) 208 final document	Follows Commission guidelines, but does not provide enough evidence to support results	The methodology presented is very brief and does not include enough evidence or statements to confirm the steps taken. For example, it is not clear why only one day is corrected for sea spray, without discussion of discarded days or discussion of this natural sources' persistent nature. There is no specific detail on the chemical analysis conducted or whether Na^{+} concentrations measured to quantify the contribution of sea spray are made at the same site or elsewhere. Similarly, not enough evidence is provided to reliably indicate where or when the wild-land fire episode originated and how it reached Latvia in the subsequent days. Both corrections are also missing discussions of uncertainty, and potential artefacts, to meet the criteria of the first key principle. Consequently, the calculated sum could be an overestimate. We recommend that the report is revised to present the evidence and discussion outlined above to be missing.
Malta	Sea spray	2019	Other	Significant deviation from Commission guidelines	Sea spray is identified and corrected in 2019 using a simplified parameterisation method (derived in 2012-2013) which veers significantly from the Commission's guidelines. This method is not justified or examined in the presented report. We recommend that this aspect could be discussed, including further justification of substituted wind speed measurements using collected data.

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
					Similarly, possible uncertainties and potential artefacts in the quantified correction could be discussed (e.g., possible effects from alternative sources such as winter road salting), to meet the criteria of the first key principle.
	Saharan dust		The natural source guidelines, SEC (2011) 208 final document with additional methods of identification	Corrections applied in line with Commission guidelines, but missing discussion of uncertainty	The methodology presented for Saharan dust correction follows the Commission's guidelines and is fairly well evidenced. However, the Maltese report is missing the discussion of possible uncertainties and potential artefacts through evidence to meet the first key principle. The Hidden Markov Models (HMM) approach used in identifying Saharan dust events is robust and could be explored for future guidelines to satisfy the criteria of the fifth key principle. We recommend that the Maltese report include a critical analysis of the method used, and discussion of uncertainties in their results.
Poland	Saharan dust, wild-land fire	2020	New method utilising CAMS modelling	Possible improvement to the Commission guidelines, but not enough detail provided to justify or validate it	The Polish voivodeship reports provide a strong and varied evidence base which has been used to identify Saharan dust and wild-land fire episodes for each measurement station corrected. The evidence used generally follows the Commission's recommended sources. Quantified contributions for both natural sources have been determined using beam analysis models launched by the CAMS50 project. However, insufficient detail and evidence has been provided to describe, justify, or validate the model used in this method. We recommend that the reports are revised to include the identified missing discussion of uncertainties or possible artefacts.
Slovenia	Saharan dust	2019	The natural source guidelines, SEC (2011) 208 final document	Follows Commission guidelines, but does not provide enough	The methodology follows the Commission's guidelines but is missing some necessary information to independently validate the method used and results presented.

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
				evidence to support results	We recommend that this is added to the report, alongside discussion of uncertainty or potential artefacts to meet the criteria of the first key principle.
Spain	Sea spray	2020	The natural source guidelines, SEC (2011) 208 final document with additional analysis steps	**Corrections applied in line with Commission guidelines, but missing discussion of uncertainty**	The Spanish sea spray report provides a detailed methodology, and clear quantifications of sea spay corrections which were independently verified. Evidence provided for 2020 is extensive and analysed through multiple routes. However, this report is missing discussion of uncertainty and potential artefacts (e.g., winter road salting) to meet the criteria of the first key principle. We recommend this report be highlighted as an example, with a caveat about the missing discussion mentioned.
	Saharan dust	2020	The natural source guidelines, SEC (2011) 208 final document	**Follows Commission guidelines, but missing necessary evidence and discussion**	The documentation provided by Spain (linked through the main 2020 dust report) collectively provides enough information to verify quantified Saharan dust correction. However, the methodology assessed was written in 2013, and not discussed in relation to the year corrected specifically (2020). We recommended that zones referenced in the methodology and associated evidence use the same zones reported to DfG or provide a conversion to ensure transparency and allow for more straightforward verification of results.

Broadly, all Member States followed the guidelines provided by the Commission in the natural source guidelines SEC (2011) 208 final document when applying natural source corrections. However, a continuous theme noted between all assessments is the lack of sufficient information presented by each Member State to verify the methodology used. As such, only the parts of the methodology explicitly available could be assessed.

This ranges from Cyprus, who only present results in their report, to the Saharan dust correction methodology presented by Spain which provides an appropriate level of detail, but much of the cited method has not been described in relation to the year corrections have been applied (2020). This particularly pertains to the possibility of uncertainty in the calculations, and discussion of potential artefacts or interferences from other sources. This was similarly missing from all other Member States methodology reports assessed.

Many Member States fall somewhere between these, providing some information but not enough to allow the reported methodology to be reproducible by an independent third party. This includes missing evidence (e.g., satellite images and model results that confirm specific days affected by Saharan dust episodes), not confirming steps taken (e.g., only referencing the Commission's natural source guidelines with no further discussion), as well as discussions of potential uncertainty already mentioned.

Poland do not use the method recommended in the Commissions guidelines, instead adopting a new approach to quantify the contribution of Saharan dust and wild-land fire within the voivodeships. The use of the Copernicus Atmosphere Monitoring Service (CAMS) operational system for the identification of the episodes affected by natural sources is welcomed. However, the methodology used to calculate and quantify the contributions has limitations. Only quantified contributions of the natural sources are presented in the Polish voivodeship reports, and the method used for calculating the contribution is not discussed or validated with known measurements. A full methodology should be provided of how the quantification of natural sources is derived.

Some Member States provided examples of good practice within their reported methodologies which should be highlighted. These include:

- **Spanish sea spray report.** Generally, this report was the best examined. The methodology is provided with sufficient context, with a good level of detail for each step (from collection and analysis of filter measurements to the analysis of results). Evidence is clearly provided for each step, and little has been left ambiguous or too reliant on a single reference. Analysis of the results with respect to wind direction and wave height provide discussion to somewhat validate results, which many other Member States are missing. However, discussions of uncertainty and the possible artefacts (e.g., from winter salting) are missing. Data tables have been presented in a clear and interpretable manner.
- **Hidden Markov Models (HMMs) utilised by Malta.** In addition to the suggested method for identifying Saharan dust episodes in the Commissions guidelines, the use of HMMs adds robustness to the procedure. Using models to categorise daily PM_{10} concentrations into different regimes (describing different sources) based on hidden (unobserved) states, HMMs streamline the first step of identifying episodes, which can then be further analysed with satellite images, backward trajectories and dust forecast models. This approach could be considered for further evaluation by the Commission.
- **Presentation of PM_{10} data by Greece.** Excel data sheets were uploaded to Dataflow G (DfG) alongside the methodology which show various daily average concentrations of PM_{10} at Finokalia (the regional background station) and the measurement stations where the contribution was deducted for each day in 2020 where measurements were available. This included the daily averages of the quantified background concentration at Finokalia, the determined contribution of dust, and PM_{10} measured at all relevant stations pre- and post-deduction. The layout is clear, separated into different documents for the background calculations, and the deductions in each zone (EL0001 and EL0004). Relevant cells contain the formula used which could easily be verified (though this didn't completely agree with what was reported to DfG).
- **Presentation of evidence by Spain (Saharan dust correction).** The Spanish dust report for 2020 linked a 2013 methodology document, stated to be approved by the Commission. Alongside this, it linked numerous documents as evidence for details specific to 2020. This included a PM_{10} data sheet (demonstrating the deduction applied to each measurement station in each Spanish zone), and a document summarising the required evidence to identify natural PM_{10} episodes on the Iberian Peninsula, and in the Canary Islands. These documents are not without flaws (see full assessment in Appendix Sections A9.5 and A9.6) but make the evidence quite clear and easy to find.
- **Presentation of evidence by Poland.** The Polish voivodeship reports for 2020 provide extensive information used to confirm the presence of Saharan dust and wild-land fire events. This includes HYSPLIT backward trajectories, satellite imagery, NMMB-BSC dust flow maps, IMGW-PIB synoptic maps, NAAPS total optical depth, sulfate, dust and smoke surface concentration maps. For wild-land fire events, this includes evidence that the fire took place at the time and location stated (no other reports provided this evidence), as well as wind speed, direction, and precipitation maps. The standard for confirming an episode is high, resulting in few deductions being calculated for PM_{10} concentrations and no change in exceedance outcome for any zone.

4.2 SUMMARY OF WINTER SANDING OR SALTING CORRECTION ASSESSMENTS

Table 6 presents a summary of our assessment of Member States methodologies applied for winter salting or sanding corrections, compared to the Commission's winter salting and sanding guidelines (SEC (2011) 207 final document). This Table includes detail of the correction applied, year assessed methodology used, as well as our overall assessment of the methodology reported by the Member State. It also includes highlights of where Member States have followed the Commission's guidelines well, notable omissions from the evidence presented by the Member State and any recommendations for improvements to the information supplied. The rest of this section summarises all the winter sanding or salting correction methodologies assessed, as well as highlighting an example of good practice which could be highlighted by the Commission or adopted into future recommendations and guidelines.

Table 6 Summary of notes on methodology assessed, and recommendations made for winter sanding or salting corrections applied by Member States, compared to the recommendations from the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document). Comprehensive assessments for each Member State are presented in Appendices 1-9.

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
Bulgaria	Winter salting	2020	Chemical analysis of chloride	**Corrections applied in line with Commission guidelines, but missing discussion of uncertainty**	The methodology presented is clear and follows the Commission's guidelines well. The report clearly provides enough data to verify the results presented to DfG. We recommended that they include the missing discussions of uncertainty in their results (including potential artefacts, e.g., sea spray), to meet the criteria of the first key principle, that the source of the calculated adjustment should be unequivocally allocated as winter sanding or salting activities (e.g., no artefacts) and add description of unclear unit conversion in methodology for transparency.
Latvia	Winter sanding	2020	Coarse PM fraction	**Follows Commission guidelines, but does not provide enough evidence to support results**	The methodology provides a basic overview, which could mostly be verified but would benefit from more concrete evidence. Requires further critical discussion of results (e.g., uncertainty and possible artefacts), to meet the criteria of the first key principle: that the source of the calculated adjustment should be unequivocally allocated as a winter sanding or salting activities (e.g., no artefacts). Back trajectories from the NOAA HYSPLIT model have been stated to be used but no evidence is provided in the report. We recommend that since the PM_{10} and $PM_{2.5}$ used in this method are measured at different stations in Riga, a comparison between measured PM_{10} levels at both could be provided to give confidence to the choice of measurement station, and the calculated ratio. If would be preferable if Latvia also provided

Country	Correction applied	Year	Correction methodology used	Methodology assessment	Methodology notes and recommendations
					evidence of the NOAA HYSPLIT model results.
Lithuania	Winter sanding	2019	Coarse PM fraction	**Corrections applied in line with Commission guidelines, but missing discussion of uncertainty**	In general, a good reproduction of the Commission's recommended method, using the template provided. However, the report requires more critical discussion of results (including uncertainty and possible artefacts) to meet the criteria of the first key principle, namely that the source of the calculated adjustment should be unequivocally allocated as winter sanding or salting activities (e.g., no artefacts).
Poland	Winter sanding	2020	Coarse PM fraction	**Follows Commission guidelines, but does not provide sufficient evidence to justify method choice and support results**	Poland's choice of method requires further justification, as voivodeship reports state salt was spread on roads in both zones, not sand. As such the Commission's guidelines state the chemical composition of chloride is the relevant recommended method. The coarse PM fraction method is presented and assessed against the Commission's guidelines, noting this caveat. In general, the method follows the guidelines well but requires further discussion of evidence, the persisting contribution of winter sanding and salting (over 2-weeks), and possible sources of uncertainty and possible artefacts to meet the criteria of the first key principle.

All Member States mostly followed the guidelines provided by the Commission in the winter sanding and salting guidelines in the SEC (2011) 207 final document when applying winter sanding or salting corrections. However, a continuous theme noted between all assessments is the lack of sufficient information presented by each Member State to verify the methodology used. As such, only the parts of the methodology explicitly available were able to be assessed.

It should be noted that Poland's choice of method does not follow the Commission's guidelines and requires further justification for its use. Both Polish voivodeship reports that determine a winter sanding or salting correction state that winter salting took place near the urban traffic measurement stations deducted, but the winter sanding (coarse PM fraction) method is used to quantify it, over determining the chemical composition of chloride. This could be a misunderstanding or an issue stemming from translation of the Commission's guidelines, but the lack of discussion is a major omission in the otherwise acceptable reports. Similarly, Poland have quantified and deducted corrections over 2-weeks after the initial spreading event in certain locations. They have provided no discussion to evidence that the sand or salt remained on the road for that long or justified this assumption using peer-reviewed studies that show the effects of road spreading on PM_{10} can persist for at least that duration.

All Member State methodologies assessed are lacking discussion of possible sources of uncertainty and quantification of possible artefacts (e.g., brake and tyre wear contributions to winter sanding, or sea spray contributions to winter salting estimates) to avoid overestimation of each contribution.

Though no Member States report was determined to be a perfect example, some have provided an example of good practice within their methodology, which should be highlighted, as it is missing from each of the other reports assessed.

- **Presentation of the calculation steps by Bulgaria.** Once translated from Bulgarian Cyrillic script into English (Latin script), the data and calculation steps are clearly provided throughout the report. The calculation steps (Section 4.1 of the Bulgarian report) are logical and clear, providing good evidence from which to assess the method used. Similarly, the Tables of data are presented in a clear manner, leaving little room for misinterpretation. Ultimately, this allowed the independent assessment to be completed easily and adds a good level of transparency to the Bulgarian report.
- **Overall report submitted by Lithuania.** Lithuania used the winter sanding example report in the Commission's winter sanding and salting guidelines (Annex B) to present the required evidence for the correction applied. Although it is short, it meets the conditions presented in the Commission's guidelines clearly and mostly provides extra detail where required. The last table of the report summarises all the necessary data and evidence in relation to each day in exceedance which made verification of the results easy. Overall, it is a clear and concise report. However as with most other Member States, it is missing discussions of uncertainty and possible artefacts.

4.3 SUMMARY OF RECOMMENDATIONS

Our assessment initially started by trying to identify those Member States that had applied a correction for either natural sources or winter sanding and salting. As highlighted in Section 2.1 the identification of Member States that had applied a correction for either winter sanding and salting or natural sources was difficult due to the inconsistent approach taken by Member States when completing their submissions to Dataflow G.

Across all the Member States methodologies assessed (Appendices 1-9), the information and evidence provided by each Member State demonstrated that similar elements were consistently missing. This implies that either the guidelines provided by the European Commission are not being consulted thoroughly, or that the guidelines are not provided clearly. For example, where the Commission's guidelines are specific (e.g., the annual report checklist in Section 4.1.6 of the natural source guidelines; SEC (2011) 208 final document), the required contents are more likely to be presented. However, where the guidance is vague, there is more variability in the information presented by Member States. The specific areas noted in the assessments conducted in this report are highlighted in Box 2.

Box 2 Summary of recommendations to the European Commission based on the individual findings in the methodology of each Member State assessed.

Inconsistencies in data submitted to Dataflow G	The Commission could consider providing clearer instructions on how to report a correction to Dataflow G, so it can be more easily identified in the future and not miscategorised. The instructions could also address potential contradictions, such as Greece reporting an "Adjustment Type" of sea spray, but a "Description of Assessment Type" specifying only a methodology for correcting Saharan dust contributions.
Missing discussions of uncertainty	In both the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) and the natural source guidelines (SEC (2011) 208 final document), the first key principle discusses that the source of the calculated adjustment should be determined to be exclusively contributed by the specified source (e.g., no artefacts). This is the most common omission from all reports assessed. We recommend that the Commission consider adding more detailed instructions on how to do this within the guidelines. For example, it would be useful to illustrate to Member States that if they are providing evidence of winter salting correction, they should explicitly state there is no possible influence of sea salt due to the distance of the monitoring

	station from the closest sea/ocean, or clearly state that the method they have used to determine the correction is solely due to winter salting and no other sources. The Commission's guidelines could be updated to give clear examples of what evidence should be provided to satisfy the requirements of the first key principle.
Necessary evidence not presented	The Commission's guidelines excel where it specifies what exactly should be included in the report, almost as a checklist. For example, there are many fewer instances of missing information for Saharan dust corrections, than there are for sea spray corrections due to the clarity of Section 1.4.6 of the Commission's natural source guidelines (SEC (2011) 208 final document). Similarly, the results template provided for reporting winter sanding or salting methodologies in Annex B of the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) provided a good base from which Bulgaria, Latvia and Lithuania presented their results. As such, the necessary information has been clearly laid out, and the evidence that the required conditions had been met were easy to identify. We recommend that similar resources could be provided for the other valid corrections (e.g., sea spray) where specific evidence is required to verify the Member States' methodology and results. This will help more Member States meet the fifth key principle in the Commission's winter sanding and salting guidelines, and to some extent the sixth key principle for the Commission's natural source guidelines, also.
Unclear methodology	The Commission's guidelines could be updated to specifically state that the methodology provided must include sufficient information so that an independent third party could replicate the method and achieve the same results as they have presented. This comprises of three components: First, the methodology used should be specific to the year the correction has been applied, and evidence has been presented. References to a previous year's methodology are not sufficient without supporting evidence from the year corrected (e.g., Spain's Saharan dust assessment). Similarly, blanket references to the Commission's guidelines, or the peer-reviewed publications cited therein, is not sufficient without specified consideration to the Member State. Second, data provided as evidence by Member States is incredibly helpful in verifying the results presented. Examples which could be highlighted as examples of this good practice include data sheets provided by Greece for their Saharan dust correction, Spain for sea spray and Bulgaria for winter salting. Finally, methodologies which use modelling approaches or have identified simpler parameterisations require further explanation and justification of the approach, for the year the correction has been applied. For example, the parameterisation used by Malta for sea spray was derived in 2013 but applied to measurements in 2020 with no further validation to ensure that it remained applicable. The CAMS operational model approach Poland used to quantify Saharan dust and wild-land fire contributions to PM_{10} can be very useful, however it was not clear how the actual quantification of the correction was carried out and whether the quantified results were validated against any measurements. A recommended approach will not use the CAMS dust or wildfire concentrations directly as corrections but will evaluate the correction instead, accounting for the biases of the CAMS modelled results with respect to observations at the background stations in Poland. Detailed guidance on how the CAMS information can be used as correction for natural sources is currently not in the SEC (2011) 208 final document but is highly recommended to add such guidelines in future revisions of the SEC (2011) 208 final document.

5. CONCLUSIONS

This report provides an overview of the Member States which have applied a correction to their reported PM_{10} measurements due to a contribution from a combination of natural sources, and/or winter sanding or salting. Between 2018 and 2020 it was identified that ten Member States applied a correction attributed to these types of sources, a summary of which is provided in Table 7 below. The report for France (Martinique) had previously been assessed under the "SR3 contract" and has therefore not been reviewed as part of this assessment.

Table 7 Overall assessment of the presented methodology for the Member States corrections identified and assessed in this report. The full assessment scale ranges from "Inadequate" (worst), to "Moderate", "Good" and "Excellent" (best), described in Appendix Table 8.

Country	Correction type stated	Correction applied	Years	Overall methodology assessment
Bulgaria	Winter sanding or salting	Winter salting	2020	**Good**
Cyprus	Natural source	Sea spray and Saharan dust	2018, 2019, 2020	**Inadequate**
France	Natural source	Saharan dust	2018	**Good** (Previously assessed under "SR3 contract")
Greece	Natural source	Saharan dust	2018, 2019, 2020	**Good – with some reservation**
	Natural source	Sea spray	2018, 2019, 2020	Not assessed*
Latvia	Winter sanding or salting	Winter sanding	2018, 2020	**Good – with some reservation**
	Natural source	Sea spray and wild-land fire	2020	**Moderate – not enough information provided**
Lithuania	Winter sanding or salting	Winter sanding	2018, 2019	**Good**
Malta	Natural source	Sea spray	2018, 2019	**Inadequate**
	Natural source	Saharan dust	2019	**Good**
Poland	Natural source	Saharan dust	2018, 2019, 2020	**Good – with some reservation**
	Natural Source	Wild-land fire	2020	**Good – with some reservation**
	Winter sanding or salting	Winter sanding	2018, 2019, 2020	**Moderate – not enough information provided**
Slovenia	Natural source	Saharan dust	2018, 2019	**Moderate – not enough information provided**

Country	Correction type stated	Correction applied	Years	Overall methodology assessment
Spain	Natural source	Saharan dust	2018, 2019, 2020	Moderate – not enough information provided
	Winter sanding	Sea spray	2019, 2020	Good – with some reservation

** Not assessed as no methodology has been provided by Greece, due to a nominal contribution determined (<5 µg m^{-3}).*

The methodology reports and evidence provided by each Member State reviewed as part of this assessment largely follow the Commission's guidelines, with very few going beyond the methodologies presented in the guidelines. However, since the publication of the guidelines in 2011, there have been many advancements and developments to the methodologies which are now more widely available. As such, these are recommended for inclusion in any future updates to the guidelines. Member States are still using old, and possibly outdated, methodologies because the guidelines allow it. This includes both the monitoring developments, particularly on chemical composition of aerosols, and the availability of information from modelling services, especially dedicated to natural sources.

When assessed against the existing guidelines, the overall outcome of each Member States reviewed methodology is outlined in Table 7 above. Following our assessment of the Member States' methodology reports the following recommendations for updates to the guidelines for the Commission's suggestion are stated below, based on the information both included and missing from the submitted reports.

Guidelines for reporting corrections data

As detailed in Section 2.1, the way in which Member States have provided data onto EIONET CDR in their XML files is not consistent across all Member States. There is a user guide guidance document[19] which outlines the steps Member States should follow when including a correction to their dataset. The columns are being completed inconsistently by Member States (see Section 2.1), therefore it may be useful to have a specialist session at the next Implementing Provisions Reporting (IPR) meeting to try and encourage Member States to complete the columns relating to corrections applied in a more consistent way. This may require some revision of the IPR Guidance document to better clarify how corrections should be consistently reported across Member States.

From an initial check of automatic quality assurance checks of some of the Member States, it appears as though the inconsistencies identified during the assessments in this report were not flagged as errors or blockers. It is most likely that Member States do not know that they are completing these fields in a different way to other Member States, and therefore would not be seeking guidance from the help desk or guidance documents.

Requirement of information and evidence

As described in Section 4 (particularly in Box 2), Member States reported methodologies are consistently missing necessary sections and evidence required to verify their results. These omissions play out as a lack of clarity in the results presented and are therefore not traceable. This can make it difficult to determine where and why corrections were applied and raises questions about the validity of the deduction or whether it follows the Commission's guidelines.

The clearest example of this is the methodology reported by Cyprus. The report reads like a set of results, which although detailed, could not be independently verified in this assessment. Specific sections in this report imply that the Commission's guidance has been followed in applying sea spray and Saharan dust corrections, but again this could not be verified. More detail is provided in Appendix 2.

The winter sanding or salting correction applied in Poland illustrates a possible issue in misunderstanding. From the evidence provided in the relevant voivodeship reports, it is implied that winter salting took place in 2020. However, the methodology detailed in the same reports follows Section 4.1 of the Commission's winter

[19] https://www.eionet.europa.eu/aqportal/doc/UserGuide2_AQD_XML_v3.4.1.pdf

sanding and salting guidelines (SEC (2011) 207 final document) "Winter sanding – difference between $PM_{2.5}$ and PM_{10}", rather than Section 4.2 "Winter salting – chemical composition (chloride)". Although neither these, nor Section 3.2 ("Particle size distribution") of the Commission's winter sanding and salting guidelines, specifically state that this approach is not recommended. As such it is currently allowed under the existing guidelines, despite the difference in properties of the materials spread on the road. Following this assessment, we would recommend that the conditions for these methods include a clear and detailed description of the types of sand and salt that would be permitted for use in each instance.

Section 4.1.6 of the Commission's natural source guidelines (SEC (2011) 208 final document) provides a checklist of points which should be covered in the report justifying and describing each Saharan dust episode for every calendar year. The fifth point in that list states: *"The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas"*. As a result, almost all reports applying a deduction based on the contribution of Saharan dust have provided a table to evidence the PM_{10} daily concentration, the quantified contribution of dust determined, and the concentration after this has been deducted. It is recommended that similar checklists be compiled for all accepted corrections (e.g., sea spray, wild-land fire, winter sanding and salting), to provide Member States with more firm guidance to follow.

Similarly, Annex B of the Commission's winter sanding and salting guidelines (SEC (2011) 208 final document) provides an example report for winter sanding contributions that follows the guidance. Bulgaria, Latvia, and Lithuania adopt and adapt this template for their reports, based on the requirements (e.g., Bulgaria adapts for application to winter salting methodology). As such, the relevant information was highlighted more clearly in each of these reports. Latvia provides an important example to highlight, as the use of this template meant the winter sanding deduction was more clearly evidenced than the comparable sea spray and wild-land fire deductions. From this assessment, it is recommended that similar templates be derived and presented for other reports. The templates would benefit from including a specified section to discuss the uncertainty in the results, to encourage more Member States to consider and report it.

Requirement of critical analysis and uncertainty assessments

Across all nine Member States there is no discussion of uncertainty or critical analysis of the results presented. This includes the consideration of positive and negative artefacts, such as the contribution of sea spray to quantified estimates of winter salting (and vice versa). This is likely because in some instances, e.g., Section 4.1.6 of the Commission's natural source guidelines, it is stated that critical analysis is required only if appropriate to the reported year. As such, many Member States have chosen to neglect this important aspect when applying corrections. However, there are always underlying assumptions to the methods applied which could propagate into large uncertainties in quantified values. Without a discussion of the possible sources of uncertainty present, the deductions quantified are not completely justified. Similarly, without quantified uncertainty, these results cannot be compared against other similar quantifications, which is a problem as multiple Member States are following the same methodology.

The previous report for France (Martinique) assessed by Ricardo under the "SR3 contract" provided a good example of this done well. Extensive chemical analysis at multiple sites allowed for exploration of the results. This amounted to spatial and temporal analysis of the results, using simultaneous measurements at different measurement stations to hypothesise the same source (e.g., tracers for dust), or highlight different contributions. Since black carbon (BC) was noted to be the second highest contribution, measurements of black carbon were analysed to attempt to determine the contribution of vehicular emissions (exhaust and non-exhaust) to PM_{10}. They also utilised Positive Matrix Factorisation (PMF), discussed below. The entire discussion cites peer-reviewed literature in support of its conclusions. This report demonstrates that uncertainty, possible artefacts, and interferences can be discussed comprehensively in such methodologies.

Utilisation of modelling approaches

As mentioned previously, since the Commission's guidance documents were published in 2011 there has been advancements in the assessment techniques available for Member States to quantify natural source, and winter sanding or salting contributions to their local measurements. In the reports assessed, two approaches stand out as possible improvements to the guidance: Malta's Saharan dust identification, and the modelling approach utilised by Poland to quantify the contribution of Saharan dust and wild-land fires to PM_{10}.

Poland used modelling tools launched by the CAMS50 project to quantify the contribution of Saharan dust and wild-land fire to PM_{10} at each measurement location, using data from the Copernicus Atmosphere Monitoring Service (CAMS). This regional modelling technique provided precise identification of natural source contributions in specific episodes. However, the quantification of contributions in $\mu g\ m^{-3}$ based on more indicators than a monthly moving average (or percentile) of individually identified non-episode days at a local background monitoring station is more difficult to evaluate, and it is not clear whether the correction can be deemed representative (as the method is collectively subject to significant uncertainty if performed incorrectly). This is not to say this method is not acceptable but requires further documentation and evidence to assess its capabilities.

Malta use Hidden Markov Models (HMMs), which are a statistical, time-dependent method to efficiently use observations (here, PM_{10} measurements) to generate successful predictions (attribute sources). Using hidden (unobserved) states, the model categorises the PM_{10} time series into several Gaussian distributions, which in turn are divided into different regimes based on the mean and standard deviation of each. This allowed Malta to quickly identify daily PM_{10} concentrations which could be affected by Saharan dust, in a method that is reliable and based on logic, not solely on human interpretation. As such, the subsequent identification steps (e.g., satellite images, backward trajectories etc) were more focussed.

Similarly, the previous report for France (Martinique) assessed by Ricardo under the “SR3 contract” provided a good example of identifying the contribution of primary sources to PM_{10} by use of Positive Matrix Factorisation (PMF). This technique is designed for this purpose, attributing sample species concentrations to specific sources by identifying “chemical fingerprints”, evaluating many potential source options, and minimising the uncertainty arising from the assignment. It’s relatively independent, and not influenced by human intervention but can provide a good starting point for identification. This analysis allowed France to evaluate sources in Martinique in more depth than could be done without, not only evaluating accepted contributions (e.g., sea spray and mineral dust) but also likely artefacts (e.g., vehicle emissions, biomass combustion or industrial emissions) which were not distinct to the human eye.

Overall, these methods open the door to new analyses which could be recommended by the European Commission. More sophisticated methods of episode identification and source attribution, such as HMMs and PMF but could also include the use of HYSPLIT backward trajectories for source allocation of air masses. Similarly, forecast models could be used project and determine the potential impact of an event, such as some of the closer-to-real-time analysis used by Spain (Appendix Section A9.5) when identifying possible episodes to alert local authorities where necessary. These would provide mode robust, and traceable, analyses for the initial identification of episodes which could be backed up by some of the evidence currently recommended in the Guidelines.

Quantification of natural source and winter sanding or salting contributions using models is another promising development. These models can be more complex, accounting for secondary reactions and interactions in the atmosphere, as well as local meteorological conditions, when predicting a quantified contribution of a given source. For example, Poland’s use of CAMS50, or chemical analysis using other chemical transport models like ADMS. These are also less likely to double-count contributions but could result in more systematic uncertainties if set up incorrectly.

However, as modelling approaches are taken forward, the guidance could be updated in line with this. Assumptions made in models should be clearly stated in the reported methodology. Similarly, Member States should be aware of what is/isn’t accounted for in the model operation to provide a more comprehensive discussion of possible uncertainties. As such, these elements could be detailed, and a Member State should justify the model approach taken. To ensure results output by models are reliable, each model-set up for a Member States reported year would benefit from undergoing a process of validation. For example, comparison of model outputs to locally relevant measurements. This can provide a benchmark from which error can be quantified and could provide a useful estimation of uncertainty in quantified contributions.

Further development could also occur in the future. For example, it is expected that as more real-time modelling activities become operational, these could be utilised to focus specific measurements and measurement campaigns. For example, Bulgaria only collected filter measurements of chloride ions for 5 days following snowfall (Appendix 1). The effects of the winter salting were shown to persist after that point but were not evaluated due to lack of measurements. Local air quality box modelling could be used to determine how long the effects of winter salting would persist after each snowfall and salting event, based on the meteorological conditions and amount of salt spread. However, this would require further development prior to consideration.

APPENDICES

Appendix – Levels used in the assessment of the corrections reported by Member States

Table 8 Evaluation classes used to indicate the level of agreement with specific aspects of the key principles and recommended methodologies provided in the Commission's guideline documents for the corrections of both natural sources, and winter sanding and salting in air quality exceedance reports by Member States. These assessment levels have been colour-coded, and used in Section 4, Section 5 (Conclusions) and the "Critical assessment of the *X* methodology" sections of Appendices 1-9, where *X* is winter sanding, winter salting, sea spray, Saharan dust or wild-land fire.

Assessment level	Description of assessment level
New method	Means that the methodology reported by the Member State meets the stated key principles in the Commission's guidelines but does so by following a method different but relevant method than the one recommended in the guidelines.
Excellent / Yes	Means that the methodology reported by the Member State exceeds all stated criteria established in the guidelines. No faults were identified in the report, and it could be highlighted as an ideal example in the future. This level has not currently been used for the "Critical assessment of the *X* methodology".
Good / Yes	Means that the reported methodology from the Member State mostly meets the criteria established in the guidelines.
Good / Yes – with some reservation	Means that the reported methodology from the Member State mostly meets the criteria established in the guidelines, however there is some room for improvement. For example, if the Member State has excluded a factor that should be considered in the assessment or included an unnecessary element.
Moderate / Partially – not enough information provided	Means that the reported methodology from the Member State seems to suggest that the criteria have been met, however there is not enough information provided to verify this. Additional information needs to be provided.
Inadequate / No	Means that the reported methodology from the Member State does not meet the criteria established in the guidelines.

Appendix 1 – Bulgaria: Winter salting or sanding correction

A1.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G (DfG), winter salting corrections were identified to have been applied to PM_{10} concentrations in two zones in Bulgaria (Sofia, BG0001; and Plovdiv, BG0002) in 2020. No baseline data has been provided by Bulgaria in 2020, so exceedances in both the annual mean and the number of days above the daily PM_{10} limit value prior to the deduction are not reported. The methodology for the winter salting corrections assessed have been sourced from the Bulgarian envelope on Dataflow G for the most recent year (2020). No corrections were declared in 2018 or 2019, and as such no methodologies have been provided to the Bulgarian envelope.

The Bulgarian 2020 report was uploaded to DfG in the form of a scanned document, written in Bulgarian Cyrillic script. A translation was required by the Commission; however, this was unclear in some instances, particularly for equations used. As such, the supplementary translations to English were necessary for this assessment and required the use of image recognition software, which may have led to more uncertainty in the interpretation. This has been recognised and accounted for in this assessment. Table 9 provides a lookup table derived during this assessment to translate key terms used in the Bulgarian report (in Bulgarian Cyrillic script) to English (in Latin script), which are used in this report's discussion.

The Bulgarian 2020 report outlines that corrections were subtracted from measured PM_{10} concentrations for the re-suspension of particulates following winter salting activities. The Bulgarian report details the methodology used to deduct the contribution of winter salting at two traffic measurement stations: Pavlovo in Sofia (BG0073A), and zh.k. Trakia in Plovdiv (BG0078A)[20]. Both sites are part of the “АИС” (AIS) monitoring network in Bulgaria. The final data reported on Dataflow G is provided in Table 10. It is assumed that the data reported to DfG is for the traffic sites where deductions have been discussed, however this is not clearly acknowledged.

Bulgaria's methodology for the identification and quantification of winter salting contributions are assessed against the key principles detailed in Section 2 of the Commission's winter sanding and salting guidelines SEC (2011) 207 document in Appendix Section A1.3, and against the relevant recommended method outlined in Section 4 of the same document in Table 11 below (Appendix Section A1.4).

Table 9 Key terms used in the Bulgarian report, written in Bulgarian Cyrillic script, and the corresponding translations to English (Latin script) used in this assessment. Translations were mainly provided by the European Commission, with supplementary translation conducted using a variety of online image recognition tools.

Key terms in the Bulgarian 2020 report (Bulgarian Cyrillic script)	**Translation used in this report (Latin script)**	**Description**
София	Sofia	Translation of zone BG0001 name
Пловдив	Plovdiv	Translation of zone BG0002 name
КФС Рожен	KFS Rozhen[21] or Rozhen	Rural background site in Bulgaria, used to determine the background concentrations of Cl^- ions, $[Cl^-]_{BG}$ (see below).
АИС “Павлово”	AIS Pavlovo[22] or Pavlovo	Traffic site where deductions were calculated and subtracted in Sofia

[20] Site codes identified from : https://airindex.eea.europa.eu/Map/AQI/Viewer

[21] Translation of site name verified by locating site on World's Air Pollution: Real-time Air Quality Index Map: https://aqicn.org/city/bulgaria/rozhen-kfs/ (last accessed 11th May 2022).

[22] Translation of site name verified by locating site on World's Air Pollution: Real-time Air Quality Index Map: https://aqicn.org/city/bulgaria/sofia/pavlovo/ (last accessed 11th May 2022).

Key terms in the Bulgarian 2020 report (Bulgarian Cyrillic script)	Translation used in this report (Latin script)	Description
АИС "жк. Тракия"	AIS zh.k. Trakia[23] or zh.k. Trakia	Traffic site where deductions were calculated and subtracted in Plovdiv
ФПЧ$_{10}$	PM_{10}	Translation of PM_{10} from Bulgarian Cyrillic script
C_{Cl}	[Cl^-]	Annotated concentration of Cl^- ions has been changed to be consistent in this report with other concentration names
$C_{Cl\ фон}$	[Cl^-] $_{BG}$	The calculated background concentration of Cl^- ions from filter measurements at Rozhen rural background station
$C_{Cl\ осол}$	[Cl^-] $_{SALT}$	The concentration of salt determined from measured chloride, attributed to winter salting
$C_{ФПЧ_{10}\ осол}$	[PM_{10}] $_{SALT}$	The concentration of PM_{10} attributed to winter salting in Bulgaria

A1.2 SUMMARY OF CORRECTIONS REPORTED

Table 10 Summary table of results from the assessment of corrections applied in Bulgaria in 2018[24], 2019[25] and 2020[26] for inclusion in the final summary report. Not all years had reported corrections, as such these are missing from the table. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
BG0001	Sofia	2020	*	**47 days**	Days above limit value	Winter-salting and sanding
BG0002	Plovdiv	2020	*	**43.69 µg m^{-3}**	Annual mean value	Winter-salting and sanding
BG0002	Plovdiv	2020	*	**83 days**	Days above limit value	Winter-salting and sanding

** Baseline data not declared in Bulgaria (BG) Dataflow G for 2020 or stated in the methodology presented by Bulgaria. Only final value (after correction) presented.*

A1.3 CRITICAL ASSESSMENT OF THE WINTER SANDING OR SALTING CORRECTION

A1.3.1 Contributions must be attributed unequivocally to winter sanding or salting activities

Bulgaria has quantified the contribution of winter salting to PM_{10} concentrations by using measured concentrations of chloride at the sites deducted. The method is assessed in Appendix Section A1.3.2. To attribute conditions to winter salting, Tables 1, 2 and 3 of the Bulgarian report document the type, frequency

[23] Translation of site name verified by locating site on World's Air Pollution: Real-time Air Quality Index Map: https://aqicn.org/city/bulgaria/plovdiv-zh.k.-trakia/ (last accessed 11th May 2022).
[24] BG Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/bg/eu/aqd/g/envxve8eg/DataFlowG2018.xml/manage_document
[25] BG Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/bg/eu/aqd/g/envx2iluw/DataFlowG2019.xml/manage_document
[26] BG Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/bg/eu/aqd/g/envyucyhq/DataFlowG2020__4_.xml/manage_document

and approximate locations of winter salting events in Sofia, Plovdiv and Stara Zagora (no exceedance is reported to DfG for this zone but is included in their report), respectively. This information is stated to have been provided by the Sofia Inspectorate, and the Municipalities of Plovdiv and Stara Zagora.[27] Table 4 in the Bulgarian report outlines observed days of snowfall between January and April 2020 in the same three cities.[28]

Collectively, this information provides evidence that winter salting is likely to be an influence on each of the days deducted, with an exception. The days deducted in Sofia during January 2020 (2nd, 4th and 6th) are noted to be days directly following observed snowfall (1st and 5th). This is not a requirement for the chemical composition method used to quantify winter salting contributions, however the salting of roads prior to these dates has not been noted in Table 1 of the Bulgarian report (first reported event on 12th January). It is anticipated that as these events are close to the start of 2020, road salting may have occurred at the end of 2019 with effects persisting into the new year.

Bulgaria have somewhat demonstrated the persisting effects of winter salting; between the salting event and the day the contribution has been deducted. Bulgaria have stated that samples of chloride were collected for 5 days following snowfall events in 2020,[29] as such winter salting contributions to PM_{10} concentrations have only been considered for this duration. However, the Bulgarian report concludes that this duration is insufficient and should be extended, as the contribution of winter salting has not depleted during this period.[30] The longest time between a specified salting event, and a day the contribution of winter salting has been deducted is seven days (Sofia; 8th and 15th February, respectively).

Overall, it would be better if more evidence was provided to confirm that the contribution of winter salting from the events stated had persisted to the days deducted, specifically. Such as demonstrating that precipitation events did not occur between these stated days to wash away the road salt spread. The Commission's natural source guidelines indicate that it must be ensured that no other sources than winter salting have contributed to the increased PM_{10} concentration. For instance, demonstrating that the influence of sources like sea spray are sufficiently small. As discussed in Appendix Section A1.3.2, the background concentration of chloride (quantified at a rural background station, Rozhen) is subtracted from that measured at each traffic station, leaving the amount attributed to winter salting. This is good practice, however no other influences on ambient chloride concentrations have been discussed. Similarly, the potential difference in chloride contribution at the rural background measurement station (Rozhen) to the traffic stations (zh.k. Trakia, Plovdiv; and Pavlovo, Sofia) has not been discussed (see Appendix Section A1.3.3).

A1.3.2 Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value

The Bulgarian report estimated the contribution of winter salting to measured PM_{10} at both traffic measurement stations in Sofia and Plovdiv using the same methodology, based on the chemical analysis of chloride ions, as outlined in Section 4.1 of the Bulgarian report.[31] The equations are translated here using key terms defined in Table 9 for clarity in this assessment.

The first step of the methodology quantifies the background concentration of chloride ions, $[Cl^-]_{BG}$, in µg m^{-3}, using equation (4) in the Bulgarian report, translated here:

$$[\mathrm{Cl}^-]_{\mathrm{BG}} = \frac{\sum_{i=1}^{n}[\mathrm{Cl}^-]_i}{n}$$

Where $[Cl^-]_i$ is each measured chloride concentration, and n is the number of measurements. This method uses the concentration of chloride measured in each of the 48 (approximately weekly) filters collected at the rural background station (Rozhen; Table 5 of the Bulgarian report) to determine an average background concentration in Bulgaria in 2020. This is stated to be 0.0997733 µg m^{-3},[32] but rounded when used in subsequent calculations (0.09977 µg m^{-3}; column 6, Tables 8 and 9).[33] The background concentration value has been independently verified in this assessment, as indicated below. However, Bulgaria have not discussed

[27] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 3-5.
[28] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 6.
[29] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 9.
[30] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 14.
[31] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 15-19.
[32] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 8.
[33] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), Tables 8 and 9, pages 12-13.

the representativeness of Rozhen, and whether the same exceedances influencing the traffic stations are likely to affect measurements made there too (discussed in Appendix Section A1.3.3).

To conduct our own independent verification of the Bulgarian background value, the units that measured chloride concentrations were provided in by the external laboratory in Tables 5-7 of the Bulgarian report (mg dm^{-3}) required conversion to the units that the final $[Cl^-]_{BG}$ concentration is presented in, and that are used in subsequent calculations in the Bulgarian methodology (µg m^{-3}). The calculation used for this conversion has not been specified in the Bulgarian report, but was derived during our assessment to be:

$$[\mathrm{Cl}^-]\ (\mu\mathrm{g\ m^{-3} day^{-1}}) = \frac{\text{Filter measurement } [\mathrm{Cl}^-]\ (\mathrm{mg\ dm^{-3}}) \times \text{extraction volume of filter } (10\ \mathrm{cm^3})}{\text{Volume of air } (\mathrm{m^3\ day^{-1}})}$$

This equation quantifies the mass of chloride measured in each filter, and then divides this mass by the volume of air that filter was exposed to during the day (provided in Tables 5-7 of the Bulgarian report), to determine the average concentration measured per m^3 in that 24-hour period, appropriate for the daily deductions applied.

The converted daily chloride concentration measurements on days with PM_{10} exceedances, $[Cl^-]$, were then used to determine the concentration of chloride ions which can be attributed to winter salting, $[Cl^-]_{SALT}$ for each day deducted in the equation below. The results are presented in column 9 (in µg m^{-3}) of Table 8 and 9, for zh.k. Trakia (Plovdiv) and Pavlovo (Sofia), respectively. The calculation is done using equation (5) in the Bulgarian report, translated below:

$$[\mathrm{Cl}^-]_{\mathrm{SALT}} = [\mathrm{Cl}^-] - [\mathrm{Cl}^-]_{\mathrm{BG}}$$

The composition of the road salt spread in Bulgaria is then accounted for when determining the contribution of the salt to PM_{10} concentrations, $[PM_{10}]_{SALT}$ in µg m^{-3}. The calculation uses Equation (6), which translates as:

$$[\mathrm{PM}_{10}]_{\mathrm{SALT}} = a\ \frac{110}{70}\ [\mathrm{Cl}^-]_{\mathrm{SALT}} + b\ \frac{58}{35}\ [\mathrm{Cl}^-]_{\mathrm{SALT}} + d\ \frac{94}{70}\ [\mathrm{Cl}^-]_{\mathrm{SALT}}$$

Where a, b and d are the percentage contribution of $CaCl_2$, NaCl and $MgCl_2$ to the road salt used, respectively. The fractions expressed in each part of the expression are the stoichiometric ratios of the molar mass of the salt to the mass of Cl in that salt. This equation allows the concentration of chloride, used as a tracer, to be scaled up to the total contribution of the salt used to PM_{10}. However, since the composition of salt used in Plovdiv and Sofia is 100% NaCl (column 5; Tables 8 and 9 of the Bulgarian report, respectively),[34] this equation can be simplified to:

$$[\mathrm{PM}_{10}]_{\mathrm{SALT}} = b\ \frac{58}{35}\ [\mathrm{Cl}^-]_{\mathrm{SALT}}$$

These results are presented for days eligible for deduction in column 10 of Tables 8 and 9 of the Bulgarian report. This criterion is deemed to have been met if the chloride concentration that has been attributed to winter salting, $[Cl^-]_{SALT}$, exceeds the average background chloride concentration, $[Cl^-]_{BG}$ (columns 7 and 8).

Finally, the reduced concentration of PM_{10}, $[PM_{10}]_{RED}$, was determined (in µg m^{-3}) for each day and site by subtracting the concentration of PM_{10} attributed to the winter salting event from the measured PM_{10} on the same day and location, as given below (in equation (7) of the Bulgarian report):

$$[\mathrm{PM}_{10}]_{\mathrm{RED}} = [\mathrm{PM}_{10}] - [\mathrm{PM}_{10}]_{\mathrm{SALT}}$$

The final concentrations of PM_{10} are presented in column 11 of Tables 8 and 9 of the Bulgarian report, for zh.k. Trakia (Plovdiv) and Pavlovo (Sofia), respectively.

All concentrations presented in Tables 8 and 9 have been independently verified in this report and deemed accurate. The time resolution of these concentrations (daily) is consistent with the averaging period of the daily PM_{10} limit value exceedances, of which there were too many: 47 in Sofia (BG0001) and 83 in Plovdiv (BG0002) in 2020. In terms of the annual mean concentration, only exceedance occurs in Plovdiv in 2020 (43.69 µg m^{-3}). This final concentration is not stated in the Bulgarian report, and as such it is unclear how it has been determined. It is assumed that the reduced PM_{10} concentrations have been used to calculate the reduced annual mean, as this is recommended by the Commission's winter sanding and salting guidelines.[35] However, not enough data has been provided for this to be independently verified.

[34] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), Tables 8 and 9, pages 12-13.

[35] SEC (2011) 207 final document, page 8.

Overall, the methodology presented by Bulgaria is detailed and follows the Commission's winter sanding and salting guidelines outlined in the SEC (2011) 207 final document. It provides a moderately robust method for changing conditions in the future, particularly if different salt compositions are used. However, the uncertainty in these calculations have not been quantified or discussed. The potential contribution of other sources to chloride concentrations have not been acknowledged.

A1.3.3 Representativeness of the measuring stations at which contribution is determined

Section 2 of the winter sanding and salting guidelines SEC (2011) 207 final document outlines that the influence of PM_{10} emissions from winter sanding or salting is typically measured at traffic related monitoring stations, and the procedure to subtract such a contribution should be applied at each measuring station separately. This criterion is satisfied for the deductions applied in both Sofia (zone BG0001) at Pavlovo traffic monitoring station, and Plovdiv (zone BG0002) at zh.k. Trakia traffic monitoring station. The discrete calculations and deductions at both sites are presented at Tables 9 and 8 of the Bulgarian report, respectively.

At both sites the same mean background concentration of chloride ions, $[Cl^-]_{BG}$, for 2020 have been deducted. Section 1 of the Bulgarian report states that these filter measurements were made at Rozhen, a rural background station. No further discussion on the representativeness of this site is included. This site is not within the European Monitoring and Evaluation Program (EMEP) monitoring network. From our assessment, this site appears to be in the grounds of "NAO Rozhen", near the town of Chepelare in the south of Bulgaria.[36] This site appears to be in a rural location, but discussion of the influence of the altitude of the site on its representativeness is missing. Similarly, there is no discussion to identify whether this background station is appropriate to serve as an identifier of possible sea spray contributions for the two traffic measurement stations in Sofia and Plovdiv.

A1.3.4 The contribution of winter sanding or salting to the measured PM10 concentration has to be quantified in µg m^{-3} for each exceedance day under consideration

Column 8 of Tables 8 and 9 in the Bulgarian report show that four days in Plovdiv (BG0002) and seven days in Sofia (zone BG0001) are eligible for the deduction of winter sanding contributions from measured PM_{10} at the relevant traffic measurement station (zh.k. Trakia and Pavlovo, respectively). The contribution is determined using the method presented in Appendix Section A1.3.2, and results in quantified contributions to PM_{10} presented in µg m^{-3} in column 10 of Tables 8 and 9 of the Bulgarian report. As such, this criterion has been satisfied by Bulgaria.

A1.3.5 The method to determine this contribution has to be documented

As described in the sections above, the methodology used by Bulgaria in 2020 follows the guidance set out in Section 4.2 of the Commission's winter sanding and salting guidelines of the SEC (2011) 207 final document ("Winter salting – chemical composition (chloride)"). This has been provided in the Bulgarian report, adapting the example template provided in Annex B of the guidance.

A1.4 CRITICAL ASSESSMENT OF THE WINTER SALTING METHOLOGY

A brief overview of the methodology that Bulgaria has applied against the recommended methods in the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) for identifying and quantifying winter salting contributions have been summarised in Table 11 below, in the form of a checklist. The criteria have been taken from Section 4.2 of the Commission's winter sanding and salting guidelines: "Winter salting – chemical composition (chloride)", including the conditions for using this method (Section 4.2.1) and the suggested procedure (Section 4.2.2). The evidence provided in the Bulgarian report to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A1.3.

[36] Assessed using the World's Air Pollution: Real-time Air Quality Index Map: https://aqicn.org/city/bulgaria/rozhen-kfs/ (last accessed 12th May 2022), and Google Earth (Satellite Imagery from 2021, last accessed 12th May 2022).

Table 11 Summary of the assessment of the methodology provided by Bulgaria for quantifying and subtracting a winter salting, against the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document.

Content	2020 report	Assessment comments and recommendations
Collected information about the chemical properties of the salt dispersed on the roads near the monitoring site	Yes	Tables 1-3 in the Bulgarian report[37] provide the information about the times and locations that winter salting occurred in 2020 in three different agglomerations in Bulgaria (Sofia, Plovdiv and Stara Zagora). These Tables state that the salt used is NaCl technical salt. Comments following these Tables suggest that the frequency of salting events, and quantity of salt spread, is significantly lower than previous years.[38] Tables 8 and 9 of the Bulgarian report[39] evidence the deductions applied. Column 5 for each row states that the composition of the salt used in Sofia and Plovdiv is 100% NaCl.
Chemical analysis of chloride, or other relevant chemical constituents of the PM_{10} samples which correspond to the dispersed salt	Yes	Sections 1 and 2 in the Bulgaria report state that chloride ion concentrations in PM_{10} are determined at Rozhen (rural background site) and the two traffic sites assessed (Pavlovo, Sofia; and zh.k. Trakia, Plovdiv).[40] These are determined from filters collected at each site, and analysis undertaken by an accredited laboratory ("Aquateratest"), following standards described in Section 4(1) of the EMEP Manual and Methodology, adopted by the Minister for the Environment and Water for determining the exceedances of the daily PM_{10} limit value that can be attributed to winter salting of the roads.[41] The Bulgarian report Annex includes a sample of the laboratory results, for samples collected at Rozhen between 6th August and 25th December 2020.[42] The methodology used to get these results is stated to be "BDS EN ISO 10304-1: 2009" (БДС = BDS; Bulgarian Institute for Standardisation). It is assumed that this methodology is consistently used for all filter samples. **We recommend that confirmation of the methodology used for the chemical analysis be included in the methodology.**
Critical discussion to ensure that high concentrations of the relevant chemical constituents (e.g., chloride) do not originate from other sources. For example, contribution to PM_{10} from sea spray must be clearly distinguished from	Partially – not enough information provided	The quantification of the contribution of winter salting to PM_{10} from measured chloride ions is specific, calculated using the method outlined in Section 4.1 of the Bulgarian report, and discussed in detail in Appendix Section A1.3.2 above. Despite this methodology accounting for background chloride concentrations using measurements at Rozhen, the average for the year provided (from 48

[37] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 3-5.
[38] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 8.
[39] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), Tables 8 and 9, pages 12-13.
[40] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 7-9.
[41] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), page 7.
[42] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 15-19.

Content	2020 report	Assessment comments and recommendations
winter salting of roads to avoid salt contents from being subtracted twice		filter samples during 2020) does not account for the episodic nature of sea spray. This contribution is otherwise not quantified or accounted for (e.g., by analysing backward trajectories for dominant wind directions). The distance of these sites from the coast may have been considered too long (around 100-220 km for Rozhen, Plovdiv and Sofia), but this has not been stated. **Therefore, we recommend that a more detailed analysis of this contribution from sea spray be discussed in the Bulgarian report.**
Subtract the derived fraction of salting material from the PM_{10} concentration, using an appropriate time averaging	Yes	Tables 6 and 7 demonstrate that chloride (Cl^-) concentrations for each day winter salting have been measured using a filter exposed for 24 hours, at zh.k. Trakia (Plovdiv) and Pavlovo (Sofia), respectively.[43] Tables 8 and 9 provide an overview of the deduction calculated at these, at zh.k. Trakia (Plovdiv) and Pavlovo (Sofia), respectively.[44] Both the contribution of winter salting to measured chloride concentrations, $[Cl^-]_{SALT}$ and PM_{10} concentrations, $[PM_{10}]_{SALT}$, are quantified with a daily time resolution. As such, the deduction of these from measured PM_{10} at each site occurs at an appropriate time resolution, following the recommended procedure from the Commission's guidelines. It should be noted that although the daily average concentrations of PM_{10} measured at each traffic site before the winter salting correction have been applied are reported in the Bulgarian report (column 3 of Tables 8 and 9), the baseline data for both zones have not been reported to Dataflow G (Table 10), so cannot be verified.
Uncertainty analysis	No	The results provided in the Annex of the Bulgarian report include a space to provide the uncertainty in the quantified chloride concentrations, however these are left blank.[45] Similarly within the main body of the Bulgarian report there is no uncertainty quantified for any of the calculated results. There is also no discussion of possible artefacts or interferences to measured chloride concentrations, or potential uncertainties arising from the calculation assumptions. **We recommend that an evaluation of uncertainties is included in the reported Bulgarian methodology.**
References to the methodological reports/papers	Yes	The Bulgarian report mentions the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) on multiple occasions, to demonstrate that it follows the set guidance. For the methodology used by the laboratory quantifying chloride concentrations on the filter samples, the EMEP Manual and Methodology has

[43] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), Tables 6 and 7, page 9.
[44] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), Tables 8 and 9, pages 12-13.
[45] Bulgaria: Report on the quantification of emissions from the winter sanding or salting of roads (2020), pages 15-19.

Content	2020 report	Assessment comments and recommendations
		been mentioned, but not directly referenced. Results in the Annex of the Bulgarian report cite a standardised methodology from the Bulgarian Institute for Standardisation (BDS; БДС). This citation leads to the method "Water quality – Determination of dissolved anions by liquid chromatography of ions – Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate (ISO 10304-1:2009)",[46] which is appropriate for this analysis.

A1.5 ASSESSMENT SUMMARY FOR BULGARIA

Contributions from winter salting were identified by Bulgaria in 2020. Final data provided by Bulgaria to Dataflow G (DfG) indicates that the number of days in above the daily PM_{10} limit value are in exceedance in Sofia (47 days; zone BG0001) and Plovdiv (83 days; zone BG0002). In Plovdiv, the annual mean is also in exceedance of the limit value in 2020 (43.69 µg m^{-3}). There is no baseline data provided to DfG, however the deductions presented in the Bulgarian report indicate that the subtraction of winter salting contributions only reduces the PM_{10} concentration below the daily PM_{10} limit value on one day in each zone (4th January in Sofia and 9th February in Plovdiv). Both zones remain in exceedance (of the number of days in exceedance and the annual mean) following the deduction.

The Bulgarian methodology assessed was from the "Report on the quantification of emissions from the winter sanding or salting of roads (2020)", uploaded to Bulgaria's "Data Flow G 2020 BG" envelope on DfG. The Bulgarian report adapted the example template presented in Annex B of the Commission's guidelines,[47] and mostly satisfied the criteria stated in Section 4.2 of the Commission's guidelines (for "Winter salting – chemical composition (chloride)"). Since the report was submitted to DfG as a scanned document, translation from Bulgarian Cryillic script required use of image recognition software and may have led to more uncertainty in the interpretation.

All data required for the quantification of the winter salting contribution and subsequent deduction from measured PM_{10} concentrations has been clearly provided throughout the Bulgarian report. Tables 5 to 7 of the Bulgarian report present the measured concentrations of chloride ions at the rural background site (Rozhen), as well as the two traffic sites (zh.k. Trakia, Plovdiv; and Pavlovo, Sofia). However, there is no discussion of the representativeness of the background concentrations of chloride measured at Rozhen applied at the two traffic measurement stations. The calculation steps are provided in Section 4.1 of the Bulgarian report, and the method used is logical and clear. Similarly, the deduction is clearly outlined in Tables 8 and 9 of the Bulgarian report. The only missing step in the outlined methodology is how the filter measurements of chloride ions (in mg dm^{-3}) are converted to µg m^{-3} for subsequent calculations (Appendix Section A1.3.2). Our independent assessment derived this method and deemed it reasonable. All other calculations were verified using the raw data provided by Bulgaria.

Evidence provided for unequivocally attributing the contributions calculated to winter salting events was acceptable. Dates of winter salting events occurring near the traffic stations, as well as days of observed snowfall are provided in Tables 1-4 of the Bulgarian report. These align well and provide reasonable indication that the influence of winter salting was present, except early January in Sofia where it is assumed that the salt spreading occurred in late December 2019 but is not stated. The contributions were noted to persist over at least 5 days after snowfall and consequently the Bulgarian report suggests that future years should consider chloride concentrations for a longer period. There is no discussion of other potential contributions to measured chloride concentrations (e.g., sea spray), or other uncertainties that may arise from the results presented.

Overall, the Bulgarian report provides a good assessment of the quantification of winter salting contributions using a method based on the chemical composition of the road salt used but requires justification of the background station used, better analysis of sea spray contributions and more critical discussion of the presented results and identification of other possible artefacts. The baseline values for reported exceedances

[46] Bulgarian Institute for Standardisation, БДС EN ISO 10304-1:2009, https://bds-bg.org/en/project/show/bds:proj:79923 (last accessed 11th May 2022).

[47] SEC (2011) 207 final document, Annex B, pages 37-42.

to the annual mean and the number of days in exceedance of the daily PM_{10} limit value need to be reported to Dataflow G for 2020.

Appendix 2 – Cyprus: Sea spray and Saharan dust corrections

A2.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G, natural source corrections were identified to have been applied to adjust the baseline concentrations in one zone in Cyprus (CY001A) for the years 2018, 2019 and 2020. The methodology for the natural source corrections assessed is sourced from in the Cypriot information on Dataflow G, for the most recent year (2020). The same method has been reported Cyprus in 2018 and 2019, therefore only the most recent methodology (2020) will be discussed in this report, as agreed with the Commission.

The Cypriot 2020 report outlines that corrections were applied for high wind events inside the Member State, with quantified contributions from both sea spray and Saharan dust subtracted from measured PM_{10} concentrations. The Cypriot report provides a high-level overview of the deduction applied to measured PM_{10} concentrations. The deduction was applied for two sites, Nicosia Traffic Station and Agia Marina Xyliatou Background Station (EMEP). The data reported on Dataflow G provided in Table 12 (Appendix Section A2.2) is for Nicosia Traffic Station. No data corrections for Agia Marina Xyliatou are provided on Dataflow G so this data was not available to be included in Table 12 (Appendix Section A2.2).

Since Cyprus' methodologies for identification and quantification of sea spray and Saharan dust contributions are presented in the same report, they are collectively assessed against the key principles detailed in Section 2 of the Commission's natural source guidelines, SEC (2011) 208 final document in Appendix Section A2.3. The methodologies used by Cyprus are separately assessed against the relevant method outlined in Section 4 of the same guidelines in Table 13 and Table 14 (Appendix Sections A2.4 and A2.5, respectively).

A2.2 SUMMARY OF CORRECTIONS REPORTED

Table 12 Summary table of results from the assessment of corrections applied in Cyprus 2018[48], 2019[49] and 2020[50] for inclusion in the final summary report. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
CY001A	Cyprus	2018	**45.2 µg m^{-3}**	31.5 µg m^{-3}	Annual mean value	Natural source
		2018	**90 days**	21 days	Days above limit value	
		2019	**41.3 µg m^{-3}**	33.5 µg m^{-3}	Annual mean value	
		2019	**69 days**	25 days	Days above limit value	
		2020	**73 days**	33 days		

A2.3 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A2.3.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). In the Cypriot report the concentration of sea salt is synonymously referred to as the concentration of Na^+ ("sea salt concentration (Na)"). Alongside the reference to Section 4.2.1 of the

[48] CY Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/cy/eu/aqd/g/envxzxtuq/REP_D-CY_DLI-MLSI__20191003-121841_G.xml/manage_document

[49] CY Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/cy/eu/aqd/g/envx3guha/REP_D-CY_DLI-MLSI__20200928-023014_G.xml/manage_document

[50] CY Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/cy/eu/aqd/g/envyubnwg/REP_D-CY_DLI-MLSI__20210915-013707_G.xml/manage_document

Commission's natural source guidelines (SEC (2011) 208 final document), it is assumed that only the concentration of Na^+ is used to quantify the concentration of sea salt using one of the equations in the guidelines. The source of Na^+ in PM_{10} is typically of marine origin, however it should be noted that both sites where this natural correction has been subtracted are approximately 20 km from the nearest coastline.[51] It is likely that sea spray can travel these distances, however the predominance of air from the coast at the time of the exceedances has not been addressed.

In terms of the dust contribution, the Cypriot report references Section 4.1.2 of the natural source guideline SEC (2011) 208 document but does not clearly describe how dust events were identified. Section A states that the HYSPLIT model was used to determine back trajectories and attribute dust elevated PM_{10} to dust transported from the Sahara, the Middle East and to a much lesser extent, Europe. Figures 3-6 of the Cypriot report present a summary of PM_{10} based on wind direction. It is assumed that this information is obtained from the HYSPLIT model results, but again this is not specified. If HYSPLIT results are used to identify the incoming wind direction, the duration of the HYSPLIT model run should be stated (e.g., 72 hours), as well as the point in the backward trajectory that the judgement of direction is made (e.g., at the start of the trajectory direction, the end, or the general direction based on human interpretation). Measured PM_{10} concentrations are divided into different direction sectors (Figure 3) and measured concentrations within each are summarised by average and standard deviation in Figure 4. The proportion of days of each wind direction are presented in Figures 5 and 6 of the Cypriot report (expressed as a percentage).

The associated discussion describes that recorded exceedances of the PM_{10} daily limit value are mainly observed under the influence of S, SW, E and SE wind directions, attributed to Saharan dust, and dust from the deserts of the Middle East. It is noted that PM_{10} concentrations from these directions are higher at both sites, while the frequency of wind to Cyprus from these directions is lower (25.1%; sum of S/SW and S/SE totals in Figure 6). It is mentioned in passing that the origin of PM_{10} is further analysed via the chemical analysis of filters, but for dust episodes no further information is provided.

The report notes that due to its location that concentrations reported in Cyprus are affected by transboundary pollution, from shipping and other countries emissions. However, this does not feature discussion of what mitigation mechanisms could be implemented to reduce these concentrations, but states that support from the European Commission would be required to negotiate these measures with the other countries.[52] This information has not been extrapolated to determine whether the emissions originating outside of Cyprus have contributed to the exceedances identified in 2020.

There is no discussion in the Cypriot report on the identification or quantification of any potential artefacts of interferences in the measured Na^+ concentrations, or natural source contributions calculated. Nor is there any discussion of whether any intervention action could significantly reduce the identified natural contribution.

A2.3.2 The quantification of the natural contribution must be sufficiently precise

Filter measurements of PM_{10} and subsequent chemical analysis were used to quantify the contribution of sea spray and dust. However, the Cypriot report does not detail the measurement method used to collect the filters, the exposure time for each filter, the method of chemical analysis used or the tracers in PM_{10} used to identify the mineral composition of dust.

This assessment assumes that Na^+ is the tracer used to quantify the concentration of sea salt from context, but this is not specifically detailed. It is also assumed here that filters with 1-day of exposure are used based on the results reported in units of days in the summary Table in Section B of the Cypriot report.[53] This Table also demonstrates that the data provided good temporal coverage in 2020, including seasons and a balance between weekdays and weekends. There are 4 days of data missing at Nicosia Traffic Station, and 15 days at Agia Marina Xyliatou Background Station.

In order to identify dust episodes, the Cypriot report mentions use of back trajectories calculated using the HYSPLIT model, which are not presented or detailed so they could be verified. Figures 4-6 of the Cypriot report present a summarised analysis of PM_{10} concentrations based on wind direction, attributing average concentrations of PM_{10} to different compass directions and the proportion of wind (as a percentage) prevailing from that direction.

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[51] Distances verified using Google Earth (last accessed: 28th April 2022).

[52] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 2.

[53] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 4.

It is assumed that the contribution of dust has been quantified for each day of available measurements that meet the criteria, due to discrete periods of dust contributions presented for each site in Figures 7 and 8 of the Cypriot report. Similarly, it is assumed that the contribution has been quantified for each day of available measurements based on a consistent contribution reported in the same Figures. However, none of this data has been clearly reported and as such cannot be verified.

The report is also missing discussion of uncertainty in the presented concentrations, and calculated contributions of each natural source.

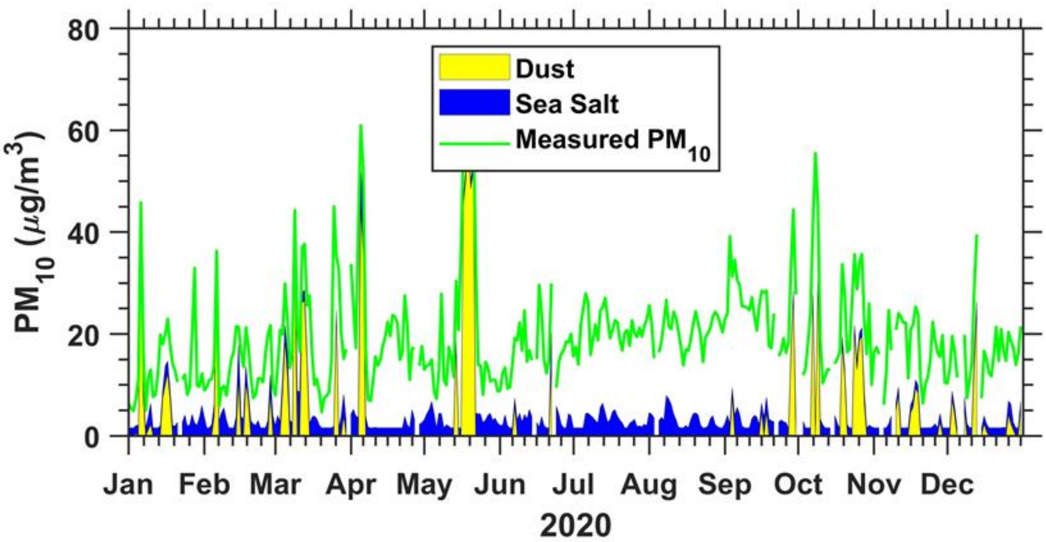
A2.3.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

As shown in Table 12 of Appendix Section A2.2, zone CY001A (Cyprus – Nicosia Traffic Station) exceeded the daily PM_{10} limit value (50 µg m^{-3}) on 73 days in 2020. Therefore, the contribution of natural sources should be quantified for daily mean concentrations. The Cypriot report does not present any calculated daily mean values in a method which can be verified. PM_{10} concentrations (presumed daily) and contributions from sea spray and dust are presented in Figures 7 and 8 of the Cypriot report (an example in Figure 5 below), as well as annual summaries of the number of days in exceedance before and after the correction is applied.

It is assumed from this context that all days were assessed for a contribution of sea spray, rather than specific days selected for analysis based on any criteria. This is important to acknowledge that sea spray can be a continuous source, varying in intensity throughout the year.

Many days in these figures show that dust comprises 0% of the total measured PM_{10}. As such it is assumed that dust was not quantified for all days of PM_{10} measurements, only for days that the criteria specified in the Commission's guidelines are met. However, this information is not stated in the Cypriot report (see Appendix Section A2.3.2).

Figure 5 Concentrations of measured PM_{10}, and the calculated contribution of dust and sea salt at Agia Marina Xyliatou Background Station (EMEP). Taken from Figure 7(a) of the Cypriot report.[54]



A2.3.4 The quantification of the natural sources must be spatially described

In 2020, the only correction reported to Dataflow G is the number of days in exceedance at Nicosia Traffic Station in Cyprus (zone CY001A). However, the results in the Cypriot report are duplicated for PM_{10} measurements at Agia Marina Xyliatou Background Station as well, reducing the number of days exceeding the PM_{10} daily limit value reduced from 8 days before the natural source corrections are applied, to 1 day after. The correction presented includes contributions from both dust (Saharan and Middle East in origin), and sea spray.

[54] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, page 9.

A2.3.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the SEC (2011) final document, the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature. In the Cypriot report, the contribution of sea spray appears to have been determined for each day measurements were available in 2020, using Na^+ as a tracer for identifying PM_{10} of marine origin. Daily average concentrations of PM_{10} are compared at both sites in Figure 2 of the Cypriot report, but there is no discussion of this beyond commenting on the deduction applied.[55]

The Cypriot report provides little evidence that the method used to identify the contribution of Saharan dust follows the Commission's guidelines (Section 4.1.1). Of the five steps that should be taken, there is only evidence that HYSPLIT back trajectories were consulted (Section A and Figures 4-6 of the Cypriot report), and this includes little traceable detail that can be verified. It is mentioned that chemical analysis is undertaken, but this is not detailed (e.g., the markers used to identify the mineral composition of Saharan dust, such as Ca or Al_2O_3). The report and associated Annex present no evidence that satellite images have been studied or that aerosol forecast model results have been analysed. The only evidence provided is that measured PM_{10} concentrations at Agia Mariana Xyliatou Background Station are noted to be high when compared to other European stations, including other EMEP background stations in the Western Mediterranean. However, this statement is not presented with supporting data or referenced.[56]

The report could provide a good assessment of the quantification of sea spray and dust and is possibly calculated correctly following the Commission's natural source guidelines. However, the necessary evidence is missing to validate or verify the results presented.

A2.3.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A2.4 CRITICAL ASSESSMENT OF SEA SPRAY METHOLOGY

A brief overview of the methodology that Cyprus has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying sea spray contributions (Section 4.2.1) have been summarised in Table 13 below, in the form of a checklist. The evidence provided in the Cypriot report to meet each of the key principles set out in Section 2 of the Commission's guidance has been compiled in the correspondingly named sub-sections of Appendix Section A2.3.

Table 13 Summary of methodology provided by Cyprus for quantifying and subtracting a sea spray correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
Analysis of the chemical composition of daily aerosol samples, or at least one of the major components of sea salt.	**Yes – with some reservation**	It is noted in Section A of the Cypriot report that the analysis of the origin of PM_{10} was based on the results of chemical analysis of filters at both measurement stations. It is assumed that the concentration of Na^+ is used to quantify the sea salt concentration as these terms are presented synonymously in Section A and on the caption of Figure 1 ("sea salt concentration (Na)"), and Section 4.2.1 ("Quantifying sea salt episodes") of the Commission's guidelines has been referenced. As no other major ions in sea salt are mentioned, it is assumed only Na^+ is used.[57] The

[55] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, page 6.

[56] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 3.

[57] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 1.

Content	2020 report	Assessment comments and recommendations
		method used for determining concentrations from filter samples has not been presented. **We recommend that the Cypriot report explicitly confirm the analysis method used to quantify sea salt concentrations, rather than rely on referencing the Commission's guidelines.**
The episodic nature of sea salt contributions should be accounted for. The time coverage for chemical composition measurements should therefore be as large as possible. Uncertainties should be considered when time coverage is not 100%.	Yes	The Table in Section B (as well as Figures 7 and 8) of the Cypriot report states that measurements and chemical analysis of PM_{10} were available for 362 and 351 days of 2020 at Nicosia Traffic Station and Agia Marina Xyliatou Background Station, respectively.[58] This provides good annual coverage (>96% data capture).
Demonstration that a daily exceedance is attributable to sea spray, through quantification. If considering Na^+ as being entirely of primary marine origin, air mass backward trajectories must be used to validate this assumption.	No	Back trajectories are assessed with respect to transport of dust from dry regions, but not specifically discussed with regards to sea salt sources. Both stations are approximately 20 km from the nearest coastline, verified using Google Earth. **We recommend that the Cypriot report include the relevant evidence for the method used, such as backward trajectories.**
The calculated mass of sea salt subtracted from the daily average PM_{10} at the sampling point.	Partially – not enough information provided	It is assumed that the top plot (a) of Figure 7 (Agia Marina Xyliatou Background Station) and Figure 8 (Nicosia Traffic Station) of the Cypriot report present the daily average concentration of sea salt calculated. The summary Table in Section B states that on days with chemical analysis, the concentration of dust and sea salt were subtracted separately from the measured PM_{10} concentration ("PM_{10} – dust – sea salt").[59] However, these numbers are not presented anywhere, so the averaging period and calculation cannot be properly verified. **We recommend that the daily average PM_{10} data and subsequent deductions be presented for independent verification. Either for each day analysed in 2020, or for an example subset (e.g., only the days in exceedance of the daily PM_{10} limit value at each site).**
Subtraction is only applicable for the area where the spatial representativeness of the measurement has been determined. Wider application must be supported by modelling results, validated through an adequate number	Yes	Chemical analysis was presumably conducted separately at each site. This is assumed from the discrete discussion and presentation of results throughout the report, and specifically the different number of total measurement days with chemical analysis in the Table in Section B.[60]

[58] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 4, 10 and 12.
[59] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, pages 9, 11 and 4.
[60] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 4.

Content	2020 report	Assessment comments and recommendations
of PM composition measurements.		
Consideration given to possible artefacts introduced by winter salting. Such sources should be identified, quantified and reported separately to avoid double counting.	No	The possible artefacts from winter salting in the quantified contribution of sea spray are not clearly discussed in this report. **We recommend that possible artefacts and interferences be explicitly discussed, even if to confirm no winter sanding or salting took place near Nicosia Traffic Station in 2020.**
Uncertainty analysis	No	Figure 1 of the Cypriot report presents evidence that a validation exercise was taken to evaluate the method used to quantify the chemical components of PM_{10}, by presenting a direct comparison of total measured PM_{10} from weighed filters at both sites, against the sum of quantified components (not specified). Good correlation is observed at both sites.[61] The report does not offer any statistical analysis of how accurate the new concentrations calculated might be. **We recommend that the presented results be analysed more critically, to identify and understand possible sources of error in the stated results.**
References to the methodological reports/papers	Partially – only references the Commission's natural source guidelines	The Cypriot report only references Section 4.2.1 the Commission's natural source guidelines, SEC (2011) 208 final document as a way to outline the method used to quantify the concentration of sea salt. **We recommend that Cyprus reference its methodology and refer to other relevant reports, particularly for the collection of PM_{10} filters as this method is not standardised in the Commission's guidelines.**

A2.5 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

A brief overview of the methodology that Cyprus has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying Saharan dust contributions (Section 4.1.6) have been summarised in Table 14 below, in the form of a checklist. The evidence provided in the Cypriot report to meet each of the key principles set out in Section 2 of the Commission's guidelines has been compiled in the correspondingly named sub-sections of Appendix Section A2.3.

Table 14 Summary of methodology provided by Cyprus for quantifying and subtracting a Saharan dust correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
List of the regional background measuring stations used for the determination of the net dust load and information	Partially – not enough information provided	The background station used in the report (Agia Marina Xyliatou) is a European Monitoring and Evaluation Program (EMEP) background station, and subject to formal siting criteria as it is intended to be a rural measurement representative of a large (~50 km^2)

[61] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, page 6.

Content	2020 report	Assessment comments and recommendations
concerning representativeness of the stations		surrounding area. However, this is not specifically mentioned. **We recommend that the representativeness of Agia Marina Xyliatou be discussed within the Cypriot report.**
The tables of daily levels of PM_{10} registered at stations representing regional background	No	No information has been provided which shows daily concentrations at background sites for the year 2020. **We recommend that this data be presented in the report, or as an associated appendix.**
The list of dates with the identification of African dust episodes	Partially – not enough information provided	The report does not provide a clear list of dates which were identified as Saharan dust events. The daily average concentration of dust determined are presented for both sites adjusted on the top plots (a) of Figures 7 and 8 of the Cypriot report. Significant contributions can be identified by peaks in this data; however, the coarse time resolution (monthly) makes these dates difficult to identify.[62] Similarly in Figure 6 of the Cypriot report, the prevailing wind direction for each day has been assigned and monthly totals presented. The compass directions presented could be broadly attributed to the dry source region (e.g., Sahara, S and SW; or Middle East, E and SE) where elevated concentrations of PM_{10} are identified (see Figure 4) but further detail is not presented.[63] **We recommend that the Cypriot report explicitly state the dates where Saharan dust events were identified, alongside the supporting evidence.**
The values of the daily net African dust load determined by means of the procedure presented in the working document	Partially – not enough information provided	Section 4.1.2 ("Quantifying Saharan dust outbreak episodes") of the Commission's natural source guidelines in the SEC (2011) 208 final document has been referenced for the method used. However, the quantified load of Saharan dust is not presented. A summary of these calculated daily average values is presented for each site in the Cypriot report Figures 7 and 8 (top plot; a), as well as the percentage the fraction of the PM_{10} measured that this comprises (middle plot; b).[64] **We recommend that the quantified dust load be presented to allow independent verification of Cyprus' results.**
The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas	Partially – not enough information provided	The report does not detail the daily averaged PM_{10} concentrations. However, a time series of PM_{10} concentrations pre- and post-subtraction of both sea spray and dust contributions are presented in Figure 2.[65] The discrete contribution of dust on a daily time resolution is not presented.

[62] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, pages 9 and 11.
[63] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, pages 7-8.
[64] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, pages 9 and 11.
[65] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, page 6.

Content	2020 report	Assessment comments and recommendations
		We recommend that the quantified daily concentrations pre- and post-subtraction be included in the report, or an associated appendix, for each site deducted. This could be combined with the quantified dust contribution for further clarity in results and allow for easier independent verification of results.
The annual concentration levels before and after subtraction of the net dust load for all assessment points and areas. The difference will yield the mean annual dust contribution from African dust.	**N/A**	Only the daily limit values are exceeding in Cyprus in 2020, and therefore the evaluation of the impact of natural dust on annual mean values is not necessary.
Uncertainty analysis	**No**	Figure 1 of the Cypriot report presents evidence that a validation exercise was taken to evaluate the method used to quantify the chemical components of PM_{10}, by presenting a direct comparison of total measured PM_{10} from weighed filters at both sites, against the sum of quantified components (not specified). Good correlation is observed at both sites. [66] The report does not offer any statistical analysis of how accurate the new concentrations calculated might be. **We recommend that Cyprus include critical discussion of the contributions calculated, and the reduced PM_{10} concentrations presented, to identify possible sources of error in the results.**
Critical analysis of the applied methodological elements relevant in the reporting year, if appropriate.	**No**	There is no discussion of a critical analysis of the applied methods in the Cypriot report. **We recommend that this be addressed by Cyprus within their reported methodology.**
References to the methodological reports/papers	**Partially – only references the Commission's natural source guidelines**	The Cypriot document only references Section 4.1.2 the Commission's natural source guidelines (SEC (2011) 208 final document) as a way to outline the method used to quantify the concentration of dust. **We recommend that Cyprus reference relevant reports to support the method used (e.g., for the chemical analysis of dust mentioned).**

A2.6 ASSESSMENT SUMMARY FOR CYPRUS

Natural source corrections were identified in Cyprus in 2018, 2019 and 2020. In all years there were exceedances of daily PM_{10} limit values reported in zone CY0001A, which were no longer in exceedance after natural source corrections were applied. The methodology assessed against the Commission's guidelines for this correction was from the "Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020", the most recent iteration uploaded to Dataflow G.

[66] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, Annex, page 6.

The report includes a moderately detailed analysis of the concentrations of PM_{10} pre- and post-subtraction, but the description of methodology used is sparse. Not enough information has been provided to allow a detailed assessment of the methodology to determine whether the guidelines have been followed, or validate the calculations performed.

It is anticipated that the reference to the Commission's natural source guidelines (SEC (2011) 208 final document) was deemed sufficient.[67] Sections 4.1.2 and 4.2.1 of the Commission's guidelines were cited for the quantification of Saharan dust and sea salt episodes, respectively.

Of what is provided, identification of sea spray and dust is outlined. The former was conducted by chemical analysis of Na^+ in sea salt follows the guidance. The latter, uses analysis of air masses immediately prior to arriving at the site (e.g., by wind direction and concentration only, back trajectories not detailed) to conclude that the source of dust are from the Sahara and Middle East. Chemical analysis for dust is mentioned, but not discussed and remains unclear how this was used, more detail is required to evaluate the validity of the methodology used by Cyprus.

In addition, there is little to no critical assessment of the results presented. Similarly, there is no discussion of possible contributions from alternative sources to total PM_{10} measured during these days, such as those with anthropogenic origins. It is noted that due to its location, measurements in Cyprus are influenced by transboundary pollution, shipping, and other countries emissions, however this is not discussed further nor quantified. Final contribution values of sea spray and dust also lack uncertainty assessments, so confidence in the final value is assumed.

Overall, the Cypriot report only provides a summary of results, and have not presented a clear methodology which was used to quantify the contribution of sea spray and Saharan dust to PM_{10} measured at each measurement station. It is assumed from the context of the reported results that the contributions were calculated following the Commission's guidelines, however the necessary evidence required to validate or verify the results presented is missing. In future, Cyprus needs to present the methodology used for the corrections applied, alongside the stated evidence, not just a summary of the results.

[67] Analysis report of sources of origin of Suspended Particles in Cyprus for the year 2020, page 3.

Appendix 3 – Greece: Saharan dust correction

A3.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G, natural source corrections were identified to have been applied to adjust the baseline concentrations in four zones in Greece between 2018 and 2020.

The methodology for the natural source corrections assessed was sourced from the Greek information on Dataflow G (DfG), for the most recent year (2020; see Table 15 of this report). This method (hereafter referred to as the "Finokalias Dust Methodology") has been similarly used in 2018, but specific detail for this year will not be discussed in this assessment. No methodology has been provided on DfG for 2019.

The "adjustment description" in the information provided to DfG for all year's provides links to air quality reports page of the Greek Ministry of Environment and Energy website. As such, the most recent report (2020; hereafter referred to as the "Annual Atmosphere Quality Report") was also examined during this assessment. Similarly, the individual data sheets uploaded to the 2020 envelope on DfG were analysed. Evidence for the derivation of the dust contributions to PM_{10} on each day in 2020 are presented in the "Finokalia PM_{10} 2020" data sheet. Deductions at each site in North Greece (zone EL0001) and Agglomeration Thessaloniki (zone EL0004) are presented in the relevant "Dust Adjustments EL000X" data sheets (where X = 1 or 4, respectively).

During the identification stage of this assessment (see Section 2.1), Greece was initially identified as a Member State where natural source corrections had been applied. However, there was a discrepancy in the data reported to the Dataflow G summary document for 2018–2020, with the "Adjustment Source" stated to be "sea spray", but the corresponding "Description of Assessment Type" stating that the Commission's methodology for deducting the contribution for Saharan dust had been applied (evidenced in Figure 3). The same description was provided to the XML files provided to Greece's information on DfG, as such both natural sources are identified in Table 3.

However, upon analysis of the 2020 Annual Atmosphere Quality Report, it is stated that from chemical analysis of ions in PM_{10}, the contribution of sea spray does not exceed 2 $\mu g\ m^{-3}$.[68] The Finokalias Dust Methodology states that between 2009 and 2015 the contribution of marine particles (sea spray) was determined to be up to 5 $\mu g\ m^{-3}$.[69] However, for the year assessed (2020) there is no further discussion or quantification of this contribution, and no methodology for the deduction of sea spray has been presented. As such, it is assumed that the contribution of sea spray has not been deducted, and only the contribution from Saharan dust has been considered in this assessment.

Greece's methodology for the identification and quantification of Saharan dust contributions to PM_{10} are assessed against the key principles detailed in Section 2 of the Commission's natural source guidelines (SEC (2011) 208 final document) in Appendix Section A3.3, and against the relevant recommended method outlined in Section 4 of the same guidelines in Table 16 (Appendix Section A3.4).

[68] Greece: Annual Atmosphere Quality Report 2020, page 53.

[69] Finokalias Dust Methodology, page 3.

A3.2 SUMMARY OF CORRECTIONS REPORTED

Table 15 Summary table of results from the assessment of corrections applied in Greece in 2018[70], 2019[71] and 2020[72] for inclusion in the final summary report. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
EL0001	North Greece	2018	**40 days**	30 days	Days above limit value	Natural source
		2020	**41 µg m^{-3}**	37 µg m^{-3} *	Annual mean value	
			74 days	**61 days**	Days above limit value	
EL0002	South Greece	2018	**48 days**	27 days	Days above limit value	
EL0003	Agglomeration Athens	2018	**61 days**	25 days		
		2019	**58 days**	**37 days**		
EL0004	Agglomeration Thessaloniki	2018	**43 µg m^{-3}**	37 µg m^{-3}	Annual mean value	
			65 days	**43 days**	Days above limit value	
		2019	**42 µg m^{-3}**	37 µg m^{-3}	Annual mean value	
			88 days	**67 days**	Days above limit value	
		2020	**64 days**	**50 days**		

** Declared as a Number Exceedance, not Numerical Exceedance in Greece (GR) Dataflow G envelope for 2020.*

A3.3 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A3.3.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). The Greek Finokalias Dust Methdology relies heavily on the information provided in referenced peer-reviewed publications for its method in identifying dust events: Escudero *et al*. (2007) and Querol *et al*. (2009).[73] These publications are also referenced for the quantification of Saharan dust contributions by the Commission's natural source guidelines and used to formulate the recommended methods. Supporting evidence for this methodology has not been provided for 2020, such as the HYSPLIT back-trajectories mentioned, nor satellite images or dust model results. Further to this, there is little explicit discussion of the influence of other sources, such as interactions between natural and anthropogenic components, nor whether human action could prevent or reduce the identified contribution.

It is stated that the Finokalia measurement station has no significant local effects on measured PM_{10}, which has been referenced with other peer-reviewed literature.[74] However, this should be acknowledged for the year

[70] GR Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyes8vq/REP_D-GR_MINENV_20200922_G-101.xml/manage_document

[71] GR Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/gr/eu/aqd/g/envx1jjqq/REP_D-GR_MINENV_20200921_G-001.xml/manage_document

[72] GR Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/gr/eu/aqd/g/envyvsqiw/REP_D-GR_MINENV_20211002_G-001.xml/manage_document

[73] Escudero *et al*. (2007), *Atmospheric Environment*, 41, 26, 5516-5524 and Querol *et al*. (2009), *Atmospheric Environment*, 43, 28, 4266-4277.

[74] Finokalias Dust Methodology, page 3.

being assessed (2020). Particularly as the site is mentioned to be very well suited for detecting transboundary pollution, the influence of anthropogenic PM_{10} emissions from further afield could be discussed (e.g., shipping).

It should also be noted that dust contributions have been calculated and deducted for every day PM_{10} measurements were available at Finokalia measurement station, except where the determined daily background concentration exceeded the measurement (219 days, 60% of the year).[75] This includes days suggested to be "clean", and not affected by Saharan dust (e.g., with air mass origins from the north).[76] As such, it is assumed that the contribution of dust was not limited to only days where dust was identified.

A3.3.2 The quantification of the natural contribution must be sufficiently precise

The contribution of dust to PM_{10} measurements across Greece has been calculated at Finokalia measurement station, in Crete. This is stated to have been determined using the methodology detailed in Escudero *et al.* (2007) and updated in Querol *et al.* (2009),[77] but is not specifically discussed for 2020. As such, not enough evidence has been provided to verify the contribution (see Appendix Section A3.3.1).

Contributions of Saharan dust are episodic, unlikely to consistently affect PM_{10} measurements every day of the year. In the data sheets provided by Greece to DfG[78] contribution has been quantified and deducted for every day PM_{10} measurements were available in 2020, except those where the determined background concentrations at Finokalia measurement station were greater than the daily average measured PM_{10} concentration on that day. In these instances, the contribution of dust is stated to be 0 µg m^{-3}. There is no discussion in the Greek reports to acknowledge or determine why the background concentration of PM_{10} at Finokalia could have exceeded that measured at the urban stations deducted in these instances.

The background concentrations determined at Finokalia could not be verified from the data provided. However, the dust contributions calculated from the background and daily PM_{10} measurements have been independently verified in this assessment, as have the deduction calculations at each site in North Greece (EL0001) and Agglomeration Thessaloniki (EL0004). Upon inspection of these results in the respective data sheets uploaded to DfG ("Dust Adjustments EL000X", where X = 1 or 4), it was concluded that the measurement stations whose data were submitted to DfG were Ptolemaida (zone EL0001) and Agia Sofia (zone EL0004). Information provided in the Annual Atmosphere Quality Report states that Ptolemaida (ΠΤΟΛΕΜΑΪΔΑ; ΠΤΟ; GR0452A) is an urban industrial site in North Greece (EL0001), while Agia Sofia (Γ. ΣΟΦΙΑ; ΑΓΣ; GR0018A) is an urban traffic site in Agglomeration Thessaloniki (EL0004).[79]

In Tables 5.6.b and 5.7 of Greece's Annual Atmosphere Quality Report,[80] the number of days in exceedance of the PM_{10} limit value, and the exceedance of the annual mean at Ptolemaida agree with the data submitted to DfG (Table 15). Ptolemaida shows a reduction in the annual mean of 4 µg m^{-3} from 41 µg m^{-3}, as well as a reduction of 13 days in exceedance of the daily PM_{10} limit value, from 74 days. The in exceedance at Agia Sofia is stated to be 64 days, reduced by 14 days.

The annual average values have been independently verified using the measurements provided in the Dust Adjustment EL0001 and EL0004 data sheets. However, the number of days in exceedance of the daily PM_{10} limit value (50 µg m^{-3}) do not match the values reported in either zone in exceedance. At Ptolemaida in North Greece (EL0001), after subtracting the contribution of dust, 65 days remain in exceedance, not 61 as stated in DfG. Similarly, at Agia Sofia in Agglomeration Thessaloniki (EL0004), 51 days are still in exceedance, not 50. This difference has been analysed to determine whether it is a result of rounding or miscalculation, but the number of days stated in DfG cannot be independently replicated with the data Greece has provided. It was considered that the difference could be explained by the contribution of sea spray but not discussed by Greece, however there is no evidence or discussion supporting this. Moreover, if it is assumed, as is stated in the Greek Annual Atmosphere Quality report, that 2 µg m^{-3} of each PM_{10} concentration after the deduction of dust can be attributed to sea spray, the number of days above the limit value is still greater than reported to DfG (62 not 61 days; zone EL0001).

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[75] Finokalia PM_{10} 2020 [Data].

[76] Finokalias Dust Methodology, page 4.

[77] Escudero *et al*. (2007), *Atmospheric Environment*, 41, 26, 5516-5524 and Querol *et al*. (2009), *Atmospheric Environment*, 43, 28, 4266-4277.

[78] Finokalia PM_{10} 2020 [Data], and ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020) and Greece [Data]: Dust Adjustments EL0004 (2020).

[79] Greece: Annual Atmosphere Quality Report 2020, Table 1.1b, pages 9-10.

[80] Greece: Annual Atmosphere Quality Report 2020, Tables 5.6.b and 5.7, pages 57-58.

The peer-reviewed papers referenced provide discussion of uncertainty in the methods presented. However, the Finokalias Dust Methodology is missing the discussion of uncertainty in the presented concentrations for 2020, and the calculated contributions of dust to PM_{10}.

A3.3.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

As shown on Table 15, North Greece (zone EL0001) exceeded the daily PM_{10} limit value (50 µg m^{-3}) on 74 days in 2020, as well as exceeding the annual mean limit value (40 µg m^{-3}) by 1 µg m^{-3} in the same year. In Agglomeration Thessaloniki (zone EL0004), the daily PM_{10} limit value was exceeded on 64 days in 2020.

The contribution of dust has been calculated for each day PM_{10} concentrations were available at Finokalia measurement station.[81] These quantified contributions have been deducted from PM_{10} measurements at three sites in North Greece (EL0001)[82] and two sites in Agglomeration Thessaloniki (EL0004).[83] Net PM_{10} concentrations provided after the natural source correction has been deducted consequently has a daily time resolution.

The annual average concentration at each of these five sites has been determined using the daily average PM_{10} measurements before and after subtraction, respectively. This follows the Commission's guidelines for this quantification.

The annual average contribution of dust has been expressed as the mean of each daily contribution of dust calculated in 2020 (5.0 µg m^{-3}). However, this is an overestimate when compared to the difference in annual average PM_{10} concentrations pre- and post-deduction at each measurement station (3.7–4.3 µg m^{-3}). This value is not used in any further calculations or discussions, but the discrepancy should be noted.

A3.3.4 The quantification of the natural sources must be spatially described

In 2020, the corrections reported to Dataflow G (DfG) are the number of days in exceedance of the PM_{10} limit value in North Greece (EL0001) and Agglomeration Thessaloniki (EL0004), and an exceedance in the annual PM_{10} limit value in North Greece (EL0001). Two data sheets are also uploaded to DfG (Dust Adjustments to EL000X, where X = 1 or 4) which present the deduction of dust applied to each site. The dust contribution stated for each site has been verified to be that determined at Finokalia.[84]

There is considerable discussion of Finokalia measurement station in the Finokalias Dust Methodology,[85] providing evidence that it is representative of dust events across a wide area and demonstrating correlation with events also observed at the Agia Marina Xylatou measurement station in Cyprus. The site is also part of the European Monitoring and Evaluation Program (EMEP) network.[86] As such it is subject to formal criteria as it is intended to be a rural measurement representative of a large (~50 km^2) surrounding area, which holds merit against this criterion. However, Finokalia measurement station is within South Greece (zone EL0002), which was not in exceedance of any PM_{10} limit values in 2020. The evidence provided by Greece does not specifically acknowledge that Finokalia measurement station is a representative background for each of the sites where its dust contribution was deducted in 2020. This should be supported using evidence for the identification of Saharan dust episodes in both zones in exceedance of PM_{10} limit values (see Appendix Section A3.3.1).

A3.3.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the Commission's natural source guidelines in the SEC (2011) 208 final document, the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature.

The Finokalias Dust Methodology states that the contribution of desert dust to PM_{10} concentrations at the regional background station (Finokalia) is determined using computational models,[87] following the

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[81] Finokalia PM_{10} 2020 [Data].

[82] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020).

[83] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0004 (2020).

[84] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020) and Greece [Data]: Dust Adjustments EL0004 (2020).

[85] Finokalias Dust Methodology, pages 2-3.

[86] EMEP Site descriptions, Greece: https://projects.nilu.no/ccc/sitedescriptions/gr/index.html (last accessed 13th May 2022).

[87] Finokalias Dust Methodology, page 4.

methodology detailed in Escudero *et al.* (2007) and updated in Querol *et al.* (2009).[88] This publication states that the origin of air masses arriving at the regional background sites where PM_{10} was measured were identified with HYSPLIT back-trajectories, and other tools such as aerosol maps (SKIRON), dust maps (BSC-DREAM) and satellite images. Further, measured PM_{10} at the regional background measurement stations (mostly EMEP) were speciated using chemical analysis. A proxy for >99% of the African dust contribution (crustal load) was quantified as the sum of major components measured on filters: SiO_2, Al_2O_3, CO_3^{2-}, Ca, Mg, Fe and K. The calculation of regional background PM_{10} levels are investigated, but ultimately calculated using a monthly moving 30th percentile. These methods are supported by the Commission's guidance.[89]

The Greek report specifically states that 5-day HYSPLIT back-trajectories are used daily for determining the quantification of PM_{10}, to determine "clean" days where there is no apparent influence of dust. The general air mass origin is indicated in the Finokalias PM_{10} 2020 data sheet,[90] however there is no clear indication of which days in 2020 were considered "clean" as each day has a quantified background PM_{10} concentration, except where measurements were not available (21st October to 27th November 2020). Air masses with southerly, easterly or mixed origins are suggested to be excluded from the "clean" days.[91] Determining the monthly 30th moving percentile excluding these trajectory origins (as well as excluding other potential directions, such as south-east, north-east and south-west) did not replicate the background concentrations declared by Greece. As such, the subsequent calculation of the background concentration of PM_{10} at Finokalia could not be verified in this assessment.

Overall, references to peer-reviewed and Commission approved methodologies suggests that the guidance in the SEC (2011) 208 final document has been followed. However more detail is required for 2020 specifically.

A3.3.6 The quantification of the natural sources must be demonstrated for each pollutant separately

In the Greek report, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A3.4 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

In Dataflow G, Greece attached a methodology report (Finokalias Dust Methodology) and several spreadsheets which contain further evidence of how corrections have been applied in Greece. The information provided also is also linked to the Annual Atmosphere Quality Report (2020) which provides an overview of air quality in Greece in 2020.

A brief overview of the methodology that Greece has applied against the recommended methods in Section 4.1.6 of the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying Saharan dust contributions have been summarised in Table 16 below, in the form of a checklist. The evidence provided in the Greek documents to meet each of the key principles set out in Section 2 of the Commission's guidance have been compiled in the correspondingly named sub-sections of Appendix Section A3.3.

Table 16 Summary of methodology provided by Greece for quantifying and subtracting a Saharan dust correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
List of the regional background measuring stations used for the determination of the net dust load and information concerning	Yes	Only the Finokalia measurement station has been used to determine the contribution of Saharan dust that has been deducted from all sites in North Greece (zone EL0001) and Agglomeration Thessaloniki (zone EL0004). This is detailed in the Finokalias Dust Methodology,[92] and demonstrated in all three data

[88] Escudero *et al*. (2007), *Atmospheric Environment*, 41, 26, 5516-5524 and Querol *et al*. (2009), *Atmospheric Environment*, 43, 28, 4266-4277.

[89] SEC (2011) 208 final document, pages 19-22.

[90] Finokalia PM_{10} 2020 [Data].

[91] Finokalias Dust Methodology, page 4.

[92] Finokalias Dust Methodology, page 3.

Content	2020 report	Assessment comments and recommendations
representativeness of the stations		sheets. The Finokalia PM_{10} 2020 data sheet presents the quantified dust contributions at the site,[93] while the Dust Adjustments EL0001 and EL0004 data sheets[94] use this quantified contribution at all sites deducted. These values have all been independently verified in this assessment. The representativeness of Finokalia measurement station has been extensively discussed in the Finokalias Dust Methodology.[95] This is a regional background site on the island of Crete (within South Greece; zone EL0002). The site position and local area is discussed in detail, as well as reasoning why this measurement station is particularly suitable for studying transboundary pollution.[96] It is noted that apart from desert dust intrusions, there are no significant local effects on measured PM_{10} concentrations due to the location of the station.[97] This statement has been referenced with multiple peer-reviewed publications using PM_{10} and ozone (O_3) measurements made here. This assessment also found that Finokalia is part of the European Monitoring and Evaluation Program (EMEP) network,[98] and is therefore subject to strict siting criteria.
The tables of daily levels of PM_{10} registered at stations representing regional background	**Yes**	Daily concentrations of PM_{10} measured at the Finokalia regional background station for each day in 2020 are presented in the Finokalia PM_{10} 2020 data sheet.[99]
The list of dates with the identification of African dust episodes	**Partially – not enough information provided**	The contribution of Saharan dust was calculated for every day PM_{10} measurements were available for in 2020 (328 days, 90% data capture). Each day is subtracted from measured concentrations at each site within North Greece (EL0001) and Agglomeration Thessaloniki (EL0004), despite noting different trajectory directions.[100] It is discussed in the Finokalias Dust Methodology that the site is specifically located to be sensitive to transboundary pollution, such as Saharan dust. However, it is stated in the Commission's natural source guidelines (SEC (2011) 208 final document) that the contribution of Saharan dust is highly episodic[101] and would be unlikely to influence every daily average in 2020. This is somewhat acknowledged in the Finokalias Dust Methodology, as

[93] Finokalia PM_{10} 2020 [Data].
[94] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020) and Greece [Data]: Dust Adjustments EL0004 (2020).
[95] Finokalias Dust Methodology, pages 2-3.
[96] Finokalias Dust Methodology, page 2.
[97] Finokalias Dust Methodology, page 3.
[98] EMEP Site descriptions, Greece: https://projects.nilu.no/ccc/sitedescriptions/gr/index.html (last accessed 13th May 2022).
[99] Finokalia PM_{10} 2020 [Data].
[100] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020) and Greece [Data]: Dust Adjustments EL0004 (2020).
[101] SEC (2011) 208 final document, page 12.

Content	2020 report	Assessment comments and recommendations
		the steps for determining the background concentration require identification of "clean" days, which are not unduly affected by Saharan dust (e.g., no southerly, easterly or mixed winds) based on the backward trajectory analyses.[102] These dates are not specified by Greece. **We recommend that Greece clearly specify the days identified to be affected by Saharan dust episodes to allow independent verification of their calculations.**
The values of the daily net African dust load determined by means of the procedure presented in the working document	Yes	The Finokalias Dust Methodology states that the contribution of desert dust to the measured total PM_{10} concentration was calculated through computational models, referencing the procedure in three peer-reviewed publications,[103] which are also referenced in the Commission's guidelines. These calculated contributions are presented in the Finokalia PM_{10} 2020 data sheet.[104]
The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas	Yes	The Dust Adjustments EL0001 data sheet presents the concentrations of PM_{10} prior to and following the deduction of dust at three Greek sites in North Greece (Larisa, GR0010A; Ptolemaida, GR0452A; and Ioannina-2, GR0410A). The equivalent is presented in the Dust Adjustments EL0004 data sheet, for two sites in Agglomeration Thessaloniki (Agia Sofia, GR0018A; and Kordelio, GR0020A). These calculations have been independently verified in this assessment for all measurement stations presented.
The annual concentration levels before and after subtraction of the net dust load for all assessment points and areas. The difference will yield the mean annual dust contribution from African dust.	Yes – with some reservation	The Dust Adjustments EL0001 and EL0004 data sheets provide traceable calculations of the annual average calculations at each measurement station.[105] The annual average before and after subtraction are calculated using the daily average PM_{10} measurements before and after subtraction, respectively. This follows the Commission's recommendation.[106] The annual contribution of dust has been expressed as the average of all quantified daily contributions of dust in 2020 (5.0 µg m^{-3}). However, this is an overestimate when compared to the difference in annual mean concentrations found at each measurement station (3.7–4.3 µg m^{-3}). **We recommend that this discrepancy be discussed, and the alternative method of quantifying the annual mean dust concentration be justified.**

[102] Finokalias Dust Methodology, page 4.
[103] Finokalias Dust Methodology, page 4.
[104] Finokalia PM_{10} 2020 [Data].
[105] "ADJUSTMENTS" sheets of Greece [Data]: Dust Adjustments EL0001 (2020) and Greece [Data]: Dust Adjustments EL0004 (2020).
[106] SEC (2011) 208 final document, page 13.

Content	2020 report	Assessment comments and recommendations
Uncertainty analysis	Partially – not enough information provided	The Finokalias Dust Methodology document references peer-reviewed publications as further sources of information for its method.[107] Both papers present at least some statistical analysis and discussion of uncertainty for the methodology used within them. This method has been verified using chemical composition measurements from Finokalia between 2004–2016, shown in Figure 2 of the Finokalias Dust Methodology.[108] This method demonstrates good correlation between the quantified dust contribution to PM_{10} (σκόνη από μοντέλο) and the sum of measured chemical components on the same day (σκόνη από χημική μοντέ). This follows assessments performed in the referenced papers,[109] which discuss this comparison on days identified dust intrusions, using the concentrations of SiO_2, Al_2O_3, CO_3^{2-}, Ca, Mg, Fe and K. This is recommended in the Commission's guidelines.[110] The same has not been provided by Greece for their 2020 measurements. **We recommend that Greece include discussion of uncertainty in the dust contributions and subsequent reduced PM_{10} concentrations quantified for 2020.**
Critical analysis of the applied methodological elements relevant in the reporting year, if appropriate.	No	There is no critical discussion of the methods presented in the Finokalias Dust Methodology for the corrections applied in 2020. **We recommend that this be addressed by Greece within their reported methodology.**
References to the methodological reports/papers	Yes	There are many references throughout the Finokalias Dust Methology, summarised in the reference list.[111] These are predominantly peer-reviewed literature paper, providing evidence for temporal and spatial trends in data at Finokalia and methods used. The NOAA HYSPLIT models used.

A3.5 ASSESSMENT SUMMARY FOR GREECE

Natural source corrections were identified in Greece in 2018, 2019 and 2020 from the information provided in Dataflow G. During 2020, there were 74 days in exceedance of the daily PM_{10} limit value reported in North Greece (zone EL0001) and 64 days in Agglomeration Thessaloniki (zone EL0004), which both remained in exceedance after the contribution of dust had been deducted (61 and 50 days, respectively). North Greece (EL0001) was also in exceedance of the annual mean PM_{10} limit value in 2020 (41 µg m^{-3}) but was no longer in exceedance after the deduction (37 µg m^{-3}). The methodology assessed against the Commission's guidelines for this correction was from the "Finokalias Dust Methodology" report, uploaded to Dataflow G (DfG).

[107] Finokalias Dust Methodology, page 4.
[108] Finokalias Dust Methodology, page 4.
[109] Querol *et al*. (2009), *Atmospheric Environment*, 43, 28, 4266-4277 and Escudero *et al*. (2007), *Atmospheric Environment*, 41, 26, 5516-5524.
[110] SEC (2011) 208 final document, page 22.
[111] Finokalias Dust Methodology, pages 5-6.

This method provides an overview, referencing peer-reviewed literature as a source of further detail.[112] These papers are also cited in Section 4.1 of the Commission's natural source guidelines as evidence of scientific validation of the suggested method, and a demonstration of it using real data.[113]

Greece have also uploaded PM_{10} data to DfG as evidence of the deduction. This includes the "Finokalia PM_{10} 2020" data sheet, presenting the determined background concentrations of PM_{10} at the rural background site, and the subsequent contribution of dust estimated for each day measurements were available in 2020. "Dust Adjustments EL000X" (where X = 1 or 4) are data sheets which demonstrate the dust contribution at Finokalia being deducted from all sites within that respective zone.

However, the evidence provided by Greece for the deduction of dust in 2020 is missing several key components. First, there is some confusion over which days PM_{10} measurements were influenced by Saharan dust. It is stated in the Finokalias Dust Methodology that HYSPLIT back-trajectories were used to determine the air mass origin for every day investigated, and only days considered "clean" were used to determine the background concentration. These days are not specified, and as such the background concentration cannot be verified in this assessment. However, a contribution of dust has been determined for every day PM_{10} data was available, which does not reflect the episodic nature of dust events. Particularly if days without the influence of dust were identified, these should not be deducted. No evidence has been presented to support the conclusion that dust is contributed every day (e.g., HYSPLIT or dust model results, satellite images).

Most calculations presented in the three data sheets can be verified, except the background concentration of PM_{10} at Finokalia (Finokalia PM_{10} 2020 data sheet), as the "clean" days used in this calculation were not specified. The number of days in exceedance of the daily PM_{10} limit value after the deduction in both zone EL0001 and EL0004 presented in the Dust Adjustments EL000X data sheets (where X = 1 or 4, respectively), did not match the values reported to DfG. It is anticipated that this discrepancy may be the result of a deduction of sea spray, however this is not acknowledged or discussed. The Finokalias Dust Methodology states that sea spray has been determined to contribute an average of 5 $\mu g\ m^{-3}$ between 2009-2015,[114] and the Annual Atmosphere Quality Report for 2020 states that in this year, the contribution did not exceed 2 $\mu g\ m^{-3}$.[115] Accounting for this maximum contribution does not resolve the difference.

Finally, there is little critical discussion of results. The cited publications discuss uncertainty in the methods used, however for Greece's deduction in 2020, there is no evaluation of uncertainty in the Finokalias Dust Methodology. There are no quantified estimations for uncertainty, and no contributions of PM_{10} from other sources assessed (e.g., transboundary anthropogenic pollution, or shipping emissions).

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[112] Escudero *et al*. (2007), *Atmospheric Environment*, 41, 26, 5516-5524 and Querol *et al*. (2009), *Atmospheric Environment*, 43, 28, 4266-4277.

[113] SEC (2011) 208 final document, page 17.

[114] Finokalias Dust Methodology, page 3.

[115] Greece: Annual Atmosphere Quality Report 2020, page 53.

Appendix 4 – Latvia: Winter sanding or salting, sea spray and wild-land fire corrections

A4.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G (DfG), both natural source and winter salting or sanding corrections were identified to have been applied to the baseline concentrations in one zone in Latvia (Riga, LV0001) in 2018 and 2020. No baseline data was provided in 2019, and the final concentrations include no declared adjustments (columns L and M in DfG). The methodology for the natural source and winter sanding corrections assessed is sourced from the Latvian envelope on Dataflow G, for the most recent year (2020). The method used in 2018 will not be discussed in this report. No method was provided in 2019.

The Latvian 2020 report outlines that corrections were subtracted from measured PM_{10} concentrations for the re-suspension of particulates following winter sanding activities, as well as the natural contributions from sea salt and wild-land fire episodes. The Latvian report is separated into three methodology sections which provide an overview methodology for each contribution separately. The deductions were applied at one measurement station in Latvia: Riga – Brivibas str. (LV0RBR6), a roadside site in Riga (zone LV0001). The data reported on Dataflow G provided in Table 17 in Appendix Section A4.2, is that for Riga – Brivibas str.

Latvia's methodology for the identification and quantification of winter sanding contributions are assessed against the key principles detailed in Section 2 of the Commission's winter sanding and salting guidelines SEC (2011) 207 final document in Appendix Section A4.3, and against the relevant recommended method outlined in Section 4 of the same document in Table 18 (Appendix Section A4.4) below. For natural corrections, the methodology used by Latvia for the identification and quantification of sea spray and wild-land fire are collectively assessed against the key principles detailed in Section 2 of the Commission's natural source guidelines in the SEC (2011) 208 final document in Appendix Section A4.5. The methodologies used by Latvia are separately assessed against the relevant method outlined in Section 4 of the same natural source guidelines document in Table 19 in Appendix Section A4.6 below (sea spray) and Appendix Section A4.7 (wild-land fire).

A4.2 SUMMARY OF CORRECTIONS REPORTED

Table 17 Summary table of results from the assessment of corrections applied in Latvia 2018[116], 2019[117] and 2020[118] for inclusion in the final summary report. Not all years had reported corrections, as such these are missing from the table. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
LV0001	Riga	2018	**54 days**	34 days	Days above limit value	Winter-salting and sanding
		2020	**66 days**	32 days		Natural source; Winter-salting and sanding

[116] LV Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/lv/eu/aqd/g/envxxtj7w/REP_LV_LEGMC_20190912_retro-2018_G.v0.xml/manage_document
[117] LV Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/lv/eu/aqd/g/envx0enva/REP_LV_LEGMC_20200826_G_2019_v0.xml/manage_document
[118] LV Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/lv/eu/aqd/g/envyuh8zw/REP_LV_LEGMC_20210920_G_v0.xml/manage_document

A4.3 CRITICAL ASSESSMENT OF THE WINTER SANDING OR SALTING CORRECTION

A4.3.1 Contributions must be attributed unequivocally to winter sanding or salting activities

The criteria required to identify the contribution to PM_{10} from winter sanding is summarised in Table 2 of this report, from the Commission's winter sanding and salting guidelines. The conditions which must be evidenced for the method to be used are: i) showing that winter sanding activities have taken place and that road sand remains on the road or nearby footpaths, ii) demonstrating that the road surface was dry, and iii) showing that the days $PM_{2.5}/PM_{10}$ ratio is less than or equal to 0.5.

In terms of the first condition, the only concrete information provided is displayed in column 4 of Table 4 in the Latvian report. This indicates (via a "y" or "n") whether winter sanding activities had taken place, and sand was present on that day in exceedance, confirmed by the Riga municipal authorities for 2020. There is no further detail evidence provided to support these conclusions (e.g., dates or locations of winter sanding activities, or quantity of sand spread). To demonstrate that the road surface was dry, Latvia consulted the Latvian Environment, Geology and Meteorology Centre for the considered period. It should be noted that this has not been referenced and could not be found independently during this assessment. Latvia also notes that the periods where the re-suspension effect was observed (January to April 2020, and November at Riga – Brivibas str.) were periods when the snow or ice had melted and streets had dried out, as well as on some occasions soon after road sanding activities. Confirmation of this condition is provided in column 5 of Table 4 of the Latvian report, in the same manner as the first condition. Finally, Figure 1 of the Latvian report provides a visual illustration of the measured ratio ($PM_{2.5}/PM_{10}$) calculated for Riga – Brivibas str. (LB0RBR6), using $PM_{2.5}$ measurements from Riga – Kronvalda blvd. (LK0RKR9),[119] a local urban background station <1.5 km away.[120] This measurement station selection follows the recommendations in the Commission's winter sanding and salting guidelines. The outcome of this is presented in column 10 of Table 4 in the Latvian report, as above. Further discussion of these conditions and recommendations for improvement are presented in Table 18 (Appendix Section A4.4).

Contributions from other PM_{10} sources which may have a similar influence on (elevated) PM_{10} concentrations must be excluded. Other than excluding the potential contribution of long-range transport to the measurement station (Riga – Brivibas str., LV0RBR6), the Latvian report does not discuss the potential influence of other PM_{10} sources. They do not discuss the direct and indirect emissions from any sources specifically mentioned in the Commission's guidelines (e.g., crustal material from the earth surface).[121]

A4.3.2 Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value

The Latvian report systematically estimated the contribution of winter sanding following the guidance outlined in Section 4.1.2 of the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document), based on the difference between PM_{10} and $PM_{2.5}$. If the conditions outlined in the Commission's guidelines are met, 50% of the coarse fraction (PM_{10} – $PM_{2.5}$) measured in Riga (zone LV0001) can be attributed to winter sanding.

To prove that conditions in the Commission's guidelines are met, Table 4 at the end of the Latvian report presents data for each day in exceedance of the PM_{10} daily limit value. Columns in this table provide a checklist for the conditions required for this method: confirmation that sanding activities took place, column 4; confirmation the road surface was dry, column 5; confirmation that the $PM_{2.5}/PM_{10}$ ratio is less than or equal to 0.5, column 7 (the ratios are also presented in Figure 1 of the Latvian report); and confirmation that the measured PM_{10} was not affected by long-range transport, column 9. Any evidence provided by Latvia to reach each of these conclusions has been discussed in Table 18 (Appendix Section A4.4). If each of these three criteria are met, the day is marked as eligible for deduction in column 10. This is the case for 31 days in 2020. For these days, the following equation is used to determine the winter sanding contribution at Riga – Brivibas

[119] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.

[120] Site coordinates taken from Table 1.2 in the 2018 winter sanding correction report on Dataflow G (https://cdr.eionet.europa.eu/lv/eu/aqd/g/envxxtj7w/Novertejums_par_sals_smilts_un_dabisko_avotu_radito_ietekmi_uz_dalinu_PM10_konc_Riga_2018.pdf, last accessed 4th May 2022), and distances verified using Google Earth (last accessed: 4th May 2022).

[121] SEC (2011) 207 final document, page 9.

str. measurement station, following the guidance from the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document:

$$\text{Contibution from winter sanding} = \frac{\mathrm{PM}_{10} - \mathrm{PM}_{2.5}}{2}$$

The winter sanding contribution, and net PM_{10} concentration following its subtraction are presented in columns 11 and 12, respectively. This reports independent assessment of both columns confirms that most of the calculations presented in this table are correct. There are 15 days where the presented winter sanding contribution is 0.1 µg m^{-3} different when checked, this is likely to be a result of rounding. Since these comprise a small difference and do not affect the compliance outcome, they are deemed acceptable. Larger differences are observed in the net PM_{10} concentrations on 28th February (0.4 µg m^{-3}) and 11th November 2019 (3.1 µg m^{-3}). These dates are not identified to be influenced by either of the natural sources assessed (Appendix Sections A4.6 and A4.7), so this discrepancy is not a result of the application of other corrections in Latvia. The source of the miscalculation in February is unclear, however it is possible that the issue in November is a transcription mistake. The net PM_{10} calculated from the data provided should be 41.2 µg m^{-3} but is presented as 38.1 µg m^{-3} which is the concentration of the coarse fraction (PM_{10} – $PM_{2.5}$). However, neither of these change the stated compliance outcome of these concentrations, so are deemed tolerable in this instance.

A4.3.3 Representativeness of the measuring stations at which contribution is determined

All particulate matter concentrations (PM_{10} and $PM_{2.5}$) are presented as daily averages in Table 4 and Figure 1 of the Latvian report. This is consistent with the averaging period of the daily PM_{10} limit value exceedances, of which there were 66 in 2020. After the winter sanding correction had been applied to all the days in exceedance in 2020, the compliance outcome changed for 31 days. Therefore 35 days remained in exceedance of the PM_{10} limit value after correction. The remaining three day difference to the final data reported to Dataflow G (Table 17 in Appendix Section A4.2) are deducted as a result of natural source contributions (see Appendix Sections A4.5 to A4.7).

Section 2 of the winter sanding and salting guidelines SEC (2011) 207 document outlines that the influence of PM_{10} emissions from winter sanding or salting is typically measured at traffic related monitoring sites, and the procedure to subtract such a contribution should be applied at each measuring station separately. The representativeness of the measuring station is only necessary to be determined when the results are to be applied in a wider spatial scale. However, as deductions are only calculated for and applied at Riga – Brivibas str. (LV0RBR6) traffic measurement station in Riga (LV0001), the criteria for this key principle have been met.

A4.3.4 The contribution of winter sanding or salting to the measured PM_{10} concentration has to be quantified in µg m^{-3} for each exceedance day under consideration

In the Latvian report each of the 31 days eligible for the deduction of winter sanding from measured PM_{10} at Riga – Brivibas str. (LV0RBR6) traffic measurement station (column 10, Table 4), the contribution attributable to winter sanding has been quantified in µg m^{-3} and presented in column 11, Table 4. As such, this criterion has been satisfied by Latvia.

A4.3.5 The method to determine this contribution has to be documented

As described in the sections above, the methodology used by Latvia in 2020 follows the guidance set out in Section 4.1 of the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document ("Winter sanding - difference between $PM_{2.5}$ and PM_{10}"). This has been succinctly provided in the Latvian report, utilising the example template provided in Annex B of the Commission's guidelines.

A4.4 CRITICAL ASSESSMENT OF THE WINTER SANDING METHOLOGY

A brief overview of the methodology that Latvia has applied against the recommended methods in the Commission's winter sanding and salting guidelines (SEC (2011) 207 final document) for identifying and quantifying winter sanding contributions have been summarised in Table 18 below, in the form of a checklist. The criteria have been taken from Section 4.1 of the Commission's winter sanding and salting guidelines: "Winter sanding – difference between $PM_{2.5}$ and PM_{10}". This includes the conditions for using this method (Section 4.1.1) and the suggested procedure (Section 4.1.2). The evidence provided in the Latvian report to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A4.3.

Table 18 Summary of methodology provided by Latvia for quantifying and subtracting a winter sanding and salting, against the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document.

Content	2020 report	Assessment comments and recommendations
Demonstrates that winter sanding activities have taken place, and that road sand (or remnants) were present on the road or adjacent footpaths.	Yes – with some reservation	The Latvian report states that the measurement station (Riga – Brivibas str., LV0RBR6) in a street canyon on a busy street (~23,000 vehicles per day) used by many heavy vehicles.[122] The evidence provided for this condition states that the Riga municipal authorities confirmed that winter sanding activities took place in 2020, with no further detail stated here (e.g., the dates of sanding activities and the time before corrections were applied, the locations or quantity of sand spread). It is noted that the sanding effect is observed at Brivibas str. mainly between January to April and in November, when the snow/ice melted and the streets dried out, as well as some cases soon after sand spreading.[123] In the Latvian report Table 4 (column 4) provides a confirmation of the presence of sanding activities for each day in exceedance of the daily PM_{10} limit value (50 µg m^{-3}).[124] **We recommend that Latvia provide further evidence from Riga municipal authorities that winter sanding activities took place on the identified dates in 2020. This could be achieved by presenting dates winter sanding took place near the station, or providing the quantity of road sand spread in a given time period, etc.**
Provides evidence that the road surface was dry. This information can be obtained from the municipal authorities responsible for winter sanding or from direct observation. If not available, road surface wetness or precipitation and snow cover meteorological information may be used.	Yes – with some reservation	The "Confirmation of the second condition" paragraph states that days with no precipitation in the Latvian Environment, Geology and Meteorology Centre annual report (not referenced) were selected as candidates to subtract the winter sanding contribution.[125] This follows the Commission's guidelines, though there is no discussion of moisture condensation effects. The result is presented in Table 4 (column 5) of the Latvian report for each day in exceedance of the PM_{10} daily limit value.[126] **We recommend that the data used as evidence for this criterion be referenced or presented within the report.**
Demonstrate that there is a high fraction of course particles (from winter sanding,	Yes – with some reservation	The $PM_{2.5}/PM_{10}$ ratio has been calculated and provided in Figure 1[127] and in Table 4 (column 7) of the Latvian report. Where this ratio is ≤0.5, column 9

[122] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 1.
[123] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 2.
[124] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, pages 7-10.
[125] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 2.
[126] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, pages 7-10.
[127] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.

Content	2020 report	Assessment comments and recommendations
as well as road abrasion, discounting the contribution of long-range transport) by proving the $PM_{2.5}/PM_{10}$ ratio is less than or equal to 0.5. This requires parallel monitoring of PM_{10} and $PM_{2.5}$ (in both measurement method and location).		of Table 4 is marked as “n” (day not affected by long-range transport).[128] Only these have been considered eligible for a deduction. It is stated that the absence of long-range transport was further confirmed by analysis of backward trajectories from the NOAA HYSPLIT model. This is presented in column 8 of Table 4 for the 27th and 28th March 2020.[129] These results are not presented. **We recommend that this evidence be included in the reported Latvian methodology.** $PM_{2.5}$ data used to determine the PM ratio was from a local urban background station (Riga – Kronvalda blvd., LK0RKR9),[130] <1.5 km direct distance away in Riga.[131] This follows the Commission’s guidelines, if $PM_{2.5}$ measurements are not available at the same station, or at a comparable kerbside location in the same city. There is no comment on whether the measurement methods are the same for both size fractions. The Latvian report implies that both $PM_{2.5}$ and PM_{10} measurements at Riga – Kronvalda blvd. are used to determine the PM ratio. However, the reported concentrations in Figure 1[132] and Table 4 (columns 3, PM_{10} and column 6, $PM_{2.5}$) in the Latvian report are measured at Riga – Brivibas str. and Riga – Kronvalda blvd., respectively. The ratios determined in column 7 of Table 4 have been independently verified as correct in this assessment, using the data provided in Table 4. However, as daily average concentrations of PM_{10} at these two sites are unlikely to be the same, it is considered that there is missing evidence in the description provided. It has not been possible to determine whether PM_{10} was also measured at Riga Kronvalda blvd as this station does not report results to DfG. **A comparison graph between the two stations used to compare PM_{10} measurements, if available, would have given confidence in the suitability of choice of station to create the ratio. However, if this is not possible, the choice of site could still be justified.**
Show comparatively low background concentrations (rural and urban), excluding exceptional transboundary events.	**No**	Figure 1 provides the only comparison of concentrations measured in Riga (zone LV0001), as it shows daily $PM_{2.5}$ measured at an urban background site (Riga – Kronvalda blvd., LV0RKR9) and daily PM_{10} measured at the roadside site (Riga – Brivibas str., LV0RBR6). This difference in size fraction does not provide a good comparison to background

[128] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, pages 7-10.
[129] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, pages 7-10.
[130] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.
[131] Site coordinates taken from Table 1.2 in the 2018 winter sanding correction report on Dataflow G (https://cdr.eionet.europa.eu/lv/eu/aqd/g/envxxtj7w/Novertejums_par_sals_smilts_un_dabisko_avotu_radito_ietekmi_uz_dalinu_PM10_konc_Riga_2018.pdf, last accessed 4th May 2022), and distances verified using Google Earth (last accessed: 4th May 2022).
[132] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.

Content	2020 report	Assessment comments and recommendations
		concentrations, as such this criterion has not been met. **We recommend that the daily PM background concentrations, unaffected by winter sanding or other events, be presented or highlighted in the Latvian report.**
Uncertainty analysis	No	The Latvian report only provides positive confirmation that each condition for this method have been met. There is no discussion of potential sources of uncertainty in the calculated contribution of winter sanding, or the deducted PM_{10} concentrations. **We recommend that uncertainties in the identification of days affected by winter sanding, and the quantified contribution be discussed, and any artefacts or interferences acknowledged.**
References to the methodological reports/papers	Yes – with some reservation	The Latvian report references the Commission's winter sanding and salting guidelines SEC (2011) 207 document in the methodology description (Section I.4), as well as the NOAA HYSPLIT model used. An indication to the Latvian Environment, Geology and Meteorology Centre annual report has been made when identifying days with no precipitation, but this has not been properly referenced. **We recommend that Latvia cite this annual report, as well as the relevant evidence and data presented to support conclusions, where possible.**

A4.5 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A4.5.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). In Section II of the Latvian report, the mass of sea salt is stated to have been calculated using the equation below:

$$[\text{sea salt}] = \frac{100}{30.6}\,[\text{Na}^+] = 3.27 \times [\text{Na}^+]$$

The equation presented above are found in the Commission's natural source guidelines SEC (2011) 208 document in Section 4.2.1, where Na^+ concentrations are used as a tracer for sea salt.[133] It is stated in the Latvian report that the mass of sea salt determined is subtracted from the daily average PM_{10} concentrations at Riga – Brivibas str. (LV0RBR6). It is presumed from the context of this equation and description replicated from the Commission's natural source guidelines that the concentrations of Na^+ were measured at the same site using daily aerosol samples,[134] however this is not specifically stated. There is no further discussion of the possible origin of the sea salt contribution on the day it was deducted (27th August 2020). There is also no discussion as to why the deduction is made on only this date.

The methodology used to identify wild-land fire episodes included analysis of satellite images and back-trajectories, as well as a comparison of measured PM_{10} concentrations at Riga – Brivibas str. (LV0RBR6) and

[133] SEC (2011) 208 final document, page 27.
[134] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.

a relevant regional background station to this site (Rucava; LV00010).[135] A list of coincident peaks were identified in the two PM_{10} time series, but this has not been presented.

The contribution from wild-land fires were deducted from PM_{10} at Riga – Brivibas str. (LV0RBR6) on the 2nd and 3rd of October 2020 (Table 3 of the Latvian report).[136] This is attributed to fires in eastern Ukraine and south Russia during the start of October, for which no evidence of the initial fire has been provided. The consequent smoke and dust clouds from this are stated to have reached Latvia from the south-east, evidenced in the satellite images.[137] The satellite images provide some evidence of this but not complete evidence of this conclusion. This could have been strengthened with the presentation and analysis of relevant HYSPLIT backward trajectories calculated by Latvia[138] and further discussion. Further uncertainty is introduced with the mention of the contribution of sand and dust particles from desert regions.[139] This alternative source of PM_{10} has not been quantified or discussed, which as an identified artefact to the wild-land fire contribution, it should be.

Overall, there is not enough information provided in the Latvian report to exclusively attribute the quantified natural source contributions presented in Tables 2 and 3 to the sea spray and wild-land fire, respectively. As such, this report cannot fully verify the methodology used for identification. There is also no discussion on the identification or quantification of any potential artefacts or interferences, or on whether any intervention action could significantly reduce the identified contribution.

A4.5.2 The quantification of the natural contribution must be sufficiently precise

The concentration of sodium ions (Na^+) has been used by Latvia to quantify the contribution of sea salt to PM_{10} measured at Riga – Brivibas str. (LV0RBR6). The measurement method and location of these chemical analysis measurements have not been disclosed in the Latvian report, so cannot be verified in this assessment.

The quantified contribution of the wild-land fire episodes on the 2nd and 3rd of October 2020 is presented in Table 3 of the Latvian report.[140] These have been calculated using the average PM_{10} concentrations in the 15 days pre- and post-episode at the Rucava (LV00010) measurement station (approximately 200 km south-west of Riga; in Latvia, zone LV0200), excluding the days during the episode.[141] The difference between the daily average measured PM_{10} concentration and the 30-day average is considered as the wild-land fire contribution. This follows the suggested methodology of the Commission in Section 4.4.1 (point g). Only an overview of the deduction has been provided by Latvia (Table 3 of the Latvian report), therefore the calculated contributions cannot be verified.

The report is also missing discussion of uncertainty in the presented concentrations, and calculated contributions of each natural source.

A4.5.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

Table 17 shows that in Riga (zone LV0001; Riga – Brivibas str., LV0RBR6) exceeded the daily PM_{10} limit value (50 $\mu g\ m^{-3}$) on 66 days in 2020. Therefore, the contribution of natural sources should be quantified for daily mean concentrations. The Latvian report presents the deduction of the contributions of both sea spray and wild-land fire in Table 2 and 3, respectively. Both Tables demonstrate that these contributions are subtracted from daily average PM_{10} concentrations which exceed the limit value. As such, it is presumed that the quantified natural contributions presented are daily averages, but this isn't explicitly stated. Data is not provided, so this cannot be independently verified here.

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[135] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, pages 4-5.

[136] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Table 3, page 6.

[137] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 4.

[138] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 3.

[139] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 4.

[140] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Table 3, page 6.

[141] Site coordinates taken from Table 1.2 in the 2018 winter sanding correction report on Dataflow G (https://cdr.eionet.europa.eu/lv/eu/aqd/g/envxxtj7w/Novertejums_par_sals_smilts_un_dabisko_avotu_radito_ietekmi_uz_dalinu_PM10_konc_Riga_2018.pdf, last accessed 4th May 2022), and distances verified using Google Earth (last accessed: 6th May 2022).

A4.5.4 The quantification of the natural sources must be spatially described

In 2020, the only correction reported to Dataflow G is the number of days in exceedance in Riga (zone LV0001) is at the Riga – Brivibas str. (LV0RBR6) site, where this drops from 66 to 32 days. The quantified contribution of both sea spray and wild-land fire were only applied at this site.

In calculating the contribution of wild-land fire, the measurements of PM_{10} background station (Rucava; LV00010) are used in quantifying the contribution. There is no discussion of the suitability of this site as a regional background PM_{10} concentration, however this site is within the European Monitoring and Evaluation Program (EMEP) network.[142] As such it is subject to formal criteria as it is intended to be a rural measurement representative of a large (~50 km^2) surrounding area, which holds merit against this criterion.

A4.5.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the Commission's natural source guidelines (SEC (2011) 208 final document), the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature.

In the Latvian report, the contribution of sea spray has been quantified using Na^+ as a tracer for identifying PM_{10} of marine origin. The concentration calculated on the 27th of August 2020 (the only day this contribution was deducted) appears to be at a daily resolution, in order to be subtracted from the daily average PM_{10}. As Riga is a coastal city, it remains unclear why only one day in exceedance of the daily PM_{10} limit value was identified to have a sea spray contribution. This requires justification and discussion, particularly as sea spray can be a persistent influence, and the Commission's guidelines states that the episodic nature of sea salt contributions should be accounted for.

For the deduction of wild-land fire contributions, there is little evidence provided that describes the systematic assessment of the source of deductions applied. The Latvian report states that concurrent measured PM_{10} time series at Riga – Brivibas str. (LV0RBR6) and the EMEP background site in Rucava (LV00010) were analysed to identify coincident high peaks. These periods of simultaneous elevated PM_{10} concentrations were evidenced using satellite imagery, accompanied by a short description of the wild-land fire situation which led to exceedances in Riga on the 2nd and 3rd October. However, neither of these provide further evidence or are fully discussed. The initial presence of wild-land fire events in eastern Ukraine and southern Russia are also not evidenced or dated, as suggested in Section 4.4.1 (point f) of the Commission's guidelines.

The report could provide a good assessment of the quantification of sea spray and wild-land fire and is possibly identified following the Commission's guidelines. However, the necessary evidence required to validate or verify the results presented is missing from the Latvian report.

A4.5.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A4.6 CRITICAL ASSESSMENT OF SEA SPRAY METHOLOGY

A brief overview of the methodology that Latvia has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying sea spray contributions (Section 4.2) have been summarised in Table 19 below, in the form of a checklist. The evidence provided in the Latvian report to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A4.5.

[142] EMEP Site descriptions, Latvia: https://projects.nilu.no/ccc/sitedescriptions/lv/index.html (last accessed 6th May 2022).

Table 19 Summary of methodology provided by Latvia for quantifying and subtracting a sea spray correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
Analysis of the chemical composition of daily aerosol samples, or at least one of the major components of sea salt.	Yes – with some reservation	Section II of the Latvian report states that the mass of sea salt was calculated using an equation provided in the Commission's guidelines (see Appendix Section A4.5.1 above) which uses the concentration of sodium (Na^+) as a tracer.[143] It is assumed that daily average concentrations of Na^+ are used, since the Commission's guidelines is specifically states (*"chemical composition of daily aerosol samples…"*) and the quantified contribution is subtracted from the daily average PM_{10} concentration on 27th August 2020 in Table 2 in the Latvian report.[144] However, this is not specifically stated. **We recommend that the Latvian report include more specific detail on the chemical analysis conducted, including confirming the time resolution of aerosol samples measured.**
The episodic nature of sea salt contributions should be accounted for. The time coverage for chemical composition measurements should therefore be as large as possible. Uncertainties should be considered when time coverage is not 100%.	No	Aside from quoting the Commission's natural source guidelines in the SEC (2011) 208 final document, stating that daily aerosol samples should be analysed, there is no information provided for the temporal range of aerosol measurements collected in 2020. Similarly, there is no discussion of data capture. This may have been omitted as only one day in 2020 was adjusted to account for the contribution of sea salt to PM_{10}, when Na^+ measurements were available (27th August 2020).[145] However, this is no complementary explanation for why only one day has been selected. **We recommend that discussion of the likelihood of further sea salt contributions at Riga be included in the report, alongside the justification as to why this contribution was only deducted on one day in 2020.**
Demonstration that a daily exceedance is attributable to sea spray, through quantification. If considering Na^+ as being entirely of primary marine origin, air mass backward trajectories must be used to validate this assumption.	No	The chemical analysis used to quantify Na^+ concentrations were not coupled with any further analysis, such as back trajectories, to determine whether the exceedance on the 27th of August 2020 is attributable to sea spray. **We recommend that Latvia provide further evidence (such as the HYSPLIT backward trajectories that have already been calculated) to strengthen the argument for the subtraction of the contribution of sea spray on only one day in 2020.**
The calculated mass of sea salt subtracted from the daily	Partially – not enough	The sea salt concentration presented in Table 2 of the Latvian report was subtracted from the daily average

[143] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 4.

[144] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Table 2, page 4.

[145] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Table 2, page 4.

Content	2020 report	Assessment comments and recommendations
average PM_{10} at the sampling point.	information provided	PM_{10} concentration at the Riga – Brivibas str. (LV0RBR6) to quantify a net PM_{10} concentration at the site.[146] However, it is not stated whether measurements of Na^+ concentrations are made at the same site or elsewhere, and the uncertainty this may introduce. **We recommend that the Latvian methodology be expanded to describe the measurements of Na^+ concentrations conducted in 2020.**
Subtraction is only applicable for the area where the spatial representativeness of the measurement has been determined. Wider application must be supported by modelling results, validated through an adequate number of PM composition measurements.	Yes	Only the Riga – Brivibas str. traffic measurement station in Riga (zone LV0001) is assessed for the contribution of sea spray, and subsequently deducted from, the total PM_{10} concentrations.[147]
Consideration given to possible artefacts introduced by winter salting. Such sources should be identified, quantified and reported separately to avoid double counting.	Partially – not enough information provided	The possible influence of winter salting on the date of correction for sea salt has not been explicitly discussed in the Latvian report. However, Section I discusses the deductions made for the contribution of winter sanding at Riga – Brivibas str. measurement station (assessed in Appendix Sections A4.3 and A4.4), and the days identified as eligible for deduction of winter sanding contributions (Table 4 of the Latvian report) do not overlap with the day (27^{th} August 2020, Table 2) this sea salt contribution has been quantified. **We recommend that the Latvian report include discussion and quantification of possible artefacts and interferences in the sea spray contribution determined, such as winter salting.**
Uncertainty analysis	No	There is no discussion provided on the potential sources of uncertainty. The Latvian report also does not offer any statistical analysis of how accurate the new concentrations calculated might be. **We recommend that the Latvian report acknowledge and discuss possible sources of uncertainty in the results presented.**
References to the methodological reports/papers	No	Section II of the Latvian report is not referenced. Only in Section III (*"Quantifying of the wild-land fires episodes contribution"*)[148] is there a reference to the Commission's natural source guidelines in the SEC (2011) 208 final document. **We recommend that Latvia reference relevant reports to support the method used.**

[146] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Table 2, page 4.

[147] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 4.

[148] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, page 4.

A4.7 CRITICAL ASSESSMENT OF WILD-LAND FIRE METHOLOGY

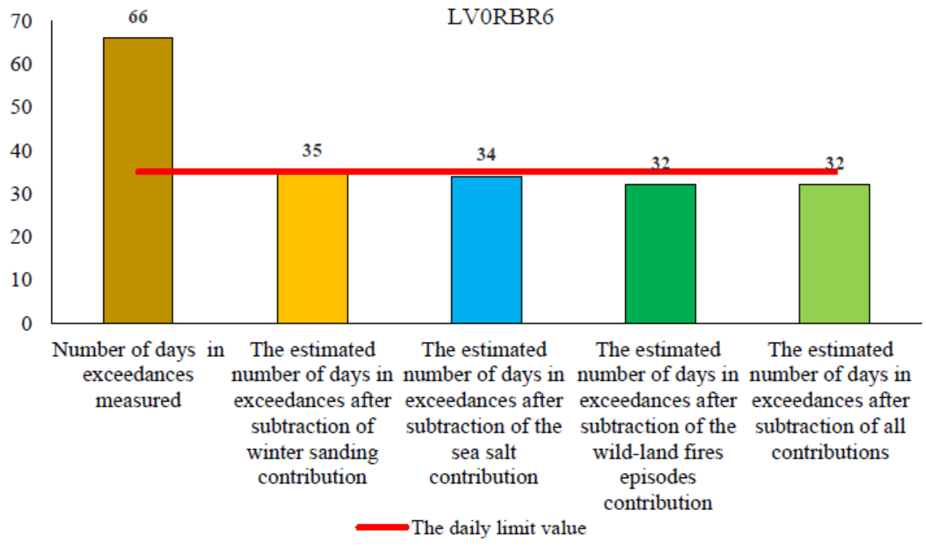
There is no exhaustive methodology for the identification and quantification of wild-land fire episodes included in the Commission's natural source guidelines, as none had been developed and communicated to the Commission at the time of the SEC (2011) 208 final document publication.[149] As such, the evidence provided by Latvia to quantify wild-land fire episodes (Section III of the Latvian report) has only been assessed against the criteria for each of the key principles required for subtraction of natural sources in Section 2 of the Commission's guidelines, in the correspondingly named sub-sections of Appendix Section A4.5.

We recommend that the Latvian report provide further evidence to support the subtraction of wild-land fire contributions. This could include expanding the methodology steps stated in Section III of the Latvian report to include evidence for each. For example: evidence of the wild-land fire events taking place at the source, back trajectories to support the assumption of the smoke travelling from the fire to Riga, and the coincident peaks in PM_{10} measured at Riga – Brivibas str. (LV0RBR6) and Rucava (LV00010). It is also recommended that a discussion of uncertainty in the presented results is included, particularly for the artefact already identified (sand and dust particles from desert regions).

A4.8 ASSESSMENT SUMMARY FOR LATVIA

Contributions from winter sanding, sea spray and wild-land fire episodes were identified by Latvia in 2020. During this year, there were 66 days in exceedance of the daily PM_{10} limit value reported in Riga (zone LV0001), which was no longer in exceedance after all contributions had been deducted (the final number of exceedances of the daily PM_{10} limit value were reduced to 32 days; Figure 6).

Figure 6 The number of days in exceedance of the daily PM_{10} limit value after subtraction of each quantified contribution identified at the Riga – Brivibas str. (LV0RBR6) station. Taken from Figure 5 of the Latvian report.[150]



The Latvian methodology assessed was from the "Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances", uploaded to Latvia's "dataflow G_2020" envelope on Dataflow G. The Latvian report adapted the example template presented in the Commission's natural

[149] SEC (2011) 208 final document, page 30.

[150] Latvia: Report on quantification of winter sanding, sea salt and wild-land fires episodes contribution to 2020 exceedances, Figure 5, page 6.

source guidelines,[151] and was split into three main sections, which separately describes the methodology for each type of correction applied in 2020. Section I of the report described the method used to identify and quantify winter sanding events and was assessed against the SEC (2011) 207 final document guidance. Sections II and III outlined the methods used to identify and quantify the contributions of sea salt and wild-land fire episodes, respectively. These were both assessed against the guidance in the Commission's natural source guidelines in the SEC (2011) 208 final document.

The Tables presented in each section of the Latvian report provide enough detail for the deduction calculations in each section to be independently verified in this assessment. Table 4 provided a good resource to validate the calculations of $PM_{2.5}/PM_{10}$ ratios, the winter sanding contribution and the correction of measured PM_{10}. Most values were within 0.1 µg m^{-3}, a difference attributed to rounding errors. Two days present larger deviations to verified concentrations: 0.4 µg m^{-3} (28th February) and 3.1 µg m^{-3} (11th November). Reasons for these are explored in Appendix Section A4.3.2, but as these differences are small and do not change the compliance outcome of the resulting PM_{10} concentrations, these are deemed acceptable in this instance. For the natural source corrections (Tables 2 and 3 of the Latvian report), there was not enough detail provided to verify the quantification of the contribution presented.

In terms of evidence, the Latvian report mostly satisfies the criteria and conditions specifically outlined for determining the contribution of winter sanding by quantifying the coarse PM fraction (Section 4.1 of the SEC (2011) 207 final document). However, more evidence could be introduced to support the evidence for conditions provided. For example, demonstrating that winter sanding activities had taken place by providing more specific information than just that the Riga authorities confirmed it (e.g., dates of events). Similarly, the meteorological annual report used to evidence that the road was dry should have been referenced. The methodology could be improved by including discussion of the uncertainties introduced by the methods used, and in the presented results (contribution and net PM_{10} concentrations). This includes other potential sources of PM_{10} at the Riga – Brivibas str. measurement station, potential artefacts from the differences in PM_{10} and $PM_{2.5}$ measurement locations should be clarified. Similarly, the measurement method of each PM size fraction should be stated (e.g., gravimetric or optical), and potential interferences discussed.

The method outlined to quantify the contribution of sea spray was limited. It relied heavily on the Commission's guidelines (that was not referenced in this section) and was not discussed in terms of its relevance in Latvia. This contribution was only deducted on one day in 2020 (27th August), and it is not clear how this day was identified from those exceeding the PM_{10} daily limit value. Particularly as Riga is a coastal city – the episodic nature of sea spray episodes should be addressed.

For the deduction of the contribution from wild-land fire episodes, more evidence has been provided but requires further discussion and justification. The selected regional background site requires discussion of its suitability, or at least mentioning that this site is part of the EMEP monitoring network and subject to formal siting criteria. The coincident peaks in PM_{10} at both sites are not addressed, while satellite images are provided with little discussion. There is no evidence to suggest that the mentioned wild-land fire events occurred on the dates stated.

For both natural source deductions, there was no critical assessment of the results presented. The Latvian report includes no discussion of potential contributions from other sources of PM_{10} measured on the days in exceedance, for example those with anthropogenic sources.

Overall, the Latvian report provides a good assessment of the quantification of winter sanding contributions, using a method based on the coarse fraction (PM_{10}–$PM_{2.5}$), but requires better documentation and more critical discussion of the presented results and possible artefacts. The methods used to quantify the natural source contributions are brief and are anticipated to be following the Commission's natural source guidelines. However, there is not enough evidence provided to validate the days identified, and there is no discussion of possible sources of uncertainty in the presented results.

[151] SEC (2011) 207 final document, Annex B, pages 37-42.

Appendix 5 – Lithuania: Winter sanding or salting correction

A5.1 GENERAL INTRODUCTION

The information supplied to Dataflow G for Lithuania did not contain a description of any corrections applied in the years between 2018 and 2020. The corrections presented in Table 20 were taken from the baseline and final data provided in Dataflow G, and as such have not declared a reason for correction 2018. The reason of "winter sanding and salting" in 2019 was taken from the methodology provided by Lithuania. This was sourced from the Lithuanian envelope on Dataflow G, for the most recent year (2019; Table 20). The method has been similarly used in 2018, but this year will not be discussed in this report. Corrections were identified to have been applied to exceedances in the number of days above the PM_{10} limit value in three zones in Lithuania: two in 2018 (Vilnius, LT0100; and Lietuva, LT0300) and one in 2019 (Kaunas, LT0200).

The Lithuanian 2019 report outlines that corrections were applied for the re-suspension of particulates following the winter sanding of roads.[152] The methodology provided uses the example template provided in Annex B of the SEC (2011) 207 final document[153] and generally follows the Commission's winter sanding or salting guidelines to identify, quantify and subtract the winter sanding contribution from measured PM_{10} concentrations. In 2019, only measurements at Kaunas–Petrasiunai traffic-oriented station (EOI station code: LT00041) in the Kaunas agglomeration (zone LT0200) were adjusted to account for the contribution of winter sanding and salting sources. The data reported to Dataflow G in zone Kaunas (Table 20) is for this site.

Lithuania's methodology for the identification and quantification of winter sanding contributions are assessed against the key principles detailed in Section 2 of the Commission's SEC (2011) 207 final document in Appendix Section A5.3, and against the relevant recommended method outlined in Section 4 of the same document in Table 21 (Appendix Section A5.4).

A5.2 SUMMARY OF CORRECTIONS REPORTED

Table 20 Summary table of results from the assessment of corrections applied in Lithuania in 2018[154], 2019[155,156] and 2020[157] for inclusion in the final summary report. Not all years had reported corrections, as such these are missing from the table. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
LT0100	Vilnius	2018	**37 days**	32 days	Days above limit value	Not stated in Dataflow G
LT0200	Kaunas	2019	**40 days**	35 days	Days above limit value	Winter-salting and sanding*
LT0300	Lietuva	2018	**61 days**	**56 days**	Days above limit value	Not stated in Dataflow G

It should be noted that in Dataflow G there is no description of the adjustment type applied. The data presented in this table is based only on the baseline and final data provided in Dataflow G. There is no baseline data for 2020 so it is not possible to determine whether any corrections have been applied.

** This reason has been taken from the justification report provided on Dataflow G for 2019.*

[152] Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 1.

[153] SEC (2011) 207 final document, Annex B, pages 37-42.

[154] LT Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/lt/eu/aqd/g/envxyrtmq/REP_D-LT_LT-EPA_20190923_G-004.xml/manage_document

[155] LT Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/lt/eu/aqd/g/envx2nj4g/REP_D-LT_LT-EPA_20200917_G-003.xml/manage_document

[156] Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 1.

[157] LT Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/lt/eu/aqd/g/envytqazq/REP_D-LT_LT-EPA_20210910_G-004__1_.xml/manage_document

A5.3 CRITICAL ASSESSMENT OF THE WINTER SANDING OR SALTING CORRECTION

A5.3.1 Contributions must be attributed unequivocally to winter sanding or salting activities

The criteria required to identify the contribution to PM_{10} by winter sanding and salting is summarised in Table 2 of this assessment (Section 1.2.11.1.11.2.2). Contributions from other PM_{10} sources which may have a similar influence on (elevated) PM_{10} concentrations must be excluded. Other than excluding the potential contribution of long-range transport to the measurement station (Kaunas–Petrasiunai, LT00041), the Lithuanian report does not acknowledge, nor discuss, the potential influence of other sources of PM_{10}.

A5.3.2 Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value

The winter sanding contribution was calculated following the guidelines outlined in Section 4.1.2 of the SEC (2011) 207 final document. If the criteria outlined are met, 50% of the coarse fraction (PM_{10} – $PM_{2.5}$) can be attributed to winter sanding.

Table 2 in the Lithuanian report shows each day in exceedance of the PM_{10} daily limit value, alongside checklists which confirm the presence of sanding activities (column 4), dry road surfaces (column 5), $PM_{2.5}/PM_{10}$ ratio ≤ 0.5 at Kaunas–Petrasiunai measurement station (column 7), and confirmation that the days were not affected by long-range transport (columns 8 and 9). This is ultimately summarised in column 10, with a note of whether the day is eligible for deduction, of which five are in 2019. For these days, the following equation is used to determine the winter sanding contribution at Kaunas–Petrasiunai measurement station:

$$\text{Contibution from winter sanding} = \frac{\mathrm{PM}_{10} - \mathrm{PM}_{2.5}}{2}$$

This follows the suggested guidelines from the SEC (2011) 207 final document. The winter sanding contribution and new PM_{10} concentration following its subtraction are presented in columns 11 and 12, respectively. This reports independent assessment of both values confirms that the presented calculations are correct, but likely include some possible rounding errors. The winter sanding contribution presented on the 15th and 18th April are 0.1 µg m^{-3} lower than when checked. The same is observed for the net PM_{10} concentration presented for the 15th of April 2019 (35.1 µg m^{-3} *c.f.* 35.2 µg m^{-3}). As this is a small margin and does not affect the compliance outcome of these concentrations, this is deemed to be acceptable.

All contributions presented use daily average concentrations of PM_{10} and $PM_{2.5}$, which is consistent with the averaging period of the daily PM_{10} limit value which had been exceeded at this site in 2019.

A5.3.3 Representativeness of the measuring stations at which contribution is determined

Section 2 of the SEC (2011) 207 final document outlines that the influence of PM_{10} emissions by winter sanding or salting is usually measured at traffic related monitoring sites, and the procedure to subtract the contribution of winter sanding or salting should be applied at each measuring station separately. As deductions are only calculated for and applied at the Kaunas–Petrasiunai (LT00041) traffic measurement station, this criteria for this key principle has been met.

A5.3.4 The contribution of winter sanding or salting to the measured PM10 concentration has to be quantified in µg m^{-3} for each exceedance day under consideration

In the Lithuanian report, for each of the five days eligible for the deduction of winter sanding from measured PM_{10} at Kaunas–Petrasiunai (LT00041) measurement station (column 10, Table 2), the contribution attributable to winter sanding quantified in µg m^{-3} and presented in column 11 (Table 2). As such, this criterion has been satisfied by Lithuania.

A5.3.5 The method to determine this contribution has to be documented

As described in the sections above, the methodology used by Lithuania follows the guidance set out in Section 4.1 of the SEC (2011) 207 final document ("Winter sanding - difference between $PM_{2.5}$ and PM_{10}"). The necessary evidence has been succinctly provided in the assessed report.

A5.4 CRITICAL ASSESSMENT OF THE WINTER SANDING METHOLOGY

A brief overview of the methodology that Lithuania has applied against the recommended methods in the SEC (2011) 207 final document for identifying and quantifying winter salting contributions have been summarised in Table 21 below, in the form of a checklist. The criteria have been taken from Section 4.1 of the Commission's winter sanding and salting guidelines: "Winter sanding – difference between $PM_{2.5}$ and PM_{10}". This includes the conditions (requirements) for using this method (Section 4.1.1) and the suggested procedure (Section 4.1.2). The evidence provided in the Lithuanian report to meet each of the key principles set out in Section 2 of the Commission's guidance have been compiled in the correspondingly named sub-sections of Appendix Section A5.3.

Table 21 Summary of methodology provided by Lithuania for quantifying and subtracting winter sanding and salting contributions, against the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document.

Content	2019 report	Assessment comments and recommendations
Demonstrates that winter sanding activities have taken place, and that road sand (or remnants) were present on the road or adjacent footpaths.	Yes	The "Confirmation of the first condition" section states that Kaunas municipal authority confirmed that winter sanding activities had taken place during this period. During the January to April and November to December periods of 2019, 769 tonnes of sand and salt mixture and 6849 tonnes of saline solution were scattered on the streets of Kaunas city, where station Kaunas–Petrasiunai (LT00041) is located.[158] From this information it is assumed that sanding and salting occurred on the road next to the monitoring station, however this is not stated. It is also noted that the resuspension effect was primarily observed in April, when the streets had dried out. In the Lithuanian report, column 4 of Table 2 shows confirmation of this for each day in exceedance of the PM_{10} daily limit value.[159]
Provides evidence that the road surface was dry. This information can be obtained from the municipal authorities responsible for winter sanding or from direct observation. If not available, road surface wetness or precipitation and snow cover meteorological information may be used.	Yes	The "Confirmation of the second condition" section states that only days with no precipitation, identified using evidence provided by the Lithuanian Hydrometeorological Service, were considered for subtraction.[160] This follows the Commission's guidelines, and is presented in the Lithuanian report in column 5 of Table 2 for each day in exceedance of the PM_{10} daily limit value.[161] There is no discussion of moisture condensation effects on days without precipitation.
Demonstrate that there is a high fraction of course particles (from winter sanding, as well as road abrasion, discounting the contribution of long-range transport) by	Yes – with some reservation	The "Confirmation of the third condition" section states that only days where the $PM_{2.5}/PM_{10}$ ratio was equal to or less than 0.5 were selected to confirm there was no long-range influence during candidate to subtract a winter sanding contribution.[162]

158 Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 2.
159 Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), Table 2, pages 3-4.
160 Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 2.
161 Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), Table 2, pages 3-4.
162 Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 2.

Content	2019 report	Assessment comments and recommendations
proving the $PM_{2.5}/PM_{10}$ ratio is less than or equal to 0.5. This requires parallel monitoring of PM_{10} and $PM_{2.5}$ (in both measurement method and location).		PM_{10} and $PM_{2.5}$ measurements from the same station (Kaunas–Petrasiunai) are stated to have been used to calculate the ratio.[163] However, there is no comment on whether the measurement method for both size fractions are the same or discussion of potential artefacts as a result of this. **We recommend that Lithuania comment on the measurement method of both PM size fractions, as well as addressing the possible uncertainty arising from use of these measurements.** It is also stated that NOAA HYSPLIT backward trajectories were analysed to confirm the absence of long-range transport.[164] However, these model results are not presented and cannot be validated. **We recommend that these be included as necessary evidence.** In the Lithuanian report columns 7, 8 and 9 of Table 2 present the $PM_{2.5}/PM_{10}$ ratio at the Kaunas–Petrasiunai measurement station, and a confirmation of long-range transport, respectively.[165] If the latter is (column 9) “n” (no), the absence of this influence has been confirmed. The ratios calculated have been independently validated to be correct.
Show comparatively low background concentrations (rural and urban), excluding exceptional transboundary events.	**No**	No concentration comparison reported by Lithuania. **We recommend that the daily PM background concentrations, unaffected by winter sanding or other events, be presented or highlighted in the Lithuanian report.**
Uncertainty analysis	**No**	The Lithuanian report only includes positive confirmation that the conditions for this method have been met. There is no discussion of potential sources of uncertainty in the calculated contribution of winter sanding, or the deducted PM_{10} concentrations. **We recommend that uncertainties in the identification of days affected by winter sanding, and the quantified contribution be discussed, and any artefacts or interferences acknowledged.**
References to the methodological reports/papers	**Yes – with some reservation**	The Lithuanian report (Section 4) references the suggested procedure in the Commission’s SEC (2011) 207 final document has been used. The NOAA HYSPLIT Trajectory Model used to calculate back trajectories and confirm the absence of long-range transport, has also been referenced. **We recommend that Lithuania reference the data used from the Lithuanian Hydrometeorological Service, to strengthen the evidence presented to confirm the road surface was dry.**

[163] Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 2.
[164] Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), page 2.
[165] Lithuania: Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21), Table 2, pages 3-4.

A5.5 ASSESSMENT SUMMARY FOR LITHUANIA

Winter sanding corrections were identified in Lithuania in 2019. During this year, there were 40 days in exceedance of the daily PM_{10} limit value reported in Kaunas (zone LT0200), which was no longer in exceedance (35 days) after the winter sanding correction had been applied. The methodology assessed against the Commission's winter sanding and salting guidelines for contributions from the re-suspension of particulates following winter sanding or salting of roads was from the "Report on Quantification of Winter Sanding Contribution to 2019 Exceedances (2008/50/EC Article 21)", uploaded to Lithuania's "Reference year 2019" envelope on Dataflow G.

The report uses the example template presented in the Commission's guidelines, and mostly satisfies the criteria and conditions specifically stated in Section 4.1, for the recommended winter sanding methodology. Table 2 of the Lithuanian report provided a good resource to independently validate the calculations of $PM_{2.5}/PM_{10}$ ratios, the winter sanding contribution and the correction of measured PM_{10}. All were within 0.1 µg m^{-3}, a difference attributed to rounding errors and deemed acceptable as it did not alter the exceedance status.

More information and discussion could have been provided in Lithuania's report, specifically to discuss the uncertainties in the data presented in the calculated winter sanding contributions and adjusted PM_{10} concentrations, including other potential sources of PM_{10} at the Kaunas–Petrasiunai traffic measurement station assessed. Potential artefacts from differences in the PM_{10} and $PM_{2.5}$ measurement methods should be acknowledged, even if just to state that the same technique was used to measure both size fractions (e.g., gravimetric vs optical).

Overall, the report provides a good assessment of the quantification of winter sanding contributions using a method based on the coarse fraction (PM_{10}–$PM_{2.5}$) but requires more critical discussion of the presented results and possible artefacts.

Appendix 6 – Malta: Sea spray and Saharan dust corrections

A6.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G, natural source corrections were identified to have been applied to adjust the baseline corrections in one zone in Malta (Maltese Agglomeration; MT0001) for the years 2018 and 2019. The methodology for the natural source corrections assessed was sourced from the Maltese envelope on Dataflow G, for the most recent year (2019; Table 22). This method is stated to be the same as described in the justification reports for previous reporting years.[166] This has been independently verified here against the methodology presented for 2018, as such the previous report will not be discussed in this assessment.

The Maltese 2020 report outlines that corrections were applied for transport of natural particles from dry regions outside the Member State, and sea spray. The Maltese report provides an overview of the methodology used to identify, quantify and subtract the contribution of natural sources to measured PM_{10} concentrations.[167] In 2019, only measurements at Msida traffic station were adjusted to account for the contribution of natural sources, and reported to Dataflow G (Table 22).

Since Malta's methodologies for identification and quantification of sea spray and Saharan dust contributions are presented in the same report, they are collectively assessed against the key principles detailed in Section 2 of the Commission's natural sources guidelines (SEC (2011) 208 final document) in Appendix Section A6.3. The methodologies used by Malta are separately assessed against the relevant methods outlined in Section 4 of the same document in Table 23 and Table 24 below (Appendix Sections A6.4 and A6.5, respectively).

A6.2 SUMMARY OF CORRECTIONS REPORTED

Table 22 Summary table of results from the assessment of corrections applied in Malta in 2018[168], 2019[169] and 2020[170] for inclusion in the final summary report. Not all years had reported corrections, as such these are missing from the table. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
MT0001	Maltese Agglomeration	2018	**43.1 µg m^{-3}**	34.8 µg m^{-3}	Annual mean value	Natural source
			86 days	**41 days**	Days above limit value	
		2019	**41.3 µg m^{-3}**	33.8 µg m^{-3}	Annual mean value	
			61 days	34 days	Days above limit value	

[166] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 2.
[167] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 1-62.
[168] MT Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/mt/eu/aqd/g/envxc0ghw/DataFlow_G_Attainment_2018_retro_V1.xml/manage_document
[169] MT Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/mt/eu/aqd/g/envx38ahq/DataFlow_G_Attainment_2019_retro_V1.xml/manage_document
[170] MT Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/mt/eu/aqd/g/envyvfpkw/MT_DataFlow_G_Attainment_2020_retro_V1.xml/manage_document

A6.3 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A6.3.1 The natural contribution must not be caused by direct or indirect human activities

A6.3.1.1 Discussion for sea spray

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). In the Maltese report, the concentration of sea salt is determined from a linear parameterisation with measured wind speed (equation [3] in the Maltese report). This is explained to have been derived from measurements of PM_{10} taken at Msida traffic station and wind speed measurements from Għarb background station between March 2012 and May 2013. During this period, filters were analysed for ions and the concentration of sea salt is said to be concentration using the following equation from the Commission's guidelines:

$$[\text{sea salt}] = ([\text{Na}^+] + [\text{Cl}^-]) \times 1.168$$

The relationship between wind speed and calculated sea salt concentrations were presented in Figure 3 of the Maltase report, and a linear parameterisation was derived for Msida:

$$[\text{sea salt}] = 1.06 \times \text{wind speed} - 1.0$$

In 2019, wind speeds measured at Għarb were used to determine the sea salt contribution at Msida traffic station, before this value was deducted from the measured PM_{10} at Msida. However, no wind speed data is provided in the report so the calculated sea salt contributions cannot be confirmed. The substitution of wind speed measurements was decided in the initial study, due to local site conditions. Where Msida is at sea level in the base of a large valley, Għarb is elevated (114 m) and is exposed to unrestricted air flow from all directions. The report also states that it is their reasonable assumption that, once PM_{10} is formed from sea spray, it will disperse "rather uniformly" over the Maltese territory due to the large-scale wind conditions which initially led to its formation. They also acknowledge that key factors are distance from the shore, and wind speed.[171] A threshold of 2 m s^{-1} was used on the measured wind speed, presumably because large scale movement of sea spray was unlikely at slower speeds than this.

Where no ion concentrations were available for 2019, this is a simple solution and provides some insight into the contribution of sea spray. However, there is no further evidence provided to support the assumptions made. There is also no critical evaluation of the use of a parameterisation derived 7-years prior, such as a comparison of general meteorological conditions across Malta, or a small subset of 2019 ion measurements to recreate Figure 3. Since the 2σ confidence intervals presented are moderate (approximately ±7 μg m^{-3} for Msida), further discussion of uncertainty is required.

A6.3.1.2 Discussion for Saharan dust

In terms of the dust contribution, the Maltese report cites the method described in Gómez-Losada *et al.* (2016)[194] to identify Saharan dust episodes. This is a highly mathematical approach using Hidden Markov Models (HMMs), interpreting the measured daily average PM_{10} concentrations time series as several Gaussian distributions which describe specific sources (or groups of), based on hidden (unobserved) states. Table 1 and Figure 2 present the results of this analysis, dividing the time series into four different regimes. Any day grouped within regimes 3 or 4 were identified to be influenced by Saharan dust due to the elevated concentrations observed.[172] These episodes were then further justified using MODIS satellite images, HYSPLIT backward trajectory plots and dust forecast model predictions (NMMB/BSC-Dust) and summarised in the table following the conclusions.[173] Independent evaluation of these comments demonstrate reasonable confidence in the justification made for each date.

Overall, the Maltese report provides good evidence for Saharan dust episodes, but weaker evidence for identification of sea salt contributions. Neither provide any discussion on the identification or quantification of any potential artefacts in the calculated sea salt or Saharan dust contributions. It is acknowledged that the intrusion of dust from the African continent will add to the local anthropogenic contribution,[174] but there is no

[171] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 7.

[172] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 4.

[173] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 10-13.

[174] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.

quantification, nor discussion of whether any intervention action could significantly reduce the identified contribution.

A6.3.2 The quantification of the natural contribution must be sufficiently precise

The quantified contributions of Saharan dust and sea spray are presented in Tables 2 and 3, respectively, for each day considered.[175] These are assumed to be best estimates, as not all concentrations required to verify the calculated contributions are present. There is no discussion, nor quantification, of any potential anthropogenic contributions to these values or to total PM_{10} measured. Similarly, for both dust and sea spray there is little to no discussion of uncertainty in the quantified values. Quantification of the contribution of sea spray (described in Appendix Section A6.3.1) is straightforward and logical but is missing justification (or validation) for its use with 2019 measurements.

A6.3.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

As shown in Table 22 (Appendix Section A6.2), the Maltese Agglomeration (zone MT0001; presenting data from Msida traffic station) exceeded the daily PM_{10} limit value (50 µg m^{-3}) on 61 days in 2019, as well as exceeding the annual mean limit value (40 µg m^{-3}) by 1.3 µg m^{-3}.

Daily average concentrations presented for Msida traffic station, and Għarb background station, are presented in Table 2 of the Maltese report alongside the contribution of Saharan Dust. Table 3 in the Maltese report presents the concentrations at the Msida traffic station alongside the contribution of sea salt. It is assumed that these concentrations, since presented in the same manner as the dates and use daily average wind speed (sea salt) and the average PM_{10} concentrations of the 15 days pre- and post-episode (dust), are also presented on the same temporal scale (daily).

The correction to the 2019 annual mean concentration is briefly mentioned after the daily corrections. Reducing from 41.3 µg m^{-3} to 38.2 µg m^{-3} after the deduction of the African dust contribution,[176] before further reducing to 33.8 µg m^{-3} following the subtraction of the average sea salt concentration (4.4 µg m^{-3}).[177]

It is not stated how the annual average concentrations are calculated after every deduction. For African dust, it is implied that the reduced daily concentrations at Msida traffic station were used to determine a new annual average, as the Commission's guidelines imply. The deduction of the "annual average sea salt concentration" at Msida occurs separately (without re-averaging daily concentrations). It is also not clear what data was involved to arrive at the 4.4 µg m^{-3} average, as it is not the mean of the sea salt contributions presented in Table 3.

A6.3.4 The quantification of the natural sources must be spatially described

In 2019, the only corrections reported to Dataflow G are the number of days in exceedance of the PM_{10} daily limit value and annual mean value at Msida traffic station (Maltese Agglomeration; zone MT0001). However, it should be noted that the report states that corrections are quantified and applied with the assumption of spatial consistency. Due to the small area comprised by the Maltese Islands, large scale plumes such as African dust are assumed to have a homogenous impact on all sites, including Msida and Għarb (on the mainland and Gozo, respectively).

Section 3.0 of the Maltese report builds on this assumption, using wind speed measurements at Għarb to both parameterise and quantify sea salt concentrations at Msida based on the difference in topography around each site (unobstructed air flow from all directions at Għarb).[178] Although this is a reasonable decision, there isn't sufficient evidence presented by Malta to justify this data substitution, particularly when this data is deducted from PM_{10} measurements made solely at Msida traffic station. A comparison could be made with the two datasets to provide evidence to their assumption, as it likely there will be considerable uncertainty introduced in the quantification of sea salt concentrations.

[175] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 6 and 9.
[176] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.
[177] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 9.
[178] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 7.

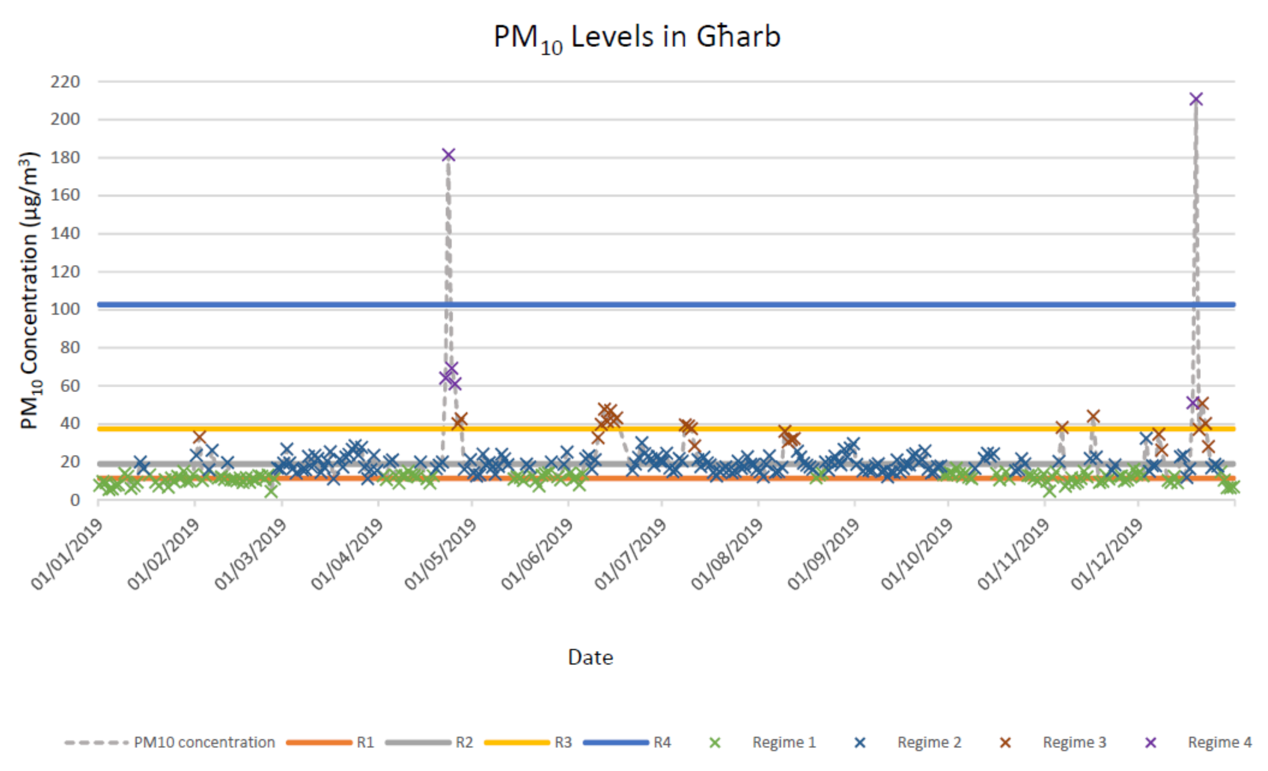
Overall, the assumption of spatial consistency of large-scale effects, such as African dust, is reasonable. This assumption would benefit from being supported by more evidence than the total area of the Maltese Islands, such as analysis of modelled results.

A6.3.5 The contributions must be demonstrated in a process of systematic assessment

A6.3.5.1 Discussion for Saharan dust

According to Section 2.5 of the SEC (2011) final document, the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature. In the Maltese report, the method used for the identification of dust episodes satisfies this criterion. The technique uses a mathematical approach called Hidden Markov Models (HMMs), which group each daily average PM_{10} measurement (in Għarb) into a different regime which can be attributed to a difference in sources. Days grouped into regimes 3 and 4 (shown in Figure 7) were then investigated further to identify Saharan dust intrusion (including $PM_{2.5}/PM_{10}$ ratio, backward trajectories, satellite images and dust forecast models). This approach provides a good basis from which to identify potential dates of dust episodes, and the justification for each day follows the guidelines provided by the Commission.

Figure 7 PM_{10} time series at Għarb background station in 2019, annotated with the four PM_{10} concentration regimes. Cross-shaped points indicate which regime each daily average has been grouped into, while solid horizontal lines indicate the average concentration for this regime. Taken from Figure 2 of the Maltese report.[179]



A6.3.5.2 Discussion for sea spray

The identification of sea salt concentrations is not as robust. Equation [1] presented in the Maltese report is a recommended method for quantifying the concentration of sea salt from filter measurements of sodium (Na^+) and chloride (Cl^-), which took place in 2012 and 2013. These calculated concentrations are then parameterised against measured wind speed (choice of measurements discussed in previous Sections), with a fairly large spread of data (R^2 = 0.45; ±7 µg m^{-3} at Msida). This linear relationship (equation [3]) is then used to quantify sea salt concentrations observed in 2019, except where measured wind speeds are slower than 2 m s^{-1}. Elevated wind speeds will increase the contribution of sea spray in local PM_{10} measurements; however, this is not the only indicator. Wind direction, for example, plays an important role. As such, the presented

[179] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, Figure 2, page 4.

methodology does not use a robust enough indicator to identify sea spray measurements. This could be improved by validating the relationship using a smaller subset of measurements from 2019, providing modelled evidence, and/or including further discussion which addresses the caveats.

A6.3.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A6.4 CRITICAL ASSESSMENT OF SEA SPRAY METHOLOGY

A brief overview of the methodology that Malta has applied against the recommended methods in the Commission's natural source guideline (SEC (2011) 208 final document) for identifying and quantifying sea spray contributions (Section 4.2) have been summarised in Table 23 below, in the form of a checklist. The evidence provided in the Maltese report to meet each of the key principles set out in Section 2 of the Commission's guidelines has been compiled in the correspondingly named sub-sections of Appendix Section A6.3.

Table 23 Summary of methodology provided by Malta for quantifying and subtracting a sea spray correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2019 report	Assessment comments and recommendations
Analysis of the chemical composition of daily aerosol samples, or at least one of the major components of sea salt.	**Partially – equation not determined in reported year**	Section 3.0 of the Maltese report states that there was no ion data available for 2019, so sea salt concentrations could not be directly determined.[180] Instead, sea salt concentrations for Msida were calculated using a linear parameterisation of wind speed. This equation (equation [3] in the Maltese report) was derived from measurements of wind speed and sea salt (as Na^+ and Cl^-; see Appendix Section A6.3.1 below) between March 2012 and May 2013, shown in Figure 3. Daily average wind speeds were taken from Għarb, a background site on the Maltese Island of Gozo (33 km away).[181] This wind data was considered more representative of the Maltese Islands, as the site is unrestricted in all directions while the Msida traffic station is at sea level in the base of a valley, which could lead to channelling effects, and the overall area of the Maltese territory is small (316 km^2), and fairly homogeneously affected by transboundary pollution or natural contributions.[182] This should have been justified using measurements or model results. Sea salt concentrations were only calculated for measured wind speeds above a 2 m s^{-1} threshold.[183] **We recommend that the parameterisation used be updated for use in 2019, for example by comparing the parameterisation derived in 2013 to a subset of ion analysis measurements (e.g., two weeks) in 2019, to ensure there has been no systematic shift in this time. Similarly, we recommend that the use of Għarb wind speed measurements from at Msida traffic station be further justified, by comparing the available data in 2019 and discussing the**

[180] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 8.
[181] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 2.
[182] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 2.
[183] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 7-8.

Content	2019 report	Assessment comments and recommendations
		possible uncertainties which may arise from this substitution.
The episodic nature of sea salt contributions should be accounted for. The time coverage for chemical composition measurements should therefore be as large as possible. Uncertainties should be considered when time coverage is not 100%.	Partially – not enough information provided	From the presented results in Table 3 of the Maltese report, it is presumed that the sea spray concentrations were calculated when the following criteria were satisfied: a) wind speed measurements were available at Għarb, b) the daily average wind speed exceeded 2 m s^{-1}, and c) the days average PM_{10} concentration was in exceedance of the daily 50 µg m^{-3} limit value.[184] This is not overtly stated. As such, more information is required. **We recommend that the Maltese report be expanded to include more clear statements on the steps taken and acknowledging possible uncertainties in the approach taken.**
Demonstration that a daily exceedance is attributable to sea spray, through quantification. If considering Na^+ as being entirely of primary marine origin, air mass backward trajectories must be used to validate this assumption.	No	The only indication that the deduction is attributable to sea spray is the linear relationship derived from the 2012–2013 ion measurements of Na^+ and Cl^- in Figure 3.[185] The 2σ confidence intervals shown demonstrate that this is not a particularly strong relationship, equating to concentrations of approximately ±7 µg m^{-3} at Msida (and ±5 µg m^{-3} at Għarb). The correlation at both sites was expressed as $R^2 = 0.45$. The parameterisation should have been updated for 2019 or validated using a smaller sample of measurements made in 2019. **We recommend that if Malta continue to use the same parameterisation in future, a minimum step of directly comparing a subset of measurements that year (e.g., Na^+) to it be undertaken and discussed, to provide confidence in the method. Otherwise, the results presented are hypothetical.**
The calculated mass of sea salt subtracted from the daily average PM_{10} at the sampling point.	Yes	Table 3 of the Maltese report shows that the concentration of sea salt calculated, were subtracted from PM_{10} daily limit exceedances at Msida measurement station before rounding to the nearest integer.[186] This Table (Table 3) only shows the correction of exceedances which become compliant after the subtraction of the sea spray contribution. These calculations have been verified. The same calculation is assumed to have been conducted for days that remained in exceedance following this natural source deduction.
Subtraction is only applicable for the area where the spatial representativeness of the measurement has been determined. Wider application	Partially – not enough information provided	Subtraction has only taken place at Msida traffic station. However, the parameterisation used wind speed measurements from Għarb rather than Msida, based on the site characteristics, with the aim of being more representative of the Maltese Islands, rather

[184] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 8-9.
[185] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 8.
[186] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 9.

Content	2019 report	Assessment comments and recommendations
must be supported by modelling results, validated through an adequate number of PM composition measurements.		than just Msida. For this to be more reliable this substitution should be justified with data, demonstrating why the final PM_{10} concentrations calculated using this parameterisation are more representative of the Maltese Islands, and are not limited by the same siting criteria as the wind speed measurements. It should also have been updated or validated for the current year (2019). **We recommend that the substitution of wind speed measurements be justified further by Malta, including a comparison of data from the relevant year (e.g., 2019 here), and discussion of relevant uncertainties which may arise as a result.**
Consideration given to possible artefacts introduced by winter salting. Such sources should be identified, quantified and reported separately to avoid double counting.	**No**	The possible artefacts from winter salting in the quantified contribution of sea spray are not clearly discussed in this report. If no winter salting has occurred at Msida, this should be stated. **We recommend that the possible contribution of artefacts be discussed, and the likely sources suggested in the Commission's guidelines but missing in the Maltese report (e.g., winter salting) be clearly stated.**
Uncertainty analysis	**No**	The linear parameterisations presented for Msida and Għarb in Figure 3 are shown with 2σ confidence intervals. This demonstrates considerable spread in the measurements, as discussed above. The representativeness, and possible channelling effects, of using wind speed measurements from Għarb rather than Msida to derive the parameterisation of, and calculate, sea spray concentration is discussed. However, this discussion is not extended to PM_{10} concentrations, and whether those are representative of Malta as a whole. Beyond this, there is no discussion of the uncertainty in the calculated contribution of sea salt to PM_{10}. **We recommend that a discussion of uncertainty arising from the method used, as well as its suitability for 2019, be included in this report.**
References to the methodological reports/papers	**Partially – only references the Commission's natural source guidelines**	The Maltese document only refers to the Commission's natural source guidelines (SEC (2011) 208 final document) as the source of equation [1] used to derive the parameterisation of sea salt concentration from wind speed in 2012/2013. **We recommend that Malta reference relevant reports to support the method used, particularly for the parameterisation derived (e.g., if similar parameterisations have been successful in previous studies, especially if peer reviewed).**

A6.5 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

A brief overview of the methodology that Malta has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying

Saharan dust contributions (Section 4.1.6) have been summarised in Table 24 below, in the form of a checklist. The evidence provided in the Maltese report to meet each of the key principles set out in Section 2 of the Commission's guidance has been compiled in the correspondingly named sub-sections of Appendix Section A6.3.

Table 24 Summary of methodology provided by Malta for quantifying and subtracting a Saharan dust correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2019 report	Assessment comments and recommendations
List of the regional background measuring stations used for the determination of the net dust load and information concerning representativeness of the stations	Partially – not enough information provided	Only Malta's rural background site in Għarb used to adjust PM_{10} concentrations measured at the Msida traffic station. It is unclear if this is the only background monitoring station in Malta as there is no discussion regarding why this station was chosen. The Maltese report does state that the background station is 33 km away from Msida traffic station (MT00005). Malta also provide a graph illustrating homogeneity of the two PM_{10} data sets at the stations (Figure 1). The only discussion of representativeness occurs in Section 3.0, where it is acknowledged that wind speeds measured at Għarb may be more representative of the Maltese Islands as a whole than those measured at Msida, as this site sits at sea level within a large valley.[187] There is no mention of whether the Għarb background station is part of a larger air quality network, with a site classification (e.g., "rural background) based on siting criteria, which could be used as evidence of its representativeness (e.g., other Member States use of EMEP sites). **We recommend that Malta include further discussion of the representativeness of both measurement stations, and justification for the substitution of wind speed measurements in 2019.**
The tables of daily levels of PM_{10} registered at stations representing regional background	No	Figure 1 shows a plot of daily average PM_{10} concentrations at Għarb and Msida measurement stations during 2019.[188] Due to the large time scale presented on a small plot, it is difficult to identify concentrations of PM_{10} on any given day. **We recommend that Malta clearly present these concentrations either in the 2019 report, or in an associated appendix.**
The list of dates with the identification of African dust episodes	Yes	Dates identified to be influenced by Saharan dust are presented in Table 2, where the subtraction is recorded.[189] These are also presented in a larger Table following the report conclusions which include a justification or comment on the dust episode based on the evidence provided.[190]
The values of the daily net African dust load	Yes	The contribution of African dust calculated from the average concentration of PM_{10} at Għarb (MT00007)

[187] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 7.
[188] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 3.
[189] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.
[190] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, pages 10-13.

Content	2019 report	Assessment comments and recommendations
determined by means of the procedure presented in the working document		approximately 15 days pre- and post-episode is presented in Table 2 of the Maltese report. The average is stated to be chosen over the 40th percentile due to the absence of specific supporting studies.[191] This approach is outlined in Section 4.1.2 of the Commission's guidelines.
The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas	Yes	Subtraction of daily average PM_{10} concentration has only been declared at Malta's Msida traffic station in 2019. Table 2 shows the measured PM_{10} concentrations at this site, the quantified contribution of African dust, as well as the resulting concentration after the deduction of the African dust load and rounding to the nearest integer.[192]
The annual concentration levels before and after subtraction of the net dust load for all assessment points and areas. The difference will yield the mean annual dust contribution from African dust.	Yes	Subtraction of the annual average PM_{10} concentration has only been declared at Malta's Msida traffic station in 2019. This is stated to reduce from 41.3 µg m^{-3} to 38.2 µg m^{-3} after the deduction has been applied.[193] The mean annual dust contribution is therefore 3.1 µg m^{-3}.
Uncertainty analysis	No	Within the Maltese report, there is no discussion of uncertainty surrounding the quantification of the dust contribution to PM_{10} concentrations measured. Nor does it offer any statistical analysis of how accurate the new concentrations calculated might be. The only discussion of uncertainty is presented in the cited study from Gómez-Losada *et al.* (2016),[194] where this method was taken from. However, this method has not been critically evaluated with the Maltese data available. **We recommend that the Maltese report include discussion of the potential uncertainty in the presented results, including the HMM method used and the potential artefacts or sources of uncertainty in 2019.**
Critical analysis of the applied methodological elements relevant in the reporting year, if appropriate.	No	There is no discussion of a critical analysis of the applied methods in the Maltese report. **We recommend that Malta address this within their reported methodology.**
References to the methodological reports/papers	Yes	The Hidden Markov Models (HMMs) method used to identify Saharan dust episodes in the Maltese report cite Gómez-Losada *et al.* (2016), who describe this approach.[194]

[191] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.
[192] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.
[193] Malta: Justification report on the contribution of natural events to the PM_{10} limit values for 2019, page 6.
[194] Gómez-Losada, Á., Pires, J.C.M, Pino-Mejías, R., 2016. *Atmospheric Environment*, 117, 271-281. http://dx.doi.org/10.1016/j.atmosenv.2015.07.027

Content	2019 report	Assessment comments and recommendations
		The Maltese report also cites the MODIS satellite images, NOAA HYSPLIT model and the WMO and SDS-WAS forecasts model used in the identification of Saharan dust episodes, as well as a general reference to the Commission's natural source guidelines (SEC (2011) 208 final document).

A6.6 ASSESSMENT SUMMARY FOR MALTA

Natural source corrections were identified in Malta in 2018 and 2019. In both years there were exceedances of both the daily PM_{10} limit values, and annual mean limit values, reported in the Maltese Agglomeration (zone MT0001). In 2019, these values were no longer in exceedance after the natural source corrections were applied. The methodology assessed against the Commission's guidelines for this correction was from the "Justification report on the contribution of natural events to the PM_{10} limit values for 2019", the most recent iteration uploaded to Dataflow G.

Both the dust and sea spray corrections utilise methodologies which have been used in previous years. The method used to quantify the contribution of dust to PM_{10} in Malta follows the guidance outlined in the Commission's natural source guidelines in the SEC (2011) 208 final document, and present evidence for the year assessed (2019). The HMM approach used to identify potential Saharan dust episodes is suitably specific, and further validated using a combination of measurements, satellite observations, backward trajectories and dust forecast models. The quantification used to determine the contribution from dust for each episode day follows the Commission's guidelines, and the deductions applied are clearly presented with the appropriate temporal resolution in Table 2. This independent evaluation was able to validate the concentrations presented, but more information is required to confirm that the adjusted annual mean concentration following the deduction of Saharan dust was calculated following the guidelines.

The method used to determine the contribution of sea spray is lacking. Requirements for the identification of sea spray have not been met in the year the deduction is applied (2019), as the method relies on a parameterisation of wind speed derived from ion filter measurements in 2012 and 2013. The method used to create this parameterisation follows the Commission's guidelines, but the 2019 report fails to justify why only wind speed has been considered. Other factors (such as wind direction) will affect the contribution of sea salt but are not acknowledged. However, the deduction applied here is clear (Table 3 of the Maltese report) and could be independently validated.

There is some discussion of the representativeness of the sites used in this assessment, and the methods rely on the assumption that large scale effects are spatially consistent across the Maltese Islands, due to their small size. As such, wind speed measurements at the Għarb background site in Gozo are used to quantify the sea spray contribution at Msida traffic station on the mainland. This is a reasonable judgement but requires further evidence and justification to support it. If this has been provided in previous assessments, it should be referenced here.

Overall, this report provides a moderate level of detail in the methods used, and mostly follow the Commission's natural source guidelines well. The evidence provided is sufficient for corrections for transport of dust, but not for the contribution of sea spray. Dust episodes are clearly identified, and evidence is supplied. The contribution from sea spray requires further evidence and justification, particularly for the parameterisation utilised and the year of data (2019). Neither of the contribution's quantification cannot be repeated from the data presented, but the application of each is fine (dust, Table 2; sea spray, Table 3 of the Maltese report).

Appendix 7 – Poland: Winter sanding or salting, Saharan dust, and wild-land fire corrections

A7.1 GENERAL INTRODUCTION

From the information supplied in Dataflow G (DfG), both natural source and winter sanding and salting corrections were identified to have been applied to adjust the baseline concentrations in a total of 16 zones in Poland between 2018 and 2020 (Table 26 in Appendix Section A7.2). This includes corrections to the number of days exceeding the daily limit value for PM_{10} (nine zones in both 2020 and 2019, seven in 2018) as well as the annual mean (six zones in 2020, and seven in both 2019 and 2018). Of these, there were a total of 27 exceedances in both PM_{10} annual mean and days above the limit value in the baseline measurements, however this number did not reduce following the application of the corrections.

The methodology for all corrections assessed have been sourced from the Polish Chief Inspectorate for Environmental Protection website, for the most recent year that corrections were applied (2020). Each report presents an annual air quality assessment for a specific administrative unit or voivodeship, and Annex 2 of each was found to contain the methodology and evidence provided by Poland for each zone ID within the geographical area of that voivodeship. A summary of the voivodeship report containing the methodology for each Polish zone in exceedance in 2020 has been summarised in Table 25.

Table 25 Summary of the nine zones in exceedance of PM_{10} limit values in 2020, and the corresponding Polish voivodeship annual air quality assessment containing the methodology and evidence for corrections assessed.

Zone ID	Zone Name	Report Name	Correction type assessed
PL0404	Strefa Kujawsko – Pomorska	Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2	Winter sanding or salting Natural sources
PL1001	Aglomeracja Łódzka	Annual Air Quality Assessment in Ÿódzkie Voivodeship for 2020, Annex 2	Natural sources
PL1002	Strefa Łódzka		
PL1401	Aglomeracja Warszawska	Annual Air Quality Assessment in the Mazowieckie Voivodeship for 2020, Annex 2	Natural sources
PL1404	Strefa Mazowiecka		
PL1602	Strefa Opolska	Annual Air Quality Assessment in the Opolskie Voivodeship for 2020, Annex 2	Natural sources
PL1802	Strefa Podkarpacka	Annual Air Quality Assessment in the Podkarpackie Voivodeship for 2020, Annex 2	Natural sources
PL2401	Aglomeracja Górnośląska	Annual Air Quality Assessment in the Silesian Voivodeship for 2020 Annex 2	Natural sources
PL2405	Strefa Śląska		

Annex 2 of each of the Polish voivodeship reports is separated into discrete methodology sections which provide a summary of each contribution separately. For each, there is a consistent methodology used across all voivodeship reports for identifying, quantifying and applying corrections. For Saharan dust, episodes were identified across all voivodeship reports, while wild-land fire episodes were only determined in three reports across five zones (Strefa Kujawsko – Pomorska, zone PL0404; Aglomeracja Łódzka, zone PL1001; Strefa Łódzka, zone PL1002; Aglomeracja Warszawska, zone PL1401; and Strefa Mazowiecka, zone PL1404). Winter sanding or salting corrections were determined for two zones: Strefa Kujawsko – Pomorska (zone PL0404) and Aglomeracja Warszawska (Agglomeration Warsaw; zone PL1401). However, the number of days in exceedance of the daily PM_{10} limit was only affected in zone PL0404 (no change in zone PL1401).

As all corrections applied by Poland have been discussed in relation to zone PL0404, Annex 2 of the "Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020" has been assessed as a representative example of the methodology used by Poland. The other five voivodeship reports are referenced where any notable differences occur. A summary of equivalent evidence provided by Poland in each voivodeships report for Saharan dust corrections has also been presented in Table 28 below (Appendix Section A7.8).

Poland's methodology for the identification and quantification of winter salting or sanding contributions are assessed against the key principles detailed in Section 2 of the Commission's SEC (2011) 207 final document in Appendix Section A7.3, and against the relevant recommended method outlined in Section 4 of the same document in Table 27. For natural corrections, the methodology used by Poland for the identification and quantification of Saharan dust and wild-land fire episodes are collectively assessed against the key principles detailed in Section 2 of the SEC (2011) 208 final document in Appendix Section A7.5. The methodologies used by Poland are separately assessed with respect to the relevant guidance outlined in Section 4 of the same document, in Appendix Section A7.6 (Saharan dust) and Appendix Section A7.7 (wild-land fire).

A7.2 SUMMARY OF CORRECTIONS REPORTED

Table 26 Summary table of results from the assessment of corrections applied in Poland in 2018[195], 2019[196] and 2020[197] for inclusion in the final summary report. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
PL0401	Aglomeracja Bydgoska	2018	40.0 µg m^{-3}	40.0 µg m^{-3}	Annual mean value	Winter-salting and sanding Natural source
			85 days	**82 days**	Days above limit value	
		2019	33.0 µg m^{-3}	33.0 µg m^{-3}	Annual mean value	
			48 days	**46 days**	Days above limit value	
PL0402	Miasto Toruń	2018	31.0 µg m^{-3}	31.0 µg m^{-3}	Annual mean value	Natural source
			52 days	**51 days**	Days above limit value	
PL0403	Miasto Włocławek	2018	34.0 µg m^{-3}	34.0 µg m^{-3}	Annual mean value	Natural source
			72 days	**71 days**	Days above limit value	
PL0404	Strefa Kujawsko - Pomorska	2018	36.0 µg m^{-3}	36.0 µg m^{-3}	Annual mean value	Natural source
			84 days	**83 days**	Days above limit value	
		2019	30.0 µg m^{-3}	30.0 µg m^{-3}	Annual mean value	
			48 days	**46 days**	Days above limit value	

[195] PL Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/pl/eu/aqd/g/envxdf5kg/PL_REP_G_2018_RETRO_v1.xml/manage_document

[196] PL Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/pl/eu/aqd/g/envx2y3iq/PL_REP_G_2019_RETRO_v1.xml/manage_document

[197] PL Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/pl/eu/aqd/g/envyyfirq/PL_REP_G_2020_RETRO_v1.xml/manage_document

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
		2020	35.0 µg m^{-3}	34.0 µg m^{-3}	Annual mean value	Winter-salting and sanding
			57 days	**54 days**	Days above limit value	Natural source
PL0803	Strefa Lubuska	2018	34.0 µg m^{-3}	34.0 µg m^{-3}	Annual mean value	Natural source
			60 days	**60 days**	Days above limit value	
PL1001	Aglomeracja Łódzka	2018	**41.0 µg m^{-3}**	**41.0 µg m^{-3}**	Annual mean value	Natural source
			92 days	**92 days**	Days above limit value	
		2019	35.0 µg m^{-3}	35.0 µg m^{-3}	Annual mean value	
			60 days	**60 days**	Days above limit value	
		2020	32.6 µg m^{-3}	32.6 µg m^{-3}	Annual mean value	
			40 days	**40 days**	Days above limit value	
PL1002	Strefa Łódzka	2018	**41.0 µg m^{-3}**	**41.0 µg m^{-3}**	Annual mean value	Natural source
			91 days	**91 days**	Days above limit value	
		2019	35.0 µg m^{-3}	35.0 µg m^{-3}	Annual mean value	
			64 days	**64 days**	Days above limit value	
		2020	31.8 µg m^{-3}	31.8 µg m^{-3}	Annual mean value	
			41 days	**41 days**	Days above limit value	
PL1401	Aglomeracja Warszawska	2019	37.0 µg m^{-3}	37.0 µg m^{-3}	Annual mean value	Winter-salting and sanding
			64 days	**58 days**	Days above limit value	Natural source
		2020	35.4 µg m^{-3}	35.3 µg m^{-3}	Annual mean value	Natural source
			50 days	**49 days**	Days above limit value	
PL1404	Strefa Mazowiecka	2020	28.3 µg m^{-3}	28.3 µg m^{-3}	Annual mean value	Natural source
			37 days	**36 days**	Days above limit value	
PL1601	Miasto Opole	2019	**47 days**	**47 days**	Days above limit value	Natural source

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
PL1602	Strefa Opolska	2019	**59 days**	**59 days**	Days above limit value	Natural source
		2020	**41 days**	**40 days**	Days above limit value	
PL1802	Strefa Podkarpacka	2020	27.3 µg m^{-3}	27.2 µg m^{-3}	Annual mean value	Natural source
			36 days	**36 days**	Days above limit value	
PL2401	Aglomeracja Górnośląska	2020	**56 days**	**56 days**	Days above limit value	Natural source
PL2405	Strefa Śląska	2020	**75 days**	**75 days**	Days above limit value	Natural source
PL2601	Miasto Kielce	2019	32.0 µg m^{-3}	32.0 µg m^{-3}	Annual mean value	Natural source
			49 days	**48 days**	Days above limit value	
PL2602	Strefa Świętokrzyska	2019	33.0 µg m^{-3}	33.0 µg m^{-3}	Annual mean value	Natural source
			50 days	**49 days**	Days above limit value	

A7.3 CRITICAL ASSESSMENT OF THE WINTER SANDING OR SALTING CORRECTION

A7.3.1 Contributions must be attributed unequivocally to winter sanding or salting activities

The criteria required to identify the contribution to PM_{10} by winter sanding and salting is summarised in Table 2 of this assessment (Section 1.2.1). Contributions from other PM_{10} sources which may have a similar influence on (elevated) PM_{10} concentrations must be excluded.

The winter sanding or salting contribution was quantified adopting the methodology that assumed that the share accounts for 50% if the coarse dust fraction (PM_{10}–$PM_{2.5}$), following the recommended methodology in Section 4.1 of the SEC (2011) 207 final document. The criteria that must be met for this method include providing evidence that winter sanding activities had taken place and sand remained on the road, that the road surface was dry and that the $PM_{2.5}/PM_{10}$ ratio ≤ 0.5 (to exclude the contribution of long-range transport). This information is summarised for days in exceedance of the daily PM_{10} limit value (50 µg m^{-3}) in Table 5.1 of the Kujawsko-Pomorskie voivodeship report (for station KpGrudPilsud in zone PL1401),[198] and Table 5.2 of the Mazowieckie voivodeship report (for station MzWarAlNiepo in zone PL1401).[199] Evidence provided to demonstrate these criteria is mixed. For example, at KpGrudPilsud (zone PL0404), the road maintenance information demonstrates that road sanding, salting or cleaning occurred within 2-weeks prior to the date deducted for all but one day (15th March 2020), where the most recent road sanding or event was 18 days prior (26th February 2020).[200] As such, this would benefit from a discussion of the evidence suggesting that road sand or salt and subsequent particulates remained 2-weeks later.

In both reports, there is no mention or discussion of the potential influence of other sources of PM_{10}.[201,202]

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198 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
199 Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.
200 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
201 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, pages 39-45.
202 Annual Air Quality Assessment in the Mazowieckie Voivodeship for 2020, Annex 2, pages 33-37.

A7.3.2 Quantification must be sufficiently precise and accurate and appropriate to the averaging period of the limit value

The winter sanding contribution was calculated following the Commission's guidelines outlined in Section 4.1.2 of the SEC (2011) 207 final document. If the criteria outlined are met, 50% of the course fraction (PM_{10}–$PM_{2.5}$) can be attributed to winter sanding.

It should be noted that the only specified events on days in exceedance are stated to be occurrences of winter salting (1st December and 8th February 2020 in zones PL0404 and PL1401, respectively). It is also stated later in the Mazowieckie voivodeship report (zone PL1401) that according to the City Cleaning Authority in Warsaw, only salt was spread.[203] This means that the methodology used is not recommended by the Commission for this contribution, with the assessment of the chemical composition of chloride preferred (Section 4.2 of the Commission's guidelines). However, since the composition of salt used in Poland in 2020 has not been specified, and no chloride measurements have been made, this cannot be directly assessed. As such, this assessment has continued to assess Poland's implementation of the size fraction methodology, while acknowledging this major caveat.

Tables in the two voivodeship reports (Table 5.1 for zone PL0404,[204] and Table 5.2 for zone PL1404)[205] present a summary of the evidence required to meet the criteria. These show each day in exceedance of the PM_{10} daily limit value, alongside columns which show the presence of sanding activities (7th column from left), dry road surfaces (8th column) and $PM_{2.5}/PM_{10}$ ratio ≤ 0.5 (4th column). The contribution of winter sanding is calculated for all days in these tables and subtracted from the daily average PM_{10} concentration, by the equations:[206]

$$\text{"share of road gritting with sand or salt"}_i = [S24(PM_{10})_i - S24(PM_{2.5})_i] \times 0.5$$

$$S24_k = S24(PM_{10})_i - \text{"share of road gritting with sand or salt"}$$

Where $S24_i$ is the measured daily average concentration of PM_{10} and $PM_{2.5}$ for day "*i*", $S24_k$ is the PM_{10} concentration following the deduction of the winter sanding contribution, and the winter sanding contribution itself is expressed as the "share of road gritting with sand or salt". This follows the suggested guidelines from the SEC (2011) 207 final document. The winter sanding contribution and the new PM_{10} concentration following its subtraction are presented in the 5th and 6th columns from the left of these tables, respectively. All figures and associated calculations presented by Poland have been independently verified in this assessment.

All contributions presented use daily average concentrations of PM_{10} and $PM_{2.5}$, which is consistent with the averaging period of the daily PM_{10} limit value which had been exceeded at both measurement stations (KpGrudPilsud and MzWarAlNiepo in zones PL0404 and PL1401, respectively). The annual average PM_{10} value was not exceeded at either of these stations in 2020,[207] therefore the quantification is appropriate to the averaging period of the limit value.

A7.3.3 Representativeness of the measuring stations at which contribution is determined

Section 2 of the SEC (2011) 207 final document outlines that the influence of PM_{10} emissions by winter sanding or salting is usually measured at traffic related monitoring sites, and the procedure to subtract the contribution of winter sanding or salting should be applied at each measurement station separately. It is stated (and highlighted in bold) in the introductory information (Section 5.1) of both of these Polish voivodeship reports that only traffic and urban background measurement stations would be considered for assessment.[208,209]

Winter sanding or salting corrections in Poland have only been calculated for and applied at one measurement station in each voivodeship (KpGrudPilsud in the Kujawsko-Pomorskie voivodeship, zone PL0404;[210] and

[203] Annual Air Quality Assessment in the Mazowieckie Voivodeship for 2020, Annex 2, page 36.
[204] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
[205] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.
[206] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, pages 40-41.
[207] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 43.
[208] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 40.
[209] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, page 34.
[210] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.2, page 45.

MzWarAlNiepo in the Mazowieckie voivodeship, zone PL1404).[211] Both are classified as "urban traffic" stations in Table 2.1 of both Polish voivodeship reports,[212,213] therefore the criteria for this key principle has been met.

A7.3.4 The contribution of winter sanding or salting to the measured PM_{10} concentration has to be quantified in µg m^{-3} for each exceedance day under consideration

In both Polish voivodeship reports, the winter sanding or salting contribution to PM_{10} for each day determined to be eligible has been quantified and presented in µg m^{-3}. These can be found in the 5th column from the left of Table 5.1 of the Kujawsko-Pomorskie voivodeship report (for station KpGrudPilsud in zone PL0404),[214] and Table 5.2 of the Mazowieckie voivodeship report (for station MzWarAlNiepo in zone PL1401).[215] The daily PM_{10} value has not been directly subtracted from exceedance statistics, which is in line with the Commission's guidelines. As such, this criterion has been satisfied by Poland.

A7.3.5 The method to determine this contribution has to be documented

As described in the sections above, the methodology used by Poland follows the Commission's guidelines set out in Section 4.1 of the SEC (2011) final document ("Winter sanding – difference between $PM_{2.5}$ and PM_{10}"). Most of the necessary evidence to meet the conditions for this method have been provided in the assessed report. However, it is stated for a single day in both Polish methodologies that winter salting took place, not winter sanding. As such, the method used by Poland does not follow the method recommended by the Commission for this situation ("Winter salting – chemical composition (chloride)"). However, since there is no description of the composition of the salt used by Poland in 2020, aside from the general introductory provided for the section, the methodology has been assessed based on the assumption that winter sanding method is applicable.

A7.4 CRITICAL ASSESSMENT OF THE WINTER SANDING METHOLOGY

A brief overview of the methodology that Poland has applied against the recommended methods in the SEC (2011) 207 final document for identifying and quantifying winter salting contributions have been summarised in Table 27 below, in the form of a checklist. The criteria have been taken from Section 4.1 of the Commission's winter sanding and salting guidelines: "Winter sanding – difference between $PM_{2.5}$ and PM_{10}", despite the likelihood that Section 4.2 "Winter salting – chemical composition (chloride)" would be the recommended method for this scenario (see discussion in Appendix Section A7.3.2). This includes the conditions (requirements) for using this method (Section 4.1.1) and the suggested procedure (Section 4.1.2). The evidence provided in the two relevant Polish voivodeship reports to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A7.3.

Table 27 Summary of methodology provided by Poland for quantifying and subtracting a winter sanding and salting, against the Commission's winter sanding and salting guidelines in the SEC (2011) 207 final document.

Content	2020 report	Assessment comments and recommendations
Demonstrates that winter sanding activities have taken place, and that road sand (or remnants) were present on the road or adjacent footpaths.	**Partially – not enough supporting information provided**	Both Polish voivodeship reports state that information about winter spreading was obtained from relevant municipal authorities for the two measurement stations assessed: Municipal Roads Management in Grudziądz for station KpGrudPilsud (zone PL0404), and the City Cleaning Authority in Warsaw for station MzWarAlNiepo (PL1401). The information is presented for days in exceedance of the daily PM_{10} limit value in Table 5.1 and Table 5.2 of the Kujawsko-Pomorskie (PL0404) and

[211] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.3, page 37.
[212] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 2.1, page 7.
[213] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 2.1, page 9.
[214] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
[215] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.

Content	2020 report	Assessment comments and recommendations
		Mazowieckie (PL1401) voivodeship reports, respectively.[216,217] The Polish voivodeships have reported the most recent sanding, salting or street cleaning event to the date in exceedance. These time frames vary from the same day (salt spread on 1st December 2020, and street cleaning on 18th March 2020; PL0404), to 18 days prior (15th March 2020; PL0404). There is no discussion or referenced information to support the assumption that road sand or salt is still present, or effects persist over two weeks after spreading. It should be noted that the only two specified spreading events in both zones are winter salting events, not sanding. As such, the method selected by Poland is not recommended in the Commission's guidelines. However, no further information has been provided (such as the composition of salt used), therefore the assessment has been continued for the method used by Poland. **We recommend that Poland provide further evidence to clarify these discrepancies. At a minimum, would benefit from including confirmation of whether road sanding or salting took place, and a subsequent justification of the choice of method, as well as evidence that the effects of road sanding and salting persist for up to (and beyond) 2-weeks after the initial spreading event.**
Provides evidence that the road surface was dry. This information can be obtained from the municipal authorities responsible for winter sanding or from direct observation. If not available, road surface wetness or precipitation and snow cover meteorological information may be used.	**Yes, with some reservation.**	Meteorological information in the Kujawsko-Pomorskie voivodeship (zone PL0404) is stated to be sourced from meteorological measurements at the same stations where PM_{10} was measured, as well as synopic information published by the IMGW-PIB website.[218] This information is presented in Table 5.1 of this Polish report.[219] The report does not explicitly state evidence that the road surface was dry, however it can be inferred. There was no precipitation occurring on the dates in exceedance, and in most cases for a few days before. The exceptions to this include the 7th and 15th February 2020, where 0.1 mm of precipitation was recorded on the day prior, and the 23rd December 2020, where 5.4 mm was recorded on the 22nd. For the Mazowieckie voivodeship (zone PL1401) meteorological information was sourced from websites such as "weatheronline.co.uk",[220] and presented in Table 5.2.[221] This archive has been used to verify that there was no recorded precipitation in Warsaw between the road salting event (7th February 2020)

[216] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
[217] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.
[218] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 41.
[219] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 5.1, pages 43-44.
[220] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.
[221] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.

Content	2020 report	Assessment comments and recommendations
		and the date a winter sanding or salting contribution was quantified and deducted (8th February 2020).[222] This follows the Commission's guidelines, though there is no discussion of moisture condensation effects. **We recommend that Poland address this within their reports.**
Demonstrate that there is a high fraction of course particles (from winter sanding, as well as road abrasion, discounting the contribution of long-range transport) by proving the $PM_{2.5}/PM_{10}$ ratio is less than or equal to 0.5. This requires parallel monitoring of PM_{10} and $PM_{2.5}$ (in both measurement method and location).	Yes	The $PM_{2.5}/PM_{10}$ ratio has been calculated and presented for all days in exceedance of the daily PM_{10} limit value, and that were deemed by Poland to meet the other conditions. These results are presented in Table 5.1 of the Kujawsko-Pomorskie voivodeship report (zone PL0404),[223] and Table 5.2 of the Mazowieckie voivodeship report (zone PL1401).[224] All ratios presented are less than 0.5. At the KpGrudPilsud measurement station (zone PL0404), there are no measurements of $PM_{2.5}$. In line with the Commission's guidelines, $PM_{2.5}$ measurements have been taken from an urban background station in the same municipality, 660 m in the WSW direction (on ul. Sienkiewicza, no site abbreviation provided).[225] Figure 5.1 of Kujawsko-Pomorskie voivodeship report evaluates the site choice, showing a strong correlation between PM_{10} measurements at the two sites.[226] There is no mention of the difference in measurement method ("manual" at ul. Sienkiewicza and "automatic" at KpGrudPilsud) and how that may affect results. It is stated that simultaneous measurements of PM_{10} and $PM_{2.5}$ were available at the MzWarAlNiepo station (zone PL0404).[227] Neither Polish report provides any evidence that the contribution of long-range transport from natural or anthropogenic sources has been considered. **We recommend that Poland include discussion of the different PM measurement methods, and the possible influence from long-range transport.**
Show comparatively low background concentrations (rural and urban), excluding exceptional transboundary events.	No	The Kujawsko-Pomorskie or Mazowieckie voivodeship reports do not clearly provide any background concentrations for comparison. **We recommend that the daily PM background concentrations, unaffected by winter sanding, salting or other events, be highlighted in the Polish report.**

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[222] Weather Online, Precipitation in Warsaw in February 2020, https://www.weatheronline.co.uk/weather/maps/city?LANG=en&WMO=12375&ART=PRE&CONT=euro&R=150&LEVEL=150&REGION=0001&LAND=__&NOREGION=1&MOD=&TMX=&TMN=&SON=&PRE=&MONAT=&OFFS=&SORT=&MM=02&YY=2020&WEEK=2 (last accessed 15th June 2022).

[223] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, pages 43-44.

[224] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Table 5.2, page 36.

[225] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 42.

[226] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figure 5.1, page 42.

[227] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, page 35.

Content	2020 report	Assessment comments and recommendations
Uncertainty analysis	No	Neither the Kujawsko-Pomorskie or Mazowieckie voivodeship reports provide any discussion of potential sources of uncertainty in the calculated contribution of winter sanding or salting, or the deducted PM_{10} concentrations. **We recommend that Poland include discussion of uncertainties in the identification and quantification of winter sanding or salting contributions, as well as acknowledging any potential artefacts or interferences.**
References to the methodological reports/papers	Yes	Both Polish voivodeship reports reference the Commission's SEC (2011) 207 final document in the methodology description. [228,229] Source materials for road maintenance and local meteorological information have been referenced in the method, and in Section 7 of both Polish voivodeship reports.[230,231]

A7.5 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A7.5.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). The approach adopted by Poland to identify Saharan dust episodes follows some of the suggested guidelines in Sections 4.1.1 and 4.4.1 of the SEC (2011) 208 final document.

For the identification of Saharan dust episodes, daily contributions of dust have been estimated using data obtained from the Institute of Environmental Protection and National Research Institute, and the Copernicus Atmosphere Monitoring Service (CAMS).[232] Other voivodeship reports mention that this data was used in the CAMS50 project. Ultimately the quantified contribution of "desert dust inflow" (in µg m^{-3}) was derived from this modelled data,[233] by aggregating extracted hourly results to daily values.[234] It is stated in all reports that this method has not been used before 2020 in Poland.[235]

In Table 3.1 of the Kujawsko-Pomorskie voivodeship report (see criterion B of Table 28 for equivalent reference in all Polish reports assessed), this quantified dust load is presented for each day in exceedance of the daily PM_{10} limit value in 2020 (50 µg m^{-3}).[236] In zone PL0404, there were 16 days presented between 27th January and 14th December 2020. Periods with air masses from tropical regions (SE, S and SW of Poland) are identified by the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) and presented in Table 3.2.[237] Days within these ranges that are also identified by CAMS are noted. Additional identification is performed for each day in exceedance in Table 3.1, by analysis of dust aerosol maps obtained from the CAMS forecast, NMMB-BSC dust flow maps and IMGW-PIB synoptic maps in Figure 3.1.[238] Meanwhile Figure 3.2 presents NAAPS total optical depth and sulfate, dust and smoke surface concentration maps for each day.[239] From all this evidence, individual dust episodes have been identified to affect the

[228] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 40.
[229] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, page 6.
[230] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, pages 52-53.
[231] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, page 38.
[232] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 8.
[233] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 8.
[234] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, page 11.
[235] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 8.
[236] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 3.1, page 8.
[237] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 3.2, page 9.
[238] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figure 3.1, pages 10-18.
[239] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figure 3.2, pages 18-21.

KpGrudPilsud measurement station in the Kujawsko-Pomorskie voivodeship in 2020. These are summarised in Table 3.3[240] and discussed separately in the following subsections of this Polish voivodeship report (Section 3.2 to 3.5).[241]

Each episode is analysed by consulting a combination of 5-day backward trajectories from the HYSPLIT (Hybrid Single-Particles Lagrangian Integrated Trajectories) at different atmospheric heights, NMMB-BSC dust forecasts before, during and after the episode, CAMS imagery and NAAPS concentration maps. At the end of each section, a conclusion is made. Either the evidence is deemed to support the presence of Saharan dust, and the contribution presented in Table 3.1 is deducted from the measured daily PM_{10} (such as episode 1 on the 27th January 2020 shown in Table 3.5),[242] or it is discounted due to lack of evidence and no correction is applied (e.g. episode 2).[243]

A similar methodology is followed to identify wild-land fire episodes. However, this also includes consultation of news reports and satellite images.[244] Evidence of a fire is presented through imagery from the "Fires API" from "breezometer.com",[245] while maps of precipitation, wind speed and direction are also presented from IMGW-PIB.[246] The air mass path of the fire is traced from the location of the fire.[247] This is broadly in line with the Commission's suggested steps (points a to f) in Section 4.4.1 of the SEC (2011) 208 final document.[248]

Overall, the Polish reports provide strong evidence for the occurrence of Saharan dust and wild-land fire episodes in 2020, resulting in positive confirmation that the "identified contributions" have natural origin. The use of CAMS data, which is thoroughly validated within the operational CAMS service provides strong, credible evidence of the existence of natural contributions to the PM_{10} episodes in 2020. However, there is a lack of description of the model calculations, particularly regarding how the dust and wild-land fire contributions stated have been quantified. As such this methodology is not clear and cannot be assessed.

Table 28 Table of references to the evidence provided by Poland to meet each of the criterion below (A-E) required for Saharan dust corrections, in each of the voivodeship reports. References for each report are equivalent to those discussed of the Kujawsko-Pomorskie 2020 voivodeship report (zone PL0404) in Appendix Section A7.5.

A: Summary of the methodology for identifying and quantifying Saharan dust contributions.
B: A list of dates in exceedance initially identified to be Saharan dust episodes.
C: Quantified daily contributions of Saharan dust at measurement stations where corrections were applied.
D: The days in exceedance of the PM_{10} limit value, and the PM_{10} annual mean before and after the subtraction of the net dust load for each measurement station corrected.
E: Reference list to source materials used in the corrections.

Zone ID	Polish voivodeship report	A	B	C	D	E
PL0404	Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2	Pages 7-21	Table 3.1 (page 8)	Tables 3.5 and 3.8 (pages 24 and 32)	Table 3.9 (page 39)	Page 53
PL1001 PL1002	Annual Air Quality Assessment in Łódzkie Voivodeship for 2020, Annex 2	Pages 10-12	Table 3.1 (page 11)	Tables 3.4, 3.6, 3.8, 3.10 and 3.12 (pages 18, 24-25, 28, 37	Table 3.13 (pages 40-41)	Pages 44-45

240 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 3.3, page 21.
241 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, pages 21-32.
242 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Table 3.5, page 24.
243 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 25.
244 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, page 33-38.
245 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figure 4.1, page 33.
246 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figures 4.2 and 4.3, page 34.
247 Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figures 4.5, pages 35-37.
248 SEC (2011) 208 final document, pages 30-31.

Zone ID	Polish voivodeship report	A	B	C	D	E
				and 40, respectively)		
PL1401 PL1404	Annual Air Quality Assessment in the Mazowieckie Voivodeship for 2020, Annex 2	Pages 10-12	Table 3.1 (page 11)	Tables 3.14 and 3.15 (page 24)	Table 3.16 (page 25)	Page 38
PL1602	Annual Air Quality Assessment in the Opolskie Voivodeship for 2020, Annex 2[249]	Pages 114-116	Tables 3.1 and 3.2 (pages 115-116)	Tables 3.4, 3.7 and 3.12 (pages 120, 124 and 129, respectively)	Table 3.12 (page 130)	Page 129
PL1802	Annual Air Quality Assessment in the Podkarpackie Voivodeship for 2020, Annex 2	Pages 9-12	Tables 3.1 and 3.2 (pages 11-12)	Tables 3.5 and 3.7 (pages 18 and 25, respectively)	Table 3.8 (page 25)	Page 25
PL2401 PL2405	Annual Air Quality Assessment in the Silesian Voivodeship for 2020, Annex 2	Pages 9-12	Table 3.1 (page 11)	Tables 3.3, 3.5 and 3.7 (pages 16, 27 and 31, respectively)	Table 3.8 (page 32)	Page 32

A7.5.2 The quantification of the natural contribution must be sufficiently precise

The contribution of Saharan dust to PM_{10} measurements across Poland has been evaluated in all nine zones in exceedance in 2020, and five of these were also evaluated for wild-land fire contributions (Strefa Kujawsko – Pomorska, zone PL0404; Aglomeracja Łódzka, zone PL1001; Strefa Łódzka, zone PL1002; Aglomeracja Warszawska, zone PL1401; and Strefa Mazowiecka, zone PL1404).

The quantification of both Saharan dust and wild-land fire contributions are based on data obtained from the Copernicus Atmosphere Monitoring Service (CAMS),[250] and expressed separately (in µg m^{-3}) in relevant summary and deduction tables throughout the voivodeship reports (for Saharan dust, see Table locations in Table 28 criterion C). This does not follow the guidelines outlined by the Commission, as it utilises an alternative method not available in operational form at the time the Commission's natural source guidelines were written (2011). However, there is no description or overview of how these numbers are quantified using this data. It appears that they are directly attributing the CAMS concentrations allocated to the natural sources without validating them or relating them to biases over the PM_{10} measurement sampling points in Poland. This information should be at least summarised in the Polish reports and referencing relevant peer-reviewed publications, CAMS operating manuals or similar, where appropriate. As a result, the quantified contributions of Saharan dust and wild-land fire presented by Poland cannot be independently verified in this assessment. The need for referencing the CAMS validation reports is important due to differences in the calculated dust contribution to PM_{10} from the global and regional services. As such, this difference may affect the corrections results determined.

It should be noted that there are 22 stations across nine zones where Saharan dust contributions have been identified, and corrections have been applied. However, this only brings one station into compliance with the daily PM_{10} limit value (Zdzieszowice at ul. Piastów in the Opolskie voivodeship, zone PL1602). All other stations (and therefore all zones in Table 26 in Appendix Section A7.2 remain in exceedance).

[249] Note that page numbering in Annex 2 of the Opolskie Voivodeship report continues from the rest of the report, rather than restarting at page 1 as the other Polish voivodeship reports do.

[250] Copernicus Atmosphere Monitoring Service (CAMS), https://atmosphere.copernicus.eu/ (last accessed 15th June 2022).

The Polish voivodeship reports do not consider any uncertainty in the quantification of the presented natural contributions, and the subsequent adjusted daily PM_{10} concentrations. Additionally, there is no evidence that contribution of artefacts from anthropogenic sources have been considered.

A7.5.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

As shown in Table 26, nine zones in Poland exceeded the daily PM_{10} limit value (50 µg m^{-3}) by more than 35 days in 2020. There are no reported exceedances of the annual mean PM_{10} limit value (40 µg m^{-3}) in 2020. Therefore, quantification of the contribution of natural sources is only required for daily mean concentrations.

The contributions of both dust and wild-land fire have been presented as daily mean values derived from the CAMS data (e.g., Tables 3.5, 3.8 and 4.1 in the Kujawsko-Pomorskie voivodeship report).[251] Equivalent Tables in the other voivodeship reports are outlined in Table 28 (criterion C and D) below. Quantification of the natural contribution is therefore temporally consistent with the averaging period of the limit value considered. Short-term events have been recognised and evaluated independently.

A7.5.4 The quantification of the natural sources must be spatially described

In 2020, the corrections reported to Dataflow G (DfG) show the nine zones exceeding the daily PM_{10} limit value across Poland. The contribution of natural sources has been identified and quantified for each of these zones in six voivodeship reports (see Table 25). This comprises corrections made at 22 stations across the nine zones, however this only changes the compliance outcome of one measurement station (Zdzieszowice at ul. Piastów in the Opolskie voivodeship, zone PL1602). As such all other measurement stations, and therefore all zones in Table 26 remain in exceedance.

The Polish voivodeship reports separately analyse the natural source episodes identified for that voivodeship (general area within Poland). Corrections have been applied to measurements made at individual measurement stations, following an assessment of supporting evidence (CAMS, HYSPLIT backward trajectories, dust forecasting, etc). The quantification deducted is stated to have been derived from CAMS data, but the methodology and resulting uncertainties has not been stated. As such, the spatial extent of the natural source contribution is not clear. It could be inferred that as a model result, the spatial resolution is likely to be high and thereby quantified contributions of Saharan dust and wild-land fire to PM_{10} are only relevant to the site deducted. This is somewhat supported in the Mazowieckie voivodeship report, by different quantifications of Saharan dust contributions for two sites in the same zone (MzOtwoBrzozo and MZWarAlNiepo in zone PL1404) in January of 2020.[252] However, without further information this is not possible to assess.

It should be noted that as the quantification for the natural sources does not follow the Commission's guidance in the SEC (2011) 208 final document, no representative background concentration has been used directly to quantify the contribution at an urban traffic or background site in exceedance. The model set-up is likely to consider more variables contributing to spatial differences in PM_{10} concentrations, and validation at certain points (e.g., measurement stations) provides confidence in the spatial representativeness of the model results. This information should be detailed in the Polish voivodeship reports if appropriate but could mean that the criteria for this key principle could be more easily met when using this method.

A7.5.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the SEC (2011) final document, the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature.

The Polish voivodeship reports derive contributions of Saharan dust and wild-land fire to PM_{10} from CAMS data (criterion B in Table 28). However, these are only deducted from PM_{10} measurements at the same station following scrutiny of extensive evidence to confirm the presence of Saharan dust and/or wild-land fire episodes at that measurement station on that date. This includes multiple different types of evidence.

For Saharan dust contributions, this includes CAMS imagery, HYSPLIT backward trajectories, dust aerosol maps (CAMS forecast), NMMB-BSC dust flow maps, IMGW-PIB synoptic maps, NAAPS total optical depth,

[251] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Tables 3.5, 3.8 and 4.1, pages 24, 32 and 38.

[252] Annual Air Quality Assessment in Mazowieckie Voivodeship for 2020, Annex 2, Tables 3.14 and 3.14, page 24.

sulfate, dust and smoke surface concentration maps for each day. There is no use of chemical analysis to determine the chemical signature to PM_{10} contributions.

Similar evidence is consulted for wild-land fire contributions but also includes providing evidence of a fire in the location stated, maps of wind speed, direction, and precipitation. In the Kujawsko-Pomorskie voivodeship report, these are accompanied by a time series of hourly measurements of PM_{10}, NO_x and CO at the KpGrudPilsud measurement station (Figure 4.6 of the voivodeship report for zone PL0404),[253] which demonstrates peak concentrations on the 1st October 2020, compared to the rest of the time series. This is broadly in line with the suggested methodology steps in Section 4.4.1 of the SEC (2011) 208 final document (points a to f). The final steps (points g and h) however, have been substituted to quantify the wild-land fire contribution from CAMS data.

As such, it is not possible to validate the natural contribution quantifications based on the information presented in the report from the CAMS data. It is recommended that more information be provided regarding how the figures were derived, and that the methodology be critically analysed and justified, with references to methodological reports/papers.

A7.5.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A7.6 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

The evidence provided in the Polish voivodeship reports to meet each of the key principles set out in Section 2 of the Commission's guidelines has been compiled in the correspondingly named sub-sections of Appendix Section A7.5, which predominantly assesses the Kujawsko-Pomorskie voivodeship report (containing zone PL0404) as a representative example. Locations of comparable evidence provided by Poland in the other voivodeship reports have been summarised in Table 28 (see Appendix Section A7.5.1).

Since the Polish voivodeship reports have used an alternative method to quantify and subtract the contribution of Saharan dust from measured PM_{10} concentrations, it has not been assessed against the recommended methods in the SEC (2011) 208 guidelines for identifying and quantifying Saharan dust contributions (Section 4.1.6). Saharan dust episodes have been quantified using CAMS data (see Appendix Section A7.5.2). Although the use of CAMS products is an interesting and welcomed advance in the identification of the episodes of events affected by natural sources, there is little detail provided in the Polish voivodeship reports to support the actual method used to quantify the contributions quoted or to present a representative validation of the modelled contribution. The evidence presented in the reports leads us to understand that they are directly deducing the CAMS concentrations allocated to the natural sources without validating them or relating them to biases over the PM_{10} sampling points in Poland. However, as previously stated there is little detail presented in the reports, so it is difficult to be certain. As such these values have not been independently verified in this assessment.

In terms of identifying Saharan dust episodes, the Polish voivodeship reports provide extensive evidence. A mixture of CAMS imagery and forecasts, HYSPLIT backward trajectories and modelled optical depths and surface concentrations of various relevant parameters (dust, smoke etc) provide confidence that dust is in fact present where the quantification has been deducted. However, the actual quantification of the natural contribution needs to be better justified, including an analysis of possible artefacts in this quantification, or validation with measured results in Poland. Similarly, there is little to no discussion of uncertainty in the Polish voivodeship reports.

We recommend that the Polish voivodeship reports provide better references for the CAMS model run used to obtain these results, and a discussion of the sources of uncertainty in the results obtained. Similarly, the use of a model to quantify the Saharan dust contribution could be justified by validating model outputs with known (measured) concentrations, and/or citing prior peer-reviewed work using CAMS to quantify natural source contributions. This will add confidence to the contributions

[253] Annual Air Quality Assessment in Kujawsko-Pomorskie Voivodeship for 2020, Annex 2, Figure 4.6, page 38.

calculated and demonstrate whether this approach improves upon the Commission's existing guidelines.

A7.7 CRITICAL ASSESSMENT OF WILD-LAND FIRE METHOLOGY

There is no exhaustive methodology for the identification and quantification of wild-land fire episodes included in the Commission's guidelines, as none had been developed and communicated to the Commission at the time publication of the SEC (2011) 208 final document.[254] As such, the evidence provided by Poland to quantify wild-land fire episodes has only been assessed against the criteria for each of the key principles required for subtraction of natural sources in Section 2 of the Commission's guidelines, in the correspondingly named sub-sections of Appendix Section A7.5.

The contribution of wild-land fire episodes to PM_{10} at each measurement station is derived from CAMS data (Appendix Section A7.5.2). As with the Saharan dust contributions (Appendix Section A7.6) there is no clear information to support the model method used to quantify these contributions or validate the model itself. Consequently, it is not possible to independently verify the quantifications presented. As with the corrections applied to the Saharan dust contributions using CAMS it is uncertain whether the method followed is using the bias for PM_{10} measurement data.

The Polish voivodeship report provide much more detail to identify the occurrence of wild-land fire episodes, which are somewhat in line with the first few of the Commission's suggested steps (point a to f) in Section 4.4.1 of the SEC (2011) final document.[255] However, less information is provided on the actual quantification of the correction applied and possible artefacts in the quantification of the reduced PM_{10} concentrations have not been discussed.

We recommend that the Polish voivodeship reports provide further evidence to describe the quantification of wild-land fire episode contributions from the CAMS data stated. The model could be justified by validating the model against known (measured) concentrations, and/or citing prior peer-reviewed work using CAMS to quantify natural source contributions to PM_{10}. Uncertainty in the quantified results (contributions and deducted PM_{10} concentrations) should be discussed.

A7.8 ASSESSMENT SUMMARY FOR POLAND

Contributions for winter sanding or salting, Saharan dust and wild-land fire episodes were identified by Poland in 2020. During this year nine zones were in exceedance of the daily PM_{10} limit value (Strefa Kujawsko – Pomorska, zone PL0404; Aglomeracja Łódzka, zone PL1001; Strefa Łódzka, zone PL1002; Aglomeracja Warszawska, zone PL1401; Strefa Mazowiecka, zone PL1404; Strefa Opolska, zone PL1602; Strefa Podkarpacka, zone PL1802; Aglomeracja Górnośląska, PL2401; and Strefa Śląska, zone PL2405). Application of the quantified deductions did not alter the compliance outcome of these zones, with all nine remaining in exceedance.

The Polish methodology assessed was found in Annex 2 of the 2020 annual air quality assessments for individual voivodeships on the Polish Chief Inspectorate for Environmental Protection website. A summary of which voivodeship report contains the evidence for corrections in each Polish zone is presented in Table 25 (Appendix Section A7.1). Each Polish voivodeship report has divided the relevant methodology into sub-sections for each correction assessed in that voivodeship. Generally, the same method has been used for each correction across all of the voivodeship reports which include it.

Winter salting and sanding corrections were assessed in two zones (PL0404 and PL1401). In both zones, the recommended methodology in Section 4.1 of the Commission's SEC (2011) 207 final document ("Winter sanding – difference between $PM_{2.5}$ and PM_{10}") has been followed to identify and quantify the contribution and has been assessed accordingly. Overall, the Commission's guidelines have been followed well but the method requires more detail, including discussion of the possible sources of uncertainty or artefacts in the results (e.g., from sea spray), and evidence that the effects of road sand or salt can persist over 2-weeks after the initial spreading event. Only one measurement station reduced the number of days in exceedance of the daily PM_{10}

[254] SEC (2011) 208 final document, page 30.

[255] SEC (2011) 208 final document, pages 30-31.

limit value, from 57 to 54 days (KpGrudPilsud in zone PL0404). As such, no zones changed exceedance status as a result of this correction.

One major caveat in this correction methodology is that both Polish voivodeship reports state that salt, not sand, was spread on the roads in the voivodeship around the stations adjusted. As such, the methodology used is not the one recommended by the Commission for this contribution, with the assessment of the chemical composition of chlorine preferred. This discrepancy in the choice of method by Poland has not been discussed or justified, which is a major omission.

In terms of natural source contributions, the method used by Poland deviates from the methodologies set out in Sections 4.1 and 4.4 of the SEC (2011) 208 final document, for Saharan dust and wild-land fire respectively. Instead of calculating the natural contribution to PM_{10} concentrations by finding the difference between measured PM_{10} concentrations and a moving average “background” concentration at a representative rural station, the Polish voivodeship reports have quantified the contribution using beam analysis models launched by the CAMS50 project (see references in criterion A of Table 28 in Appendix Section A7.5.1). The quantified contributions are derived from this CAMS data, but there is little discussion surrounding this method, including validation of the model used and discussions of uncertainty. These quantified values were only deducted from daily average PM_{10} measurement at a station if a Saharan dust or wild-land fire episode was identified. The evidence provided to identify such episodes was extensive, providing a strong justification for the subtraction of a correction on the identified episode days.

The contribution of Saharan dust was assessed for all nine zones, while wild-land fire contributions were assessed for five zones (PL0404, PL1001, PL1002, PL1401 and PL1404). However, the corrections applied did not alter the compliance outcome of any zone.

Overall, the Polish reports provide a reasonable level of detail in the methods used and follow the Commission’s guidelines well where intended. Natural source episodes are clearly identified and supported by a good evidence base presented well, the model used to quantify these contributions requires further justification and explanation. Similarly, the methodology used for the winter sanding and salting correction requires further detail and justification. Generally, the methodologies presented are missing discussions of uncertainty in the presented results, and acknowledgement and/or quantification of potential interferences or artefacts (e.g., those of anthropogenic origins).

Appendix 8 – Slovenia: Saharan dust correction

A8.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G, natural source corrections were identified to have been applied to adjust the baseline concentrations in four zones in Slovenia in 2019, and also in Primorsko Obmocje (SIP) in 2018. No corrections were declared in 2020. The only exceedance reported in Dataflow G (Table 29) occurs in zone Celinsko Obmocje (SIC) in 2019, measured at the CE Mariborska measurement station.

The methodology for the natural source corrections assessed is sourced from Slovenia's 2019 Air Quality Report. It identifies that the contribution of sea salt is not significant for Slovenia, and there were no major fires or significant volcanic eruptions that could have affected particle concentrations. However, contributions from desert dust were identified.[256]

Slovenia's methodology for the identification and quantification of Saharan dust contributions to PM_{10} are assessed against the key principles detailed in Section 2 of the Commission's natural sources guidelines (SEC (2011) 208 final document) in Appendix Section A8.3, and against the relevant recommended method outlined in Section 4 of the same document (Section 4.1.6) in Table 29 below.

A8.2 SUMMARY OF CORRECTIONS REPORTED

Table 29 Summary table of results from the assessment of corrections applied in Slovenia in 2018[257], 2019[258] and 2020[259] for inclusion in the final summary report. Not all years had reported corrections, as such these are missing from the table. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
SIC	Celinsko Obmocje	2019	**43 days**	**42 days**	Days above limit value	Natural source
SIL	Ljubljana	2019	21 days	20 days		
SIM	Maribor	2019	13 days	12 days		
SIP	Primorsko Obmocje	2018	6 days	5 days		
		2019	10 days	9 days		

A8.3 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS

A8.3.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify the contribution to PM_{10} by natural sources is summarised in Table 1 of this assessment (Section 1.1.1). The "Air quality in Slovenia in 2019 Annual Report" references the Commission's natural source guidelines SEC (2011) 208 document but does not clearly describe how dust events were identified. The report does state that the NMMB/BSC-Dust Model was used to estimate episodes of desert dust in 2019.[260] Figures 4.18 to 4.21 in Slovenia's annual air quality report present the modelled calculations of desert dust levels over Europe for the 24th, 25th, 26th and 27th of April 2019, showing increased levels of dust over Slovenia on the 24th, 25th and 26th April. The same is also evidenced by elevated concentrations of PM_{10} (compared to $PM_{2.5}$) over the same period in Figure 4.22. The estimation of the contribution of dust was also

[256] Air quality in Slovenia in 2019 Annual Report, page 60.

[257] SI Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/si/eu/aqd/g/envxdzka/REP_D-SI_ARSO_20191121_G.xml/manage_document

[258] SI Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/si/eu/aqd/g/envx2xqhg/REP_D-SI_ARSO_20200925_G.xml/manage_document

[259] SI Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/si/eu/aqd/g/envyvwxmq/REP_D-SI_ARSO_20210930_G.xml/manage_document

[260] Air quality in Slovenia in 2019 Annual Report, page 61.

verified by chemical analysis of samples from the Iskrba station before, during and after the episode (on 20th April, 26th April and 2nd May 2019, respectively).[261]

The report states that the Iskrba background station represents the situation in the unexposed rural environment in Slovenia. Figure 4.23 shows evidence of large increases in levels of strontium and aluminium, as well as smaller increases in iron, calcium, magnesium, sodium and chloride during the estimated dust episode (26th April). The Slovenian report states that desert dust is said to contain aluminium, iron, strontium, calcium, and magnesium.[262]

This is all considered to be evidence that the "identified contribution" has natural origin. However, further evidence should have been provided to justify use of the NMMB/BSC-Dust Model to determine dust events, and commentary should be provided to explain why there were increased levels of sodium and chloride at the Iskrba station in the days when the dust episode is estimated to have occurred, as these elements are not considered to be a component of desert dust and could be attributed to other sources (e.g., sea spray).

The report does not provide direct evidence that the "identified contribution" could not be derived from interactions between natural component and anthropogenic components. It also does not demonstrate that human action could not prevent or significantly reduce the "identified contribution".

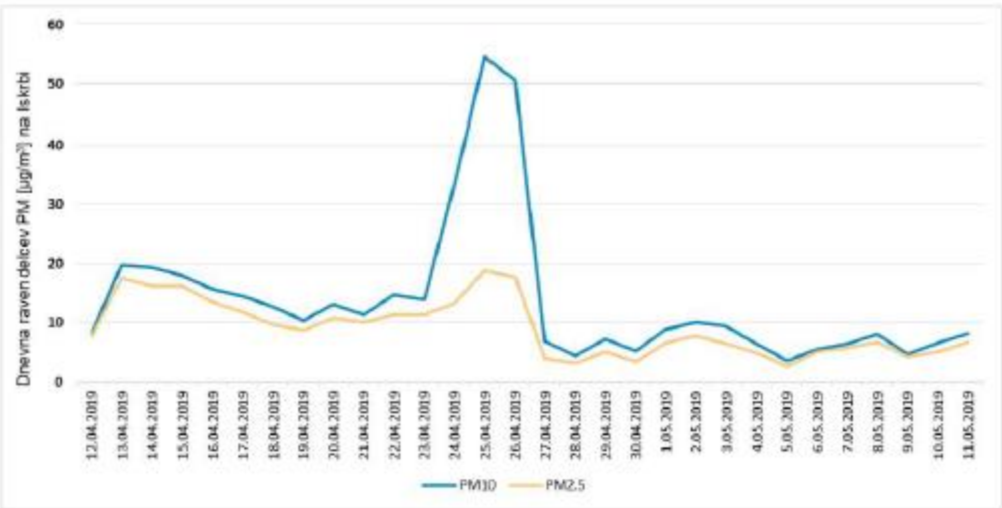
A8.3.2 The quantification of the natural contribution must be sufficiently precise

The contribution from the dust episode follows the methodology as set out in Section 4.1.2 of the Commission's natural source guidelines (SEC (2011) 208 final document). The values of the daily net African dust load were determined by calculating the background average PM_{10} at the Iskrba background site for 15 days before and after the dust episode. This average was subtracted from the PM_{10} concentrations recorded at the background station during the dust episodes.[263]

The quantified contribution of dust at Iskrba was stated to be 44 µg m^{-3} on 25th April and 40 µg m^{-3} on 26th April. The daily concentrations of PM_{10} and $PM_{2.5}$ at Iskrba between 12th April and 11th May 2019 are presented in Figure 8 below (Figure 4.22 of the Slovenian report). It is expected that these concentrations of PM_{10} are those used to quantify the dust contributions stated, and subsequently applied to each of the 11 sites adjusted.

These concentrations are assumed to be best estimates, however there is no discussion of uncertainties regarding the quantification of the contribution from desert dust. Nor is there any discussion or determination of the potential artefacts from anthropogenic sources.

Figure 8 Comparison of PM_{10} and $PM_{2.5}$ concentrations at the Iskbra measurement station between 12th April and 11th May 2019. Taken from Figure 4.22 of the Slovenian report.[264]



[261] Air quality in Slovenia in 2019 Annual Report, page 61.

[262] Air quality in Slovenia in 2019 Annual Report, page 61.

[263] Air quality in Slovenia in 2019 Annual Report, page 62.

[264] Air quality in Slovenia in 2019 Annual Report, Figure 4.22, page 62.

A8.3.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

Table 29 shows that zone Celinsko Obmocje (SIC; at the CE Mariborksa measurement station) exceeded the daily PM_{10} limit value (50 µg m^{-3}) on 43 days in 2019. Therefore, the contribution of natural sources should be quantified for daily mean concentrations. The Slovenian report does not present any calculated daily mean values, except for the daily quantified contribution of dust at Iskrba deducted from each measurement site. At CE Mariborska this decreases the number of exceedances of the daily PM_{10} limit value by 1 day (to 42 days total). Daily mean concentrations of PM_{10} are not provided for the site, so this calculation cannot be verified. The exceedances before and after subtracting the contribution of Saharan dust at the other 10 sites are presented in Table 4.12 of the Slovenian report.[265] However none of these sites were in exceedance prior to the subtraction.

A8.3.4 The quantification of the natural sources must be spatially described

In 2019, corrections reported to Dataflow G cover zones Celinsko Obmocje (SIC), Ljubljana (SIL), Maribor (SIM) and Primorsko Obmocje (SIP). In the Slovenian report, it is stated that the increase in desert dust was only accounted for at measurement stations in the DMKZ (Slovenian national monitoring network),[266] presumably as these are the sites where measurements were reported in 2019. It is also stated in the report that particle levels had risen at all measurement stations in Slovenia on the 24th, 25th and 26th of April 2019.[267] There are 19 PM_{10} sampling points identified as part of the DMKZ in Table 4.3,[268] however only 11 sites are presented with corrections in Table 4.12.[269] This difference is not clarified but may be explained by availability of PM_{10} measurements within the network.

The report is considered to be insufficient in providing a spatial description of the quantification of Saharan dust. Furthermore, the report does not provide evidence that the Iskrba background monitoring site is representative of the area which has been impacted by desert dust. Elsewhere in the 2019 Slovenian report it is stated that there is a need for more background monitoring in rural areas due to concentrations being so dependent on altitude.[270] This suggests that Iskrba may not be a very representative background monitoring site.

A8.3.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the Commission's natural source guidelines in the SEC (2011) 208 final document, the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature.

The Slovenian report provides little evidence that the method used to identify the contribution of Saharan dust follows the Commission's guidelines (Section 4.1.1). Of the five steps that should be taken, there is only the use of the NMMB/BSC-Dust Model, which includes little traceable detail that can be verified. There is no evidence that HYSPLIT back trajectories were consulted, that maps of aerosol index of Ozone Monitoring Instrument were consulted, or that the HIRLAM model has been used.

Some systematic assessment has been demonstrated. Elevated concentrations are observed during the estimated dust episode at the Iskrba measurement station in Figure 8. This is mostly verified to be the contribution of Saharan dust by the chemical analysis of samples from the same site.[271] However, this analysis is not presented in detail (e.g., the markers used to identify the mineral composition of Saharan dust, such as Ca or Al_2O_3). The report states that desert dust is said to contain aluminium, iron, strontium, calcium and magnesium, and the chemical analysis shows increased levels of all of these at Iskrba during the estimated dust episode (26th April presented).[272] Elevated levels of sodium and chloride are also shown during this period, however no discussion is provided on why this may be the case, and whether there are also contributions from other sources (e.g., sea spray).

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[265] Air quality in Slovenia in 2019 Annual Report, Table 4.12, page 63.
[266] Air quality in Slovenia in 2019 Annual Report, page 62.
[267] Air quality in Slovenia in 2019 Annual Report, page 61.
[268] Air quality in Slovenia in 2019 Annual Report, Table 4.3, page 46
[269] Air quality in Slovenia in 2019 Annual Report, Table 4.12, page 63.
[270] Air quality in Slovenia in 2019 Annual Report, page 18.
[271] Air quality in Slovenia in 2019 Annual Report, page 61.
[272] Air quality in Slovenia in 2019 Annual Report, Figure 4.23, page 64.

The report and associated Annex present no evidence that satellite images have been studied. The measured PM_{10} concentrations are noted to be high on the 24th, 25th and 26th of April 2019 at all measuring points in Slovenia. This statement is not presented with supporting data or referenced.

A8.3.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A8.4 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

A brief overview of the methodology that Slovenia has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying Saharan dust contributions (Section 4.1.6) have been summarised in Table 30 below, in the form of a checklist. The evidence provided in the Slovenian reports to meet each of the key principles set out in Section 2 of the Commission's guidelines has been compiled in the correspondingly named sub-sections of Appendix Section A8.3.

Table 30 Summary of methodology provided by Slovenia for quantifying and subtracting a Saharan dust correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2019 report	Assessment comments and recommendations
List of the regional background measuring stations used for the determination of the net dust load and information concerning representativeness of the stations	Yes – with some reservation	There is only one background station in Slovenia (Iskrba).[273] This station is part of the European Monitoring and Evaluation Program (EMEP)[274] and has been used to quantify the dust contribution for sites in the DMKZ.[275] There is no discussion on the representativeness of this station for determining the net dust load. However, it is stated elsewhere in the report that there is a need for more background monitoring in rural areas due to concentrations being so dependent on altitude.[276] This could suggest that Iskrba may not be a very representative background monitoring site. **We recommend that Slovenia include a discussion of the representativeness of the Iskrba measurement station to those where the dust load calculated here has been applied.**
The tables of daily levels of PM_{10} registered at stations representing regional background	No	The daily total PM_{10} measurements at Iskrba could not be found in the 2019 report. The only quantified concentrations at Iskrba were the dust contributions to PM_{10} on the 25th and 26th April. **We recommend that Slovenia clearly detail these in their report.**
The list of dates with the identification of African dust episodes	Yes	The report states that the 24th, 25th and 26th of April 2019 have been identified as desert dust episodes by interpreting results from the NMMB/BSC-Dust Model.[277] On these days particle levels have risen at all measuring points in Slovenia.

[273] Air quality in Slovenia in 2019 Annual Report, page 61.
[274] Air quality in Slovenia in 2019 Annual Report, page 10.
[275] Air quality in Slovenia in 2019 Annual Report, page 62.
[276] Air quality in Slovenia in 2019 Annual Report, page 18.
[277] Air quality in Slovenia in 2019 Annual Report, page 61.

Content	2019 report	Assessment comments and recommendations
The values of the daily net African dust load determined by means of the procedure presented in the working document	Yes	The methodology described in the report follows methodology as set out in Section 4.1.2 of the Commission's natural sources guidelines, SEC (2011) 208 final document (detailed in Appendix Section A8.3.2 above). The dust contribution to PM_{10} was found to be 44 and 40 µg m^{-3} on the 25th and 26th of April, respectively.[278] The contribution on the 24th of April which was also defined as a desert dust episode. However, the report states that exceedance of the PM_{10} daily limit value only occurred on the 25th and 26th of April. [279]
The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas	No	The report presents the number of exceedances of the daily PM_{10} limit value at 11 of the 19 DMKZ assessment sampling points before and after subtracting the contribution of desert dust in 2019.[280] The daily concentration levels before and after the subtraction of the net dust load are not provided for any measurement station. **We recommend that Slovenia clearly include these values in their report.**
The annual concentration levels before and after subtraction of the net dust load for all assessment points and areas. The difference will yield the mean annual dust contribution from African dust.	N/A	Only the daily limit values are exceeding in Slovenia in 2019,[281] and therefore the evaluation of the impact of natural dust on annual mean values is not necessary.
Uncertainty analysis	No	The report states that the estimation of the desert dust episode by the dust model was verified by chemical analysis of samples from the Iskrba measurement station,[282] and a graph is presented comparing chemical analysis before (20th April), during (26th April) and after (2nd May) the desert dust episode.[283] However, the report does not offer any statistical analysis of how accurate the new concentrations calculated might be. **We recommend that the Slovenian report include discussion of potential sources of uncertainty, artefacts, and interference in the presented results.**
Critical analysis of the applied methodological elements relevant in the	No	There is no discussion of a critical analysis of the applied methods in the Slovenian report. **We recommend that Slovenia address this omission within their reported methodology.**

278 Air quality in Slovenia in 2019 Annual Report, page 62.
279 Air quality in Slovenia in 2019 Annual Report, page 61.
280 Air quality in Slovenia in 2019 Annual Report, Table 4.12, page 63.
281 Air quality in Slovenia in 2019 Annual Report, page 49.
282 Air quality in Slovenia in 2019 Annual Report, page 61.
283 Air quality in Slovenia in 2019 Annual Report, Figure 4.23, page 64.

Content	2019 report	Assessment comments and recommendations
reporting year, if appropriate.		
References to the methodological reports/papers	**Yes – with some reservation**	The Slovenian report makes one reference to the Commission's natural source guidelines, SEC (2011) 208 final document (as the "Guidance on the quantification of the contribution of natural sources under the EU Air Quality Directive 2008/50/EC").[284] The report also references the NMMB/BSC-Dust model used to estimate the dust episodes.[285] **We recommend that Slovenia more clearly reference the method used to identify and quantify the contribution of Saharan dust, including example uses of the NMMB/BSC-Dust model used if relevant.**

A8.5 ASSESSMENT SUMMARY FOR SLOVENIA

Natural source corrections were identified in Slovenia in 2018 and 2019 from the information provided in Dataflow G. Only one exceedance of daily PM_{10} limit values is reported, in zone (Celinsko Obmocje, SIC) during 2019. The methodology assessed against the Commission's guidelines for this correction was source from the "Air quality in Slovenia in 2019 Annual Report". Only a brief overview of methodology is provided in the Slovenian report, missing several requirements for both identifying and quantifying Saharan dust episodes and meeting key principles for subtracting natural source contributions.

The Slovenian report references the Commission's natural source guidelines (SEC (2011) 208 final document).[286] It provides a brief overview of how dust episodes were estimated, and how the daily net African dust load was determined. It also presents the number of exceedances of the daily limit value of PM_{10} pre- and post-subtraction.[287] The deduction was applied to 11 monitoring stations in the DMKZ (državna merilna mreža za spremljanje kakovosti zunanjega zraka; the national monitoring network): the Iskrba background station (EMEP), Koper, Nova Gorica, Hrastnik, MS Rakičan, MS Cankarjeva, Maribor, Velenje, Celje, CE Mariborska and LJ Gospodarsko.

The Commission's guidelines are followed in determining the dust load at the background site in Slovenia (Iskrba). The representativeness of this site as a rural background is not explicitly discussed, however its membership of the EMEP network (and subsequent adherence to its siting criteria) holds merit. Discussion of the altitude dependence of measured PM_{10} concentrations has been stated, but it there is no discussion on how this may affect corrections calculated. Daily PM_{10} concentrations at each site both before and after corrections were applied is missing from the report. Aggregated numbers of days in exceedance at each site are presented, but this cannot be verified for any site other than Iskrba (which can only be qualitatively validated). Similarly, the calculated dust contribution cannot be quantitatively verified with only the data presented.

The Slovenian report provides basic statements on the spatial description of the results (all sites are elevated during the estimated dust episode) and the systematic assessment of Saharan dust. The report states that no major fires or pronounced volcanic eruptions were recorded in 2019 but includes little further discussion of the potential contribution of PM_{10} from other sources (such as sea spray or winter sanding or salting). Final quantified values also lack uncertainty assessments, so confidence in the final value is assumed.

Overall, this report is lacking in sufficient detail to allow the methodology to be followed completely or allow the calculations to be verified. It is anticipated that the reference to the Commission's natural source guidelines were deemed sufficient.

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[284] Air quality in Slovenia in 2019 Annual Report, page 61.
[285] Air quality in Slovenia in 2019 Annual Report, page 61.
[286] Air quality in Slovenia in 2019 Annual Report, page 61.
[287] Air quality in Slovenia in 2019 Annual Report, Table 4.1.2, page 63.

Appendix 9 – Spain: Sea spray and Saharan dust corrections

A9.1 GENERAL INTRODUCTION

From the information supplied to Dataflow G, both natural source and winter sanding and salting corrections were identified to have been applied to adjust the baseline concentrations in a total of 13 zones in Spain between 2018 and 2020. This includes corrections to the number of days exceeding the daily limit value for PM_{10} (six in 2018, ten in 2019 and nine in 2020) as well as the annual mean (one in 2019 and three in 2020). Of these, there were a total of 24 exceedances in both PM_{10} annual mean and days above the limit value in the baseline measurements, reducing to three (all occurring in zone ES0307, Aviles) following the application of these corrections.

The natural source corrections have been declared for the transport of natural particles from dry regions outside of Spain for all zones in Table 31 (below in Appendix Section A9.2). However, there is a discrepancy in the declared winter sanding and salting "adjustment types" (noted in column L in DfG) in zone ES1219 for 2019 and 2020 (Figure 3 in Section 2.1). The corresponding "adjustment description" (column M in DfG) for these entries are "sea spray" in 2019 and "natural source contributions from Saharan dust" in 2020. In 2020, the wording of this "adjustment description" matches that of the corrections declared in other zones. It is therefore anticipated that the salt contribution was accidentally omitted from the "adjustment description", as it was only applicable to one zone (ES1219).

The methodology for both natural corrections (dust and sea spray) were sourced from two separate reports for the most recent year (2020; Table 4 in Section 3.1.1). After evaluating the "Influencia del aerosol marino en la concentración de PM_{10} en A Coruña en 2020" ("Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020", hereafter referred to as the "Spanish sea spray report") report, it is evident that the correction applied is a natural source (sea salt), and the "adjustment type" has been mislabelled as winter sanding and salting. As such, the methodology will be evaluated against the Commission's natural source guidelines (SEC (2011) 208 final document) key principles and criteria.

Spain have also included an overview report in the envelope on Dataflow G, titled "Spanish adjustment natural contribution 2020" (hereafter referred to as the "main 2020 dust report"). This report provides an outline which references (via hyperlinks) a more detailed 2013 methodology document for the identification and quantification of dust episodes ("Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$", hereafter referred to as the "2013 methodology document"). This method is stated to be approved by the Commission[288] and followed for the 2020 corrections. Specific evidence is also linked for the 2020 corrections ("Natural Particulate Matter Episodes 2020") and PM_{10} data ("PM_{10} – Discounts to all stations 2020", hereafter called the "PM_{10} data sheet"). These will be collectively assessed against the Commission's natural source guidelines (SEC (2011) 208 final document) key principles and criteria.

These methods have been used in 2018 (dust) and 2019 (dust and sea spray) reports, but these presented methodologies will not be discussed in this assessment.

Since Spain's methodologies for the identification and quantification of sea spray and Saharan dust are presented in different reports, they are separately assessed against the key principles detailed in Section 2 of the Commission's natural source guidelines (SEC (2011) 208 final document) in Appendix Section A9.3 (sea spray) and Appendix Section A9.5 (Saharan dust). Similarly, the methodologies used for each correction are separately assessed against the relevant method for sea spray and Saharan dust outlined in Section 4 of the same document in Table 32 (Appendix Section A9.4) and Table 34 (Appendix Section A9.6) below, respectively.

[288] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 1.

A9.2 SUMMARY OF CORRECTIONS REPORTED

Table 31 Summary table of results from the assessment of corrections applied in Spain in 2018[289], 2019[290] and 2020[291] for inclusion in the final summary report. Values bold and in red are in exceedance of PM_{10} limit values (35 days in exceedance per calendar year, and 40 µg m^{-3} annual mean).

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
ES0118	Granada y Area Metropolitana	2019	**37 days**	15 days	Days above limit value	Natural source
ES0119	Malaga y Costa del Sol	2018	**37 days**	22 days	Days above limit value	Natural source
		2019	**37 days**	20 days		
ES0128	Zona Villanueva del Arzobispo	2018	11 days	8 days	Days above limit value	Natural source
		2019	22 days	20 days		
		2020	15 days	11 days		
ES0307	Avilés	2018	**81 days**	**74 days**	Days above limit value	Natural source
		2019	**58 days**	**49 days**		
		2020	**80 days**	**68 days**		
ES0501	Las Palmas de Gran Canaria	2020	**47 µg m^{-3}**	27 µg m^{-3}	Annual mean value	
		2020	**59 days**	9 days	Days above limit value	Natural source
ES0504	Fuerteventura y Lanzarote	2020	**59 days**	11 days	Days above limit value	
ES0508	La Palma, La Gomera y El Hierro	2018	28 days	15 days	Days above limit value	Natural source
		2020	**43 days**	6 days		
ES0510	Sur de Gran Canaria	2018	**46 days**	10 days	Days above limit value	Natural source
		2019	**64 days**	18 days		
		2020	**53 µg m^{-3}**	32 µg m^{-3}	Annual mean value	
		2020	**111 days**	32 days	Days above limit value	
ES0511	Sta. Cruz de Tenerife-S. Cristóbal de La Laguna	2019	**42 µg m^{-3}**	35 µg m^{-3}	Annual mean value	Natural source
		2019	**69 days**	15 days	Days above limit value	
		2020	**42 days**	9 days		
ES0513	Sur de Tenerife	2019	**37 days**	10 days	Days above limit value	Natural source
		2020	**41 µg m^{-3}**	26 µg m^{-3}	Annual mean value	

289 ES Dataflow G 2018 Attainment: https://cdr.eionet.europa.eu/es/eu/aqd/g/envyfiynw/ES_G_Attainment.xml/manage_document
290 ES Dataflow G 2019 Attainment: https://cdr.eionet.europa.eu/es/eu/aqd/g/envyfiyqq/ES_G_Attainment_2019.xml/manage_document
291 ES Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/es/eu/aqd/g/envyxfmyq/ES_G_Attainment.xml/manage_document

Zone ID	Zone name	Year	Baseline data	Final data	Correction	Reason for correction
		2020	**71 days**	21 days	Days above limit value	
ES0705	Comarca de Puertollano	2018	**54 days**	27 days	Days above limit value	Natural source
		2019	**52 days**	25 days		
ES0906	Plana de Vic	2019	17 days	15 days	Days above limit value	Natural source
ES1219	A Coruña + Área Metropolitana	2019	**56 days**	7 days	Days above limit value	Winter-salting and sanding*
		2020	**51 days**	16 days		

** "Adjustment type" declared as winter salting or sanding, but correction calculated and applied for sea spray.*

A9.3 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS – SEA SPRAY REPORT

A9.3.1 The natural contribution must not be caused by direct or indirect human activities

The criteria required to identify contribution to PM_{10} by natural sources are summarised in Table 1 of this assessment (Section 1.1.1). In Section 4.1 of the Spanish sea spray report, the main ions in sea salt which can be routinely analysed ion chromatography are identified as Cl^-, Na^+, SO_4^{2-}, Mg^{2+}, Ca^{2+} and K^+. It is correctly noted that soluble Na^+ is typically of marine origin, particularly when it is near to the source as the Torre de Hércules site is (200 m).[292] As such, the Spanish report has determined the concentration of sea salt using the equation below,[293] assuming that all Na^+ measured is from sea salt, and that sea salt is comprised only of NaCl.

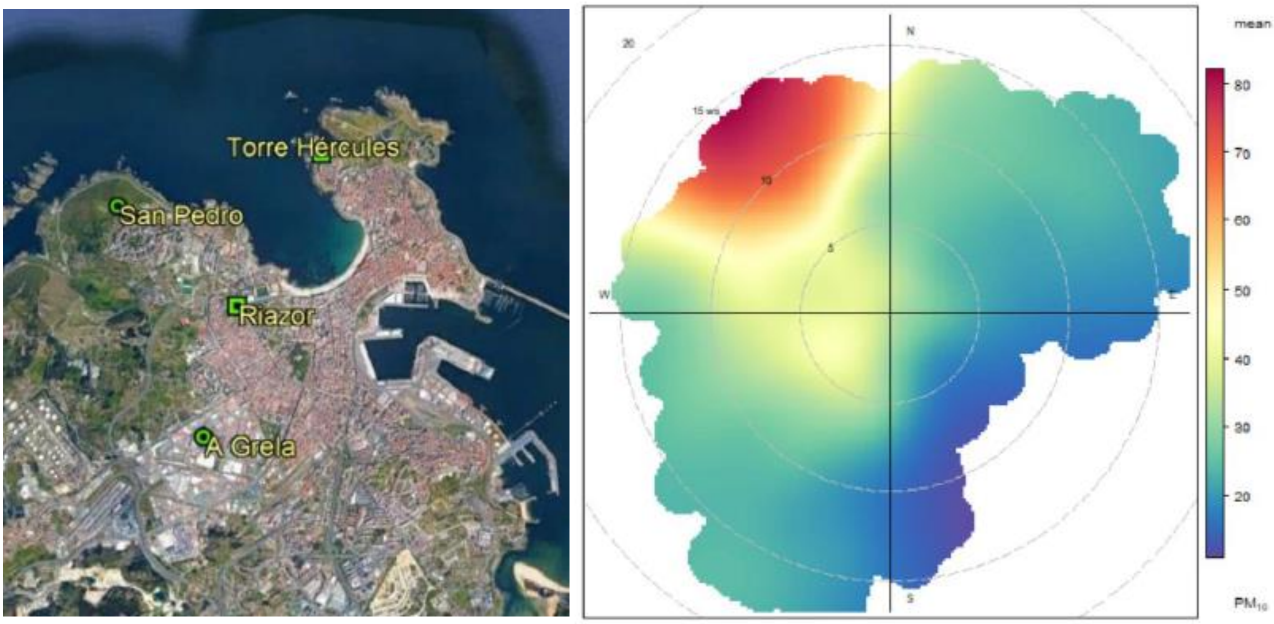
$$[\text{Sea salt}] = \frac{100}{30.6}\,[\text{Na}^+] = 3.27 \times [\text{Na}^+]$$

The equation presented above are found in Section 4.2.1 of the Commission's natural source guidelines (SEC (2011) 208 final document).[294] Back trajectories were used to support the assumption that all Na^+ measured is of marine origin. Both wind direction and intensity of maximum head wind, and general prevailing wind, were used to associate measured PM_{10} concentrations with specific compass directions for each day exceeding the PM_{10} daily limit value. Results presented show that these winds were predominantly from the north-west and south-west directions, corresponding with the immediate direction of the ocean relative to the site, shown in Figure 9. Individual back trajectories for each day are presented in Annex 2 (Anexo 2).[295] Similarly, a correlation was found between measured PM_{10} concentrations and wave heights from the Estaca de Bares buoy. All days exceeding the daily PM_{10} limit value were found to have average hourly wave height exceeding 2 m, with a large proportion exceeding 4 m (74.5%).

Combined, these analyses provide strong evidence that on days with exceedances, there was likely to be a large contribution from sea spray. This implies that there is a minimal contribution form anthropogenic sources to measured Na^+ concentrations, for example from road salt, however this is not discussed nor quantified. Nor is there any discussion of whether any intervention action could significantly reduce the identified contribution.

[292] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 33.
[293] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 16 and 20.
[294] SEC (2011) 208 final document, page 27.
[295] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, Annex 2, pages 45-69.

Figure 9 Map of air quality stations in A Coruña displaying the location of the Torre de Hércules site, and a polar plot of the distribution of PM_{10} concentrations with wind speed and direction, for maximum gusts of wind measured in 2020. Taken from Images 1 and 8 of the Spanish report[296], respectively.



A9.3.2 The quantification of the natural contribution must be sufficiently precise

Using the formula shown in the previous sections, automatic measurements of PM_{10} at Torre de Hércules (BAM 1020, Met One),[297] and the derivation of Na^+ concentrations from daily gravimetric filter measurements (Digitel DHA-80) using ion chromatography is an accurate approach to quantify the concentration of sea salt. A total of 301 filter samples were analysed to quantify Na^+ (and therefore sea salt) concentrations, giving a total of 82% data capture. Approximately half of the missing measurements were a result of laboratory sampling issues in December 2020. However, the data provided good temporal coverage, including seasons, and a balance between weekdays and weekends. The data capture for the automatic PM_{10} measurements was 98%.

These quantifications were determined separately to the potential contribution of Saharan dust, examined in Appendix Sections A9.5 and A9.6. Both sea spray (25%, 23 µg m^{-3}) and dust (15 µg m^{-3}) natural corrections are applied to the PM_{10} measurements at Torre de Hércules on 28th February 2020[298]. A natural correction for Saharan dust was also applied on 27th February 2020, however there was no filter sample for this day, so there was no correction for sea spray applied.

Aside from the analysis of evidence for sea spray contributing a large proportion to days exceeding the PM_{10} limit value in Sections 5.4 and 5.5 of the report, and summary statistics for annual Na^+ concentrations (mean, standard deviation, maximum and minimum), there is no discussion of uncertainty in the presented concentrations.

A9.3.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

As shown in Table 31 (Appendix Section A9.1), zone ES1219 exceed the daily PM_{10} limit value (50 µg m^{-3})[299] on 51 days in 2020. Therefore, the contribution of natural sources should be quantified for daily mean concentrations. The Spanish sea spray report presents such results for the quantification of sea spray, including the concentration of PM_{10}, Na^+ and sea salt, as daily mean values for each day where all required

[296] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 4 and 28.

[297] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 19.

[298] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 22.

[299] SEC (2011) 208 final document, Table 3, page 11.

measurements are available. The high data capture for these measurements means all days were assessed for potential contributions, rather than specific days selected for analysis based on certain criteria. This is important as it acknowledges that natural contributions from sea spray can occur continuously with varying intensity, particularly at sites near the coast like Torre de Hércules.

A9.3.4 The quantification of the natural sources must be spatially described

In 2020, a correction is only quantified and applied for the suburban background site of Torre de Hércules in zone ES1219. The location of the monitoring station is presented in Image 6 of the report.[300]

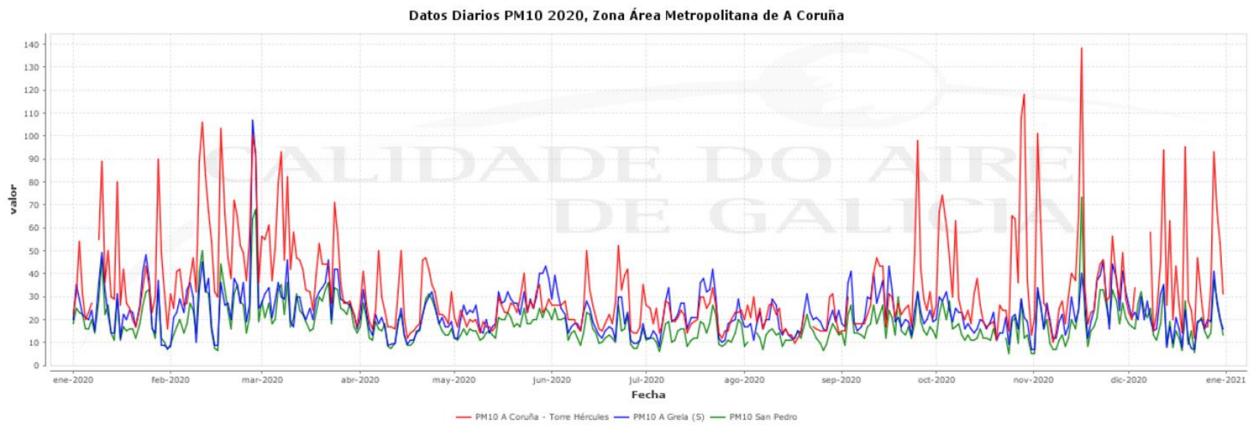
A9.3.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the Commission's natural source guidelines (SEC (2011) 208 final document), the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature. In the Spanish sea spray report, the contribution of sea spray is quantified for each day of the year where possible, due to its continuous contribution throughout the year. Na^+ is used as a tracer for PM_{10} with marine origin, which is preferred to Cl^- as it is involved in less atmospheric chemistry and suffers fewer interferences in measurement. Daily average concentrations of PM_{10} at the Torre de Hércules site are compared to two industrial sites within the same zone in 2020 (Figure 10). It is noted that despite this station having a suburban background classification, it predominantly reports the highest daily mean concentrations of PM_{10}, particularly in the autumn and winter months. This is attributed to its close proximity to the coast (approximately 200 m).

Daily mean concentrations of $PM_{2.5}$ are presented in Graph 2 of the Spanish spray report, showing a smaller increase in concentration at Torre de Hércules compared to A Grela (urban industrial site). This supports the hypothesis of the influence of sea spray on PM_{10} concentrations, as the natural marine aerosol is likely to have a larger diameter (bigger than $PM_{2.5}$).

This provides an overall correct assessment of the spatial representation of sea spray, and that using chemical analysis data is a good systematic approach for this site.

Figure 10 Daily concentrations of PM_{10} in three stations in the Metropolitan Area of A Coruña in the year 2020 (red, Torre de Hércules; blue, A Grela; and green, San Pedro). Taken from Graph 1 of the Spanish sea spray report.[301]



A9.3.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

[300] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 26.

[301] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 8.

A9.4 CRITICAL ASSESSMENT OF SEA SPRAY METHOLOGY

A brief overview of the methodology that Spain has applied against the recommended methods in the Commission's natural source guideline (SEC (2011) 208 final document) for identifying and quantifying sea spray contributions (Section 4.2) have been summarised in Table 32 below, in the form of a checklist. The evidence provided in the Spanish sea spray report ("Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020") to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A9.3.

Table 32 Summary of methodology provided by Spain for quantifying and subtracting a sea spray correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
Analysis of the chemical composition of daily aerosol samples, or at least one of the major components of sea salt.	Yes	Chemical analysis was conducted to quantify the concentration of sodium ions (Na^+),[302] which is a major ion in sea salt. This is chosen over chloride (Cl^-) due to other potential sources and losses of the ion.[303]
The episodic nature of sea salt contributions should be accounted for. The time coverage for chemical composition measurements should therefore be as large as possible. Uncertainties should be considered when time coverage is not 100%.	Yes	The sampling campaign was carried, out between 1st January–26th November 2020. Each individual filter was sampled for 24 hours (midnight to midnight). The full year could not be completed due to issues in the laboratory in December 2020.[304] As such, Spain have not applied a natural correction to measured PM_{10} on these days.[305]
Demonstration that a daily exceedance is attributable to sea spray, through quantification. If considering Na^+ as being entirely of primary marine origin, air mass backward trajectories must be used to validate this assumption.	Yes	The chemical analysis is coupled with further assessments to validate the assumption that the Na^+ concentration measured has marine origin. This includes backward trajectories of air masses arriving at the site, which identified that days with high PM_{10} concentrations (exceeding the daily limit value) were associated with winds from the northwest, southwest, and south, directions where air masses would have travelled over the sea prior to reaching the site.[306] Alongside this, Spain also note a correlation between measured wave height and high PM_{10} concentrations. Specifically on most days exceeding the PM_{10} daily limit value, measured wave height exceeded 3 m.[307]
The calculated mass of sea salt subtracted from the daily average PM_{10} at the sampling point.	Yes	For each day that chemical analysis was conducted for (between 1st January – 26th November 2020), the Na^+ concentration and estimated sea salt concentration have been quantified and subtracted from the measured PM_{10} concentration. This is presented in Table 8 (for days exceeding the PM_{10} limit value)[308] and Annex 1 (for all days in 2020).[309]

[302] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 17.
[303] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 16.
[304] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 18.
[305] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, Annex 1, pages 35-44.
[306] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 26-31.
[307] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 31-32.
[308] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 24-25.
[309] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, Annex 1, pages 35-44.

Content	2020 report	Assessment comments and recommendations
Subtraction is only applicable for the area where the spatial representativeness of the measurement has been determined. Wider application must be supported by modelling results, validated through an adequate number of PM composition measurements.	Yes	Only the Torre de Hércules suburban background site in zone ES1219 is assessed for the contribution of sea spray, and subsequently deducted from, the total PM_{10} concentrations.[310]
Consideration given to possible artefacts introduced by winter salting. Such sources should be identified, quantified and reported separately to avoid double counting.	Partially – not enough information provided	The possible artefacts from winter salting in the quantified contribution of sea spray are not clearly discussed in this report. However, it could be argued that this suburban background site is a considerable distance from the roadside, behind a hedge.[311] Therefore, it may be unlikely that the road closest to the site (P° Marítimo Alcalde Francisco Vázquez) experiences a high traffic volume, and therefore the potential contribution from the resuspension of winter road salt could be minimised. **We recommend that the Spanish report include discussion and quantification of possible artefacts and interferences in the sea spray contribution determined. This could include a clear confirmation no winter salting occurred locally.**
Uncertainty analysis	Yes – with some reservation	The “Sampling and gravimetric determination” section provides detail of the sampling methodology and includes some discussion of the precautions taken to ensure results are accurate, as well as a note to state that chloride is not used as a reference ion for sea salt, due to the wide margin of uncertainty.[312] The results presented in this report include general statistical analysis (e.g., annual mean, standard deviation, maximum and minimum) of determined Na^+ concentrations as well as PM_{10} before and after the correction was applied.[313] However, this is not discussed further. **We recommend that Spain include further discussion of possible sources of uncertainty in the presented results.**
References to the methodological reports/papers	Yes	The method references the Commission’s natural source guidelines, SEC (2011) 208 final document to specify the key principles that must be met. This suggested method is used in this correction.

310 Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 33-34.
311 Site investigated using Google Earth (last accessed: 28th April 2022).
312 Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 16-19.
313 Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, Tables 6 and 8, pages 20-21.

Content	2020 report	Assessment comments and recommendations
		The laboratory sampling method in Section 5.1 references both UNE-EN 12341 and UNE-EN 16450 standards.[314] Spain also provides a reference to a report investigating the first year the Torre de Hércules measurement station exceeded the daily PM_{10} limit value more than 35 times (2014).[315]

A9.5 CRITICAL ASSESSMENT OF THE NATURAL SOURCE CORRECTIONS SAHARAN DUST REPORT

A9.5.1 The natural contribution must not be caused by direct or indirect human activities

The 2013 methodology document describes the procedure used to identify and quantify dust episodes, and the group responsible for each step.[316] The approach used for the identification of Saharan dust outbreaks follow Section 4.1.1 of the Commission's natural source guidelines very well. The model results from these sections for 2020 are presented in the "Natural Particulate Matter Episodes 2020" report for each episode declared.[317] This includes mean surface topography maps (NOAA-CIRES Climate Diagnostics Center), surface dust concentration maps from AEMet (running HIRLAM), SKIRON, BSC/DREAM8b and NMMB/BSC-Dust, as well as NRL maps showing optical thickness and surface dust concentration. These results are grouped into two categories by geographic location: Península y Baleares (Mainland and Balearic Islands) and Canarias (Canary Islands). As such, most individual days affected by African dust are presented in this document, however the coarse spatial scale makes identification of specific zones within this area more difficult, particularly for the Mainland and Balearic Islands.

As such, the "Natural Particulate Matter Episodes 2020" report provides significant evidence for the influence of Saharan dust on the dates stated, suggesting the "identified contribution" has natural origin. Regarding potential interferences and potential influences of human activities on measured PM_{10}, it is acknowledged that:

- Selected background sites may be influenced by anthropogenic emissions, not solely by dust events;
- The difference in altitude between the background site, and the site adjusted with the quantification derived from that background site will affect the accuracy of results (e.g., a higher altitude background site may record a larger influence of dust than urban stations, resulting in a correction which is too large for the urban site);[318]
- Meteorological conditions (stagnation, dispersive conditions, precipitation) can favour the accumulation or loss of PM_{10} and can affect many stations within a network at the same time;
- And that anthropogenic emissions can result in large spatio-temporal scale variations in measured PM_{10} concentrations (e.g., weekly traffic emissions *c.f.* weekends).[319]

Unfortunately, these factors have not been discussed for the deductions calculated and applied in 2020. The quantified influence of these factors has also not been presented or discussed. There is also no discussion of whether human action could prevent, or significantly reduce, the "identified contribution".

A9.5.2 The quantification of the natural contribution must be sufficiently precise

The contribution from the dust episode follows the methodology as set out in Section 4.1.2 of the Commission's natural source guidelines (SEC (2011) 208 final document). The values of the daily net African dust load were determined by calculating a 30-day moving 40th percentile of PM_{10} concentrations at the Spanish background sites (where the day calculated for is the in the 15th position), and all days identified as part of an African dust

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[314] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 18-19.

[315] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, page 6.

[316] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 14-17.

[317] Natural Particulate Matter Episodes 2020, pages 9-289.

[318] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 17.

[319] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 24.

episode have been excluded. This is then subtracted from the PM_{10} measured at a given station on a day it has been identified to be influenced by African dust by:

> *Natural contribution in the station of the zone = PM_{10} measured in the station - (Percentile 40 estimating background levels not attributed to the African dust outbreak)*[320]

The calculated deduction at each background site has been independently verified and found to be correct based on the data provided. The choice of the 40th percentile, as well as being recommended by the European Commission, was also justified against other possibilities in Section 2.2.1 of the 2013 methodology.[321] These concentrations are assumed to be best estimates, however for the latest reported year (2020), there is no discussion of any uncertainties in the quantification of the contribution of desert dust at any background site, or in the corrections applied to other measurement stations. There is some discussion in potential influence of artefacts from anthropogenic sources, but this has not been quantified for any year.

A9.5.3 The quantification of the natural contribution must be temporally consistent with the averaging period of the limit value considered

Table 31 shows that eight zones in Spain (across the mainland and Canary Islands) exceeded the daily PM_{10} limit value (40 µg m^{-3}) by more than 35 days in 2020, and three of these zones in the Canary Islands (Las Palmas de Gran Canaria, ES0501; Sur de Gran Canaria, ES0510; and Sur de Tenerife, ES0513) also exceeding the annual mean PM_{10} limit value (40 µg m^{-3}). Therefore, the contribution of natural sources should be quantified for both daily mean and annual mean concentrations.

Spain's PM_{10} data sheet for 2020 presents a spreadsheet of daily averaged PM_{10} values at the regional background sites in each Spanish assigned zone (rounded to the nearest integer), and net African dust contributions at the same time resolution.[322] A screenshot of this table is presented in the main 2020 dust report.[323] The data resulting from application of these quantifications to other monitoring stations within Spain has not been presented, but it is sensible to assume these will also be daily averages.

The annual mean deduction is stated to be calculated by averaging the daily mean concentrations pre- and post-application of the dust correction.[324] This approach is suggested in the Commission's guidelines,[325] however the lack of data presented means these cannot be independently verified.

A9.5.4 The quantification of the natural sources must be spatially described

In 2020, dust corrections reported to Dataflow G cover eight zones in Spain, across both the mainland and the Canary Islands. Corrections to the number of days exceeding the PM_{10} limit value occur in Zona Villanueva del Arzobispo (ES0128), Avilés (ES0307), Las Palmas de Gran Canaria (ES0501), Fuerteventura y Lanzarote (ES0504), La Palma, La Gomera y El Hierro (ES0508), Sur de Gran Canaria (ES0510), Sta. Cruz de Tenerife-S. Cristóbal de La Laguna (ES0511) and A Coruña + Área Metropolitana (ES1219). The PM_{10} annual mean value has been reported as adjusted in zones Las Palmas de Gran Canaria (ES0501), Sur de Gran Canaria (ES0510), Sur de Tenerife (ES0513) and A Coruña + Área Metropolitana (ES1219).

As described in Appendix Section A9.5.1, the "Natural Particulate Matter Episodes 2020" shows aggregated evidence for each episode declared across the two main geographic locations of Spanish territory: the Península y Baleares (Mainland and Balearic Islands) and Canarias (Canary Islands), respectively. Each episode for both regions include a summary of the conditions which led to the dust episode occurring (e.g., "…transport of air masses and mineral dust was due to the effect of the low pressure generated in subtropical latitudes over the African continent together with the high pressure over the N half of Algeria.").[326] This fairly course geographic division provides minimal analysis into the influence of each dust episode on a given zone, particularly within the large area of mainland Spain (in the Iberian Peninsula). Mapped model results and satellite images within each sub-section provide some indication of this detail, however this does not provide a straightforward reference when a specific zone is examined. From the level of detail provided, and the closer-

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[320] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 2.
[321] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 20-22.
[322] PM_{10} – Descuentos todas estaciones 2020 [Data].
[323] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 3.
[324] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 17.
[325] SEC (2011) 208 final document, page 13.
[326] Natural Particulate Matter Episodes 2020, page 123 [translated to English].

to-real-time assessment of dust events described in the 2013 methodology,[327] it is likely that dust events in each zone (assigned by Spain) are examined individually and not extrapolated.

The discrepancy between zones raised an issue in this assessment, as the zones used within the Spanish reports, to determine dust episodes in Spain, and the natural corrections declared to the European Commission do not match. During our assessment we created Table 33 (below) to allow comparison between the zones used in Spain's main 2020 dust report (and evidenced linked in it) and zones reported to European Commission. Due to the scales of the maps in the Spanish reports it is not possible to verify with 100% certainty that we have identified the correct Spanish assigned zone against each of the zone names. It would have been better for Spain to have acknowledged these zones within their reports, as the zones assigned by Spain cover a far greater area than those declared to the European Commission, there is a danger that exceedances identified for a Spanish assigned zone is not relevant for all Commission assigned zones (e.g., ES0501, ES0504, ES0508, ES0510, ES0511 and ES0513 are all within Spanish zone "Canarias").

In terms of the applied deductions, the PM_{10} data sheet for 2020[328] provides the quantified African dust load for every background site within each zone (assigned by Spain) for the dates stated in the "Natural Particulate Matter Episodes 2020" report. The evidence for stating the representativeness of these sites is detailed in Table 34 (Appendix Section A9.6). The main 2020 dust report provides evidence (via a screenshot) that background sites are specifically selected for each site where the contribution of dust has been deducted based on proximity and predominant winds.[329] A secondary background site has been selected if the primary option is missing data, or unsuitable for another reason. However, not all Commission zones are presented in this screenshot, and the justification for each site selection could not be found in any of the Spanish reports.

Quantifications for the subtraction of the contributions of African dust from one episode in 2020 was found within the "Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020" ("Spanish sea spray") report.[330] This states that alongside the sea spray deduction, the quantified contributions of 40 and 15 µg m^{-3} for Saharan dust were also subtracted on the 27^{th} and 28^{th} of February, respectively. Cross-checking this with the PM_{10} data sheet of regional background sites provided by Spain[331] shows that these calculated contributions were obtained from the "Noia" background site in the "noroeste" zone (northwest zone; assigned by Spain). The legend shows that Noia is within the A Coruña province, and the deducted site (Torre de Hércules) is within the metropolitan area of A Coruña.

From this evidence, it is likely that the dust contribution calculated at background sites are only applied to non-background sites where acceptable, and not unnecessarily extrapolated for simplicity. However, this cannot be completely concluded for deductions applied in 2020 (declared in Table 31; Appendix Section A9.2), as aside from zone A Coruña + Área Metropolitana (ES1219), this information has not been clearly provided by Spain.

Table 33 Zones where corrections were declared (Table 31) recognised by the European Commission with corresponding zones presented in the "Spanish adjustment of natural contribution of Saharan dust in PM_{10}" document.[332] Identified using a combination of Google Earth and 2013–2014 European Atlas of Spanish air quality zones.[333]

Zone ID	Zone name	Spanish assigned zone
ES0118	Granada y Area Metropolitana	Sureste (SE)
ES0119	Malaga y Costa del Sol	
ES0128	Zona Villanueva del Arzobispo	
ES0307	Avilés	Norte (N)
ES0501	Las Palmas de Gran Canaria	

[327] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 14-17.

[328] PM_{10} – Descuentos todas estaciones 2020 [Data].

[329] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 3.

[330] Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020, pages 22 and 36.

[331] PM_{10} – Descuentos todas estaciones 2020 [Data].

[332] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 1.

[333] Atlas of air quality zones and monitoring stations (2013 & 2014), Spain, DG Environment Report for the European Commission, https://ec.europa.eu/environment/air/pdf/quality_by_country/ES_AirQualityZones_Current_opt.pdf, last accessed 29^{th} April 2022.

Zone ID	Zone name	Spanish assigned zone
ES0504	Fuerteventura y Lanzarote	Canarias (Canary Islands)
ES0508	La Palma, La Gomera y El Hierro	
ES0510	Sur de Gran Canaria	
ES0511	Sta. Cruz de Tenerife-S. Cristóbal de La Laguna	
ES0513	Sur de Tenerife	
ES0705	Comarca de Puertollano	Centro (Central)
ES0906	Plana de Vic	Noreste (NE)
ES1219	A Coruña + Área Metropolitana	Noroeste (NW)

A9.5.5 The contributions must be demonstrated in a process of systematic assessment

According to Section 2.5 of the Commission's natural source guidelines (SEC (2011) 208 final document), the occurrence of a natural contribution should be visible in a systematic and continuous set of measurements. This can be in the form of temporal features or a distinct chemical signature.

The 2013 methodology document[334] referenced by Spain in their main 2020 dust report[335] meets all five required steps to identify dust episodes, and aggregated evidence is provided for each in the "Natural Particulate Matter Episodes 2020" report.[336] The method used has been validated in later sections of the 2013 methodology document, including via chemical analysis of "mineral matter" at two regional background stations and one suburban station in Spain, which showed good agreement to the 40th percentile methodology used.[337] This validation has been published in a peer reviewed journal.

A9.5.6 The quantification of the natural sources must be demonstrated for each pollutant separately

For this study, only the PM_{10} daily mean concentrations were assessed for a natural contribution, as this pollutant was the only one reporting exceedances.

A9.6 CRITICAL ASSESSMENT OF SAHARAN DUST METHOLOGY

A brief overview of the methodology that Spain has applied against the recommended methods in the Commission's natural source guidelines (SEC (2011) 208 final document) for identifying and quantifying Saharan dust contributions (Section 4.1.6) have been summarised in Table 34 below, in the form of a checklist. In Dataflow G Spain attached an overview report ("Spanish adjustment of natural contribution of Saharan dust in PM_{10}", hereafter referred to as the "main 2020 dust report"). Within the main 2020 dust report are links to other reports and spreadsheets which contain further evidence of how corrections have been applied in Spain. The evidence provided in the Spanish main 2020 dust report including further evidence in linked reports to meet each of the key principles set out in Section 2 of the Commission's guidelines have been compiled in the correspondingly named sub-sections of Appendix Section A9.5.

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[334] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 14-17.
[335] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, pages 1-5.
[336] Natural Particulate Matter Episodes 2020, pages 9-289.
[337] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 21-22.

Table 34 Summary of methodology provided by Spain for quantifying and subtracting a Saharan dust correction, against the Commission's natural source guidelines in the SEC (2011) 208 final document.

Content	2020 report	Assessment comments and recommendations
List of the regional background measuring stations used for the determination of the net dust load and information concerning representativeness of the stations	Yes	A map of regional background stations in Spain and Portugal are presented in Figure 7 of the 2013 methodology document.[338] Around half of these stations are part of the European Monitoring and Evaluation Program (EMEP), while the others are classified as regional background sites. Most of these sites are included in the linked Spanish PM_{10} data sheet (excluding Portuguese sites).[339] The discrepancies between the remaining sites are assumed to result from network changes since 2013 (e.g., site relocations, closure of old sites, commissioning of new sites). Representativeness of these background sites have not been discussed detail in the main 2020 dust report. It is stated in the main 2020 dust report that the choice of background station for each correction is based on the proximity and predominant winds.[340] By means of further explanation, the referenced 2013 methodology document details some limitations, such as assuming the representativeness of the reference station despite the influence differing altitudes will have on determined dust contributions, and the inevitable influence of urban emissions on rural sites. Spain have acknowledged that this could be improved by creating a specific measurement reference for each monitoring station, but this solution is unattainable due to cost.[341] It should be noted that there is a difference in location classification between the Commission's zone IDs (Table 31, Appendix Section A9.2) and the zones discussed in all of the Spanish reports which use geographic locations in Spain (Figure 8;[342] e.g., NW Peninsula, Canary Islands). Hence, we have had to create Table 33 (Appendix Section A9.5.4) to identify which background site is applicable to each zone ID. An example screenshot is provided in the main 2020 dust report,[343] showing which background sites were identified for use in adjusting PM_{10} concentrations at the non-background sites within each zone ID. However, only zones which do not include a correction in 2020 (ES0118 and ES0119) can be seen in this screenshot.

[338] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 18.
[339] Spain [Data]: PM_{10} – Discounts to all stations 2020.
[340] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 3.
[341] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 17.
[342] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 18
[343] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 3.

Content	2020 report	Assessment comments and recommendations
The tables of daily levels of PM_{10} registered at stations representing regional background	Yes	Daily concentrations of PM_{10} for all background sites are presented in the PM_{10} data sheet for 2020, divided by region (sheet) and site (column).[344]
The list of dates with the identification of African dust episodes	Yes	The "Natural Particulate Matter Episodes 2020" report is divided into sections chronologically by month. At the start of each section is a Table summarising the dates each zone (assigned by Spain) is affected by biomass combustion, European sulphates and African dust.[345] This information is also highlighted in orange for the corresponding days (rows) in the PM_{10} data sheet for 2020.[346] The dates provided in these two sources match for all regions presented.
The values of the daily net African dust load determined by means of the procedure presented in the working document	Yes	The methodology is outlined in Spain's main 2020 dust report,[347] and described in more detail in the 2013 methodology document.[348] The approach follows the Commission's guidelines, determining a 30-day moving 40th percentile for each background site, where the day calculated is the 15th of 30 days used. Daily values used are rounded to the nearest integer, and days with any identified dust influence are excluded. This percentile is then subtracted from the daily mean PM_{10} concentration on days affected by African dust. Further justification for this method has been provided in Section 2.2.1.[349] The 40th percentile was calculated for every day data was available in 2020. These values are used to net dust load on days identified to be affected by an episode, presented by Spanish assigned zone in the PM_{10} data sheet for 2020.[350]
The daily concentration levels before and after subtraction of the net dust load for all assessment points and areas	Partially – not enough information provided	While the net dust load is quantified and clear, it is unclear which site measurements have been adjusted using this data. Screenshots at the end of the Spanish main 2020 dust report suggests this step has been performed, and that data is available as a spreadsheet and a shape file.[351] However, this data for 2020 has not been presented, and as such cannot be validated. **We recommend that Spain could include this data for clarity, white also allowing the method to be more traceable.**

[344] PM_{10} – Descuentos todas estaciones 2020 [Data].
[345] Natural Particulate Matter Episodes 2020, pages 9, 34, 65, 94, 108, 134, 148, 182, 210, 237, 258 and 279.
[346] PM_{10} – Descuentos todas estaciones 2020 [Data].
[347] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 2.
[348] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, page 16.
[349] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 20-22.
[350] PM_{10} – Descuentos todas estaciones 2020 [Data].
[351] Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 4-5.

Content	2020 report	Assessment comments and recommendations
The annual concentration levels before and after subtraction of the net dust load for all assessment points and areas. The difference will yield the mean annual dust contribution from African dust.	Partially – not enough information provided	Annual mean concentrations have been reported before and after the dust correction has been applied in the Spanish “2020_v1” envelope on Dataflow G[352] (as baseline and final data, respectively), presented here in Table 31 (Appendix Section A9.2). However, it is not clear whether these reported concentrations are from the correction of a single site within the zone ID, or multiple. Similarly, the name and location of each individual adjusted site has not been presented. **We recommend that Spain use the zone assigned by the European Commission to present data and methods, otherwise the corrections applied are unclear. Alternatively, Spain could provide a guide to convert between the two types of zones (as we have derived in Table 33; Appendix Section A9.5.4) or clearly identified which measurement stations data has been reported to Dataflow G for each Commission-assigned zone.**
Uncertainty analysis	Partially – not enough information provided	Justification and drawbacks of using the 40th percentile approach to quantify and deduct dust contributions have been discussed in the 2013 methodology document.[353] Similarly, there is some discussion of how regional background sites used were selected, and limitations faced within the monitoring networks. There is no quantified uncertainty in the estimated dust loads calculated, and how accurate the new concentrations calculated might be. **We recommend that the report include discussion of potential sources of uncertainty, artefacts, and interference in the results Spain presented.**
Critical analysis of the applied methodological elements relevant in the reporting year, if appropriate.	No	The linked 2013 methodology document is extensive, providing an extensive discussion of the approach used, and the justification for decisions made. This includes some critical evaluation of the method. However, this has not been updated for the latest reported year (2020). **We recommend that Spain justify and critically discuss the method presented for the year 2020.**
References to the methodological reports/papers	Yes	Sections 2.2.1–2.5 of the 2013 methodology document provide additional justification for the methodology presented, including use of the 40th percentile (over 30th which was found more accurate in a previous study of Atlantic advection episodes), additional justification for the persistence of African dust episodes, other considerations, and further potential method application. These sections have been well referenced where appropriate.[354]

[352] ES Dataflow G 2020 Attainment: https://cdr.eionet.europa.eu/es/eu/aqd/g/envyxfmyq/ES_G_Attainment.xml/manage_document

[353] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 20-22.

[354] Spain: Procedure for the Identification of Natural Occurrences of PM_{10} and $PM_{2.5}$, 2013, pages 22-28.

Content	2020 report	Assessment comments and recommendations
		The Commission's natural source guidelines (SEC (2011) 208 final document) is also referenced.

A9.7 ASSESSMENT SUMMARY FOR SPAIN

Natural source corrections were identified in Spain in 2018, 2019 and 2020 from the information provided in Dataflow G. This includes nine days exceeding the daily PM_{10} limit value in 2020, six in 2018 and ten in 2019, as well as three exceedances of the annual mean in 2020 and one in 2019. Two different methodologies were assessed for 2020: the contribution of sea spray in zone A Coruña + Área Metropolitana (ES1219) using the "Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020"; and the contribution of African dust episodes in Zona Villanueva Del Arzobispo (ES0128), Avilés (ES0307), Las Palmas de Gran Canaria (ES0501), Fuerteventura y Lanzarote (ES0504), La Palma, La Gomera y El Hierro (ES0508), Sur de Gran Canaria (ES0510) and Sta. Cruz de Tenerife-S. Cristobal de La Laguna (ES0511), Sur de Tenerife (ES0513) and A Coruña + Área Metropolitana (ES1219) using the "Spanish adjustment of natural contribution of Saharan dust in PM_{10}" report and linked references therein.

Both corrections utilise well described methodologies which have been used in previous years. The methodologies both follow the relevant guidance outlined in the Commission's natural source guidelines in the SEC (2011) 208 final document, and present evidence for the year assessed (2020).

For the method used to determine the contribution of sea salt in zone A Coruña + Área Metropolitana (ES1219) in 2020, the Spanish sea spray report provides all necessary information required to assess the methodology used to deduct this natural contribution from measured PM_{10} concentrations at the Torre de Hércules suburban background site and validate relevant calculations. The additional deductions contributed by Saharan dust on 27th and 28th February 2020 (outlined in Appendix Section A9.5.4) can be traced to the Noia regional background station in A Coruña, where the deductions have been verified. Collectively, the data presented in the "Influence of marine aerosol on PM_{10} concentration in A Coruña in 2020" report was enough to validate the results reported to the Commission, presented in Table 31 (Appendix Section A9.2).

For the dust correction, the main 2020 dust report cites a more detailed methodology used by Spain and published in 2013 ("2013 methodology document"), stated to be approved by the Commission.[355] This provides a good overview of the methodology, but suffers from a lack of specific detail. The calculated dust contribution (40th percentile) at each regional background site has been independently verified in this assessment using the PM_{10} data sheet provided by Spain. However, the application of these dust contributions to other sites are not presented beyond a screenshot of the final data table.[356] This is likely a result of the quantity which would be provided (e.g., many sites adjusted across multiple zones), and as such the only dust deduction which can be verified for 2020 is for zone ES1219.

Discussions surrounding the uncertainty within presented results in 2020 could also be improved. The Spanish sea spray report methodology provides good discussion of sources of uncertainty in the laboratory-based measurement of Na^+ on filters, and precautions taken to avoid them. The 2013 methodology document referenced in the main 2020 dust report for the Saharan dust contribution outlines possible sources of uncertainty, particularly with respect to representativeness of sites, and justifies the 40th percentile calculation method used with peer-reviewed literature. However, this has not been updated for 2020. In both methodologies (main 2020 dust report and the 2013 methodology document) provided by Spain, more discussion is required on possible interferences to the quantified contributions, such as anthropogenic-sourced artefacts. For example, the contribution of winter salting to the quantification of sea spray. It may be the case that no road salting occurred near the measurement station, but that should be clearly stated. This is particularly important as the "adjustment type" (column L in DfG) has been misclassified as "winter sanding and salting".

Overall, Spain have provided good detail in their methods, anad follow the Commissions' guidelines well. The evidence provided is often sufficient, and for the contribution of sea spray, this is excellent. Dust episodes are well evidenced, but their coarse geographic separation and lack of discussion regarding how these episodes affect specific zones where corrections are reported (Table 31) mean this data cannot be fully verified. At a

355 Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 1.

356 Spanish adjustment of natural contribution of Saharan dust in PM_{10}, page 5.

minimum, an example calculation at one non-background site in the Spanish main 2020 dust report would provide the necessary evidence the required to verify the calculations.

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