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**establishing guidelines for the agreements on setting up common measuring stations for  
PM<sub>2,5</sub> under Directive 2008/50/EC on ambient air quality and cleaner air for Europe**

## Abstract

The EU Air Quality Directive 2008/50/EC requires that as a minimum one rural background station is installed every 100 000 km<sup>2</sup> for measuring PM<sub>2.5</sub> in order to get data on the total mass concentration and the chemical speciation. This minimum is larger than the total surface area of several Member States. The Directive further states that Member States shall set up at least one measuring station or may by agreement with adjoining Member States set up together one or several common measuring stations. This document provides guidance to Member States regarding the selection and implementation of these stations.

It is recommended to identify types of rural background areas relating to climatic and topographic conditions which can be considered to cover large parts of the Member State's territory. Existing stations or potential new sites can then be selected in such a way that a maximum percentage of the territory is covered. Subsequently agreement with neighbouring Member States on appropriate common stations should be sought.

Representativeness criteria for large-scale regions are discussed and it is recommended to restrict the representativeness of a site to areas in the same climatic-topographic regions with a maximum distance of about 200 km and a maximum difference in altitude of 500 metres.

EMEP stations can generally be expected to fulfil the criteria and may therefore be designated as common stations.

Member States are advised to draw up an agreement on their common stations which defines the characteristics of the stations and responsibilities for quality assurance maintenance and reporting. Each Member State involved must notify a common station to the Commission and declare which one is responsible for measurement quality assurance/quality control and reporting.

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## **1. INTRODUCTION**

### **1.1. General**

This document gives guidance on how to set up common air quality measuring stations for PM<sub>2.5</sub>. It is aimed at those responsible for developing a measuring network under Directive 2008/50/EC<sup>1</sup>.

### **1.2. Legal Provisions**

According to Article 6(5) of Directive 2008/50/EC, Member States shall operate measurement stations at rural background sites away from significant sources of air pollution for the purposes of providing, as a minimum, information on the total mass concentration and the chemical speciation concentrations of fine particulate matter (PM<sub>2.5</sub>) on an annual average basis [...] using the following criteria:

- (a) one sampling point shall be installed every 100 000 km<sup>2</sup>;
- (b) each Member State shall set up at least one measuring station or may, by agreement with adjoining Member States, set up one or several common measuring stations, covering the relevant neighbouring zones, to achieve the necessary spatial resolution;
- (c) where appropriate, monitoring shall be coordinated with the monitoring strategy and measurement programme of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

According to Article 28(3) of Directive 2008/50/EC, the Commission shall draw up guidelines for the agreements on setting up common measuring stations as referred to in Article 6(5).

### **1.3. Aim and scope**

The aim of this document is to support Member States in the selection and implementation of common rural background measuring stations for measuring total mass and chemical speciation of PM<sub>2.5</sub> as required under Article 28(3) of Directive 2008/50/EC.

Considerations will be given to the following items:

- the number of stations
- synergies with the EMEP monitoring programme
- responsibilities for data reporting
- the representativeness of stations.

Data from such stations are also expected to be included in the regular assessment under Directive 2008/50/EC; however this document does not provide any further guidance in relation to the regular assessment of PM<sub>2.5</sub> or the PM<sub>2.5</sub> average exposure indicator (AEI). The siting criteria of rural background measuring stations are different from the criteria for stations to assess compliance with the PM<sub>2.5</sub> limit value or for the determination of the AEI.

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<sup>1</sup> OJ L 152, 11.6.2008, p.1

## **2. METHODOLOGY**

### **2.1. Key principles**

The provisions Article 6(5) of Directive 2008/50/EC require a minimum of one rural background measuring station for PM<sub>2.5</sub> and its compounds per 100 000 km<sup>2</sup> of each Member State.

This document gives guidance on the general and technical issues to be considered when Member States wish to share measuring stations in order to fulfil the requirement of the minimum number of stations and on the practical implications like the reporting of data.

Additionally considerations about the representativeness of the measuring stations are provided. Since these are rural background stations they have to be located remote from major emission sources. The representativeness of rural background stations relates to the regional scale (large-scale) and is characterised by climatic and topographic conditions which influence the local dispersion conditions as well as large-scale transport.

As an additional criterion PM<sub>2.5</sub> background measuring stations operated under Article 6(5) of Directive 2008/50/EC should cover if possible different representative areas.

In many cases the respective representative areas (see Figure 1 and Figure 2 in Chapter 4) – related to the minimum number according to Article 6(5) – do not cover the total territory of the Member State. PM<sub>2.5</sub> background measuring stations have to be therefore selected in such a way that they measure the regional background concentrations representative for a portion of the territory and the population of the Member State that is as large as possible.

The following procedure is recommended:

1. calculate the required number of stations;
2. identify the large-scale representative areas covering the territory;
3. identify existing stations (e.g. EMEP sites) or potential new sites which fulfil the criteria for rural background stations – with the objective to maximize the number of different representative (i.e. climatic) areas covered and also to cover the maximum percentage of the Member State's territory;
4. find agreement with neighbouring Member States for appropriate common measuring stations.

The recommended methodology to determine the representative area for each measuring station is available in the report 'Representativeness and classification of air quality monitoring stations' (UMWELTBUNDESAMT 2007). The representative area should not extend farther than a distance of approximately 200 km in the same climatic area (see Section 4.4).

### **2.2. Common measuring stations for Directive 2004/107/EC**

Article 4(9) of Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons (PAH) in ambient air<sup>2</sup> states that Member States have to operate one rural background measuring station per 100 000 km<sup>2</sup> where concentration and deposition of heavy metals and PAHs are to be monitored. Article 4(9) allows Member States to install common measuring stations to achieve the appropriate spatial resolution.

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<sup>2</sup> OJ L 23, 26.1.2005, p.3

The siting criteria for such common measuring stations would make them suitable also as common PM<sub>2.5</sub> measuring stations according to Article 6(5) of Directive 2008/50/EC.

Based on the pilot assessment questionnaires on annual assessment under all four daughter directives<sup>3</sup> no common measuring stations for heavy metals and PAHs have been reported for the years up to 2007. The reporting under the Directive 2004/107/EC which has become mandatory from 2008 onwards indicates that at least one common background measuring station has been established and is in operation<sup>4</sup>.

### 3. CONSIDERATIONS FOR LOCATING COMMON PM<sub>2.5</sub> MEASURING STATIONS

#### 3.1. Minimum number of PM<sub>2.5</sub> measuring stations required per Member State

Table 1 lists the EU Member States together with their surface area and the minimum number of PM<sub>2.5</sub> background measuring stations according to Article 6(5) of Directive 2008/50/EC. '1–' means that mathematically less than 1 station is required and that one station might be shared with neighbouring countries. The '+' means that in order to achieve the spatial resolution at the EU scale in addition to the given number a 'common' measuring station with the neighbouring Member States is suggested.

*Table 1: Area of EC Member States and required minimum number of PM<sub>2.5</sub> background measuring stations*

Member State	Area (km <sup>2</sup> )	Number of background stations
Austria	83 870	1–
Belgium	30 528	1–
Bulgaria	110 910	1+
Cyprus <sup>1)</sup>	30 528	1–
Czech Republic	78 866	1–
Denmark	43 094 <sup>2)</sup>	1–
Estonia	45 226	1–
Finland	338 145	3+
France	547 030	5+
Germany	357 021	3+
Greece	131 940	1+
Hungary	93 030	1
Ireland	70 280	1–
Italy	301 230	3
Latvia	64 589	1–
Lithuania	65 300	1–
Luxembourg	2 586	1–
Malta	316	1–
Netherlands	41 526	1–
Poland	312 679	3+
Portugal	92 391	1
Romania	237 500	2+
Slovakia	48 845	1–

<sup>3</sup> Questionnaire under Decision 2004/461/EC modified to include pollutants regulated under 2004/107/EC.

<sup>4</sup> EoI code FI0096R shared by FI + SE measuring PAH.

Member State	Area (km <sup>2</sup> )	Number of background stations
Slovenia	20 273	1–
Spain	504 782	5
Sweden	449 964	4+
United Kingdom	244 820	2+

<sup>1)</sup> whole island

<sup>2)</sup> without Faeroe Islands

For the total EU area of 4 304 175 km<sup>2</sup> a minimum number of 43 PM<sub>2.5</sub> background measuring stations can be derived.

### 3.2. Common PM<sub>2.5</sub> background measuring stations

Member States may share one common PM<sub>2.5</sub> background measuring station under Article 6(5) if the following criterion is fulfilled:

- The sum of the number of PM<sub>2.5</sub> background measuring stations in these Member States corresponds to the sum of the areas covered by these Member States divided by 100 000 km<sup>2</sup>.

Article 6(5) does not explicitly state whether a Member State with an area of less than 100 000 km<sup>2</sup> may utilize exclusively common measuring stations in other countries but it would not be practical when very small Member States would have to operate a background PM<sub>2.5</sub> measuring station if representative stations for the small Member State exist in larger neighbouring countries.

On the other hand a larger Member State may utilize a common measuring station in addition to its own stations in order to increase the area covered by representative background PM<sub>2.5</sub> measuring stations.

### 3.3. Spatial coverage of PM<sub>2.5</sub> background measuring stations

When choosing the site of common PM<sub>2.5</sub> background measuring stations operated under Directive 2008/50/EC the following criteria should be considered:

- the representative area of the common PM<sub>2.5</sub> background measuring station – related to the climatic-topographic regions described in Section 4.3 – should cover significant parts of the territories of the Member States involved;
- the measuring stations should be representative for different climatic-topographic regions as outlined in Chapter 4;
- the measuring stations should match the criteria for the large-scale representativeness recommended in Section 4.4;
- in the case that the number of climatic-topographic regions within a Member State exceeds the required number of PM<sub>2.5</sub> background measuring stations, not only the size of the area but also the population covered by the representative area of the PM<sub>2.5</sub> background measuring stations may be a criterion for selecting certain sites;
- the siting criteria for EMEP measuring stations (see Section 4.1) should apply to common PM<sub>2.5</sub> background measuring stations.



- following Article 6(5)c existing EMEP stations may be used as common PM<sub>2.5</sub> measuring stations.

Annex A gives a few examples of possible common stations for small Member States. The common PM<sub>2.5</sub> measuring stations can be also used as rural background measuring station for arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons (see Section 2.2).

#### **4. REPRESENTATIVENESS OF RURAL BACKGROUND MEASURING STATIONS**

##### **4.1. Criteria for 'rural background'**

Article 6(5) requires measurements of PM<sub>2.5</sub> at 'rural background locations away from significant sources of air pollution' without giving detailed criteria for 'away from significant sources'. Annex III Part B Point 1 d of Directive 2008/50/EC however gives criteria for the siting of rural background stations: these must be located at a minimum distance of 5 km from agglomerations and industrial areas. This criterion must in any case apply for PM<sub>2.5</sub> background stations according to Annex IV of the Directive.

Similar criteria apply for rural background stations operated according to Article 4(9) of Directive 2004/107/EC; these are specified in Annex III Part I of the Directive.

Article 6(5)c of Directive 2008/50/EC refers also to EMEP sites. EMEP sites should per definition be representative of large rural areas. Relating to the EMEP model with a spatial resolution of 50 km the area of representativeness of EMEP sites should roughly cover a model grid cell. Criteria regarding the representativeness of EMEP sites are given in Chapter 2 'Siting criteria' of the EMEP Manual for Sampling and Chemical Analysis<sup>5</sup> (NILU 2001):

'The station chosen for sampling and measurements should be representative of a larger area. The size of this area is determined by the variability of the air and precipitation quality and the desired spatial resolution in the concentration and deposition fields. Urban and industrial areas and the areas immediately outside such areas are not to be included [...]

When the major part of the emissions influencing the air quality in an area are situated outside that area selection of the station involves mainly consideration of the effects of the immediate surroundings and emissions within the nearest 20 km. These local emissions should not be allowed to result in unrepresentative measured air concentrations or precipitation chemistry at the site [...]. In addition consideration of local meteorological conditions such as prevailing wind directions and formation of stagnant air should be considered.'

Annex B discusses the spatial coverage of examples of EMEP stations.

Article 6(5)a of Directive 2008/50/EC requires one sampling point per 100 000 km<sup>2</sup>. It gives no provisions on the representative area of these measuring sites but it can be concluded that the representative area of these PM<sub>2.5</sub> background measuring sites should cover an area of approximately 100 000 km<sup>2</sup> as far as this is possible with respect to the representativeness criteria outlined below.

<sup>5</sup>

<http://www.nilu.no/projects/CCC/manual/>

## 4.2. Criteria for representativeness

A concept for the 'representativeness of air quality monitoring stations' – also taking the EMEP siting criteria (NILU 2001) into account – has been developed in a study funded by the European Commission (UMWELTBUNDESAMT 2007<sup>6</sup>).

In this concept the definition of the representative area comprises the following criteria:

- the concentration is within a certain range related to the respective measuring station;
- the area of representativeness is delimited according to large-scale topographic and climatic regions as well as different types of topographic areas on a small-scale (e.g. plain valley mountain);
- all sites in the representative area are affected to a similar extent by similar emission sources – however emissions have to be 'low' for the common PM<sub>2.5</sub> measuring stations<sup>7</sup>;
- the area of representativeness is under average European conditions not much larger than an area with a radius of approximately 100 km around the measuring station<sup>8</sup>.

Up to now the spatial coverage of PM<sub>2.5</sub> data has been insufficient to assess any representativeness of PM<sub>2.5</sub> measuring stations according to UMWELTBUNDESAMT (2007). The spatial distribution of PM<sub>2.5</sub> can be assumed to be similar but spatially somewhat smoother compared to PM<sub>10</sub>.

## 4.3. Large-scale representative regions

A basic criterion for the assessment of representativeness is the large-scale climatic-topographic regions. These climatic-topographic regions have been proposed in UMWELTBUNDESAMT (2007) in the framework of the service contract to the European Commission mentioned above.

The underlying concept is that the representative area of an air quality measuring station shall – amongst other criteria – cover areas with similar dispersion conditions for which different spatial scales are considered:

- street scale – building structure: relevant only for traffic related sites;
- local scale covering a vicinity of some to 10 kilometres – differentiating e.g. plane valley basin mountains;
- regional scale covering a vicinity of about 100 km – differentiating climatic-topographic regions with different types of landscape and climate.

These regions are delimited according to topographic and climatic features and differ according to the conditions listed in the following table.

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<sup>6</sup> [http://www.umweltbundesamt.at/publikationen/publikationssuche/publikationsdetail/?&pub\\_id=1684](http://www.umweltbundesamt.at/publikationen/publikationssuche/publikationsdetail/?&pub_id=1684)

<sup>7</sup> For details see UMWELTBUNDESAMT (2007).

<sup>8</sup> This criterion is based on average wind speeds and the residence time of air pollutants in the atmosphere related to the average transport distance of air masses over 12 hours; this time scale itself is related to the chemical conversion processes of NO<sub>2</sub> secondary inorganic aerosols or ozone. This transport distance is about 100 km in central Europe higher in oceanic climate in western and northern Europe and smaller in southern or south-eastern Europe.

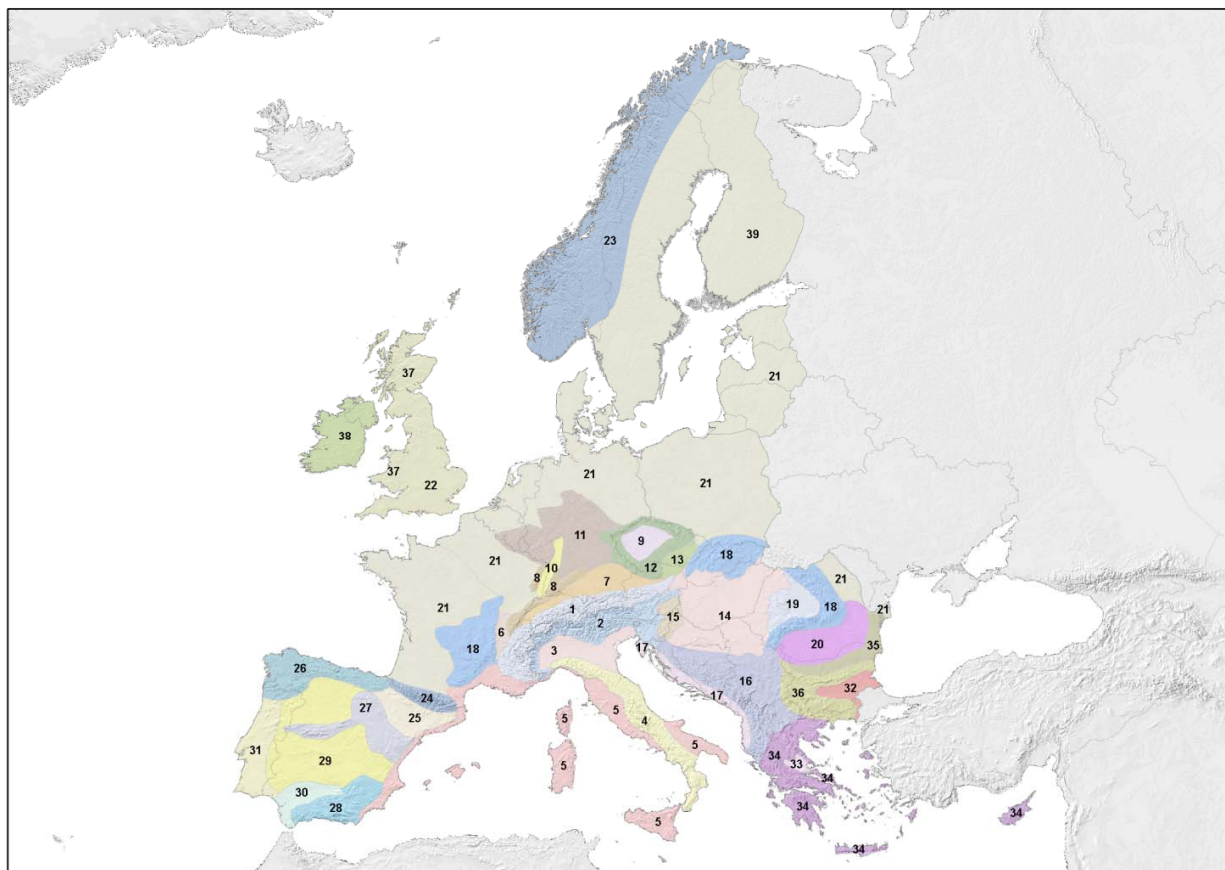
Table 2: *Influence of dispersion conditions on air quality*

Dispersion condition	Influence
Local dispersion conditions	E.g. adverse dispersion conditions south-east of the Alps favourable dispersion conditions in plains of western Central Europe
Exposure to oceanic or continental air masses	E.g. Po Valley shaded from oceanic air masses northern Central Europe exposed to oceanic air masses
Local variability of concentrations	E.g. high variability in mountainous areas low variability in large-scale plains

The delimitation of these areas is not based on clear quantitative criteria owing to several reasons:

- experts in the field of dispersion modelling as well as geography could not provide information about the 'quantification' of dispersion conditions depending on large-scale topography;
- it turned out that fairly simple criteria for a quantitative distinction of different types of topography cannot be applied within a geographical information system.

Therefore the climatic-topographic regions are delimited according to 'obvious' geographic and climatic criteria as shown in Figure 1. The main criteria applied in this figure are elevation/topography and origin of air masses. E.g. mountain chains and mountainous areas are distinguished and in addition mountain chains are divided and coastlines are separated depending on the main origin of air masses.



- |    |   |    |   |
|----|---|----|---|
| 1  | <i>Alps north or west of the main chain exposed to oceanic air masses</i>   | 17 | <i>the eastern Adriatic coast</i>                         |
| 2  | <i>Alps south or east of the main chain shaded from oceanic air masses</i>  | 18 | <i>the Carpathians</i>                                    |
| 3  | <i>the Po Valley</i>  | 19 | <i>Transylvania</i>                                       |
| 4  | <i>the Apennines</i>  | 20 | <i>Walachia</i>   |
| 5  | <i>the western Mediterranean Coast</i>  | 21 | <i>the western and northern Central European Lowlands</i> |
| 6  | <i>the Rhone-Saone Valley</i>   | 22 | <i>the flat and hilly parts of England</i>                |
| 7  | <i>the northern alpine foothills (Alpenvorland, Schweizer Mittelland)</i>   | 23 | <i>the Scandinavian mountains</i>                         |
| 8  | <i>Lower mountain ranges north of the Alps: Jura, Vosges, Schwarzwald (Black Forest), Schwäbische Alb (Swabian mountains)</i> | 24 | <i>the Pyrenees</i>                                       |
| 9  | <i>Bohemian basin</i>   | 25 | <i>the Ebro Basin</i>                                     |
| 10 | <i>the Upper Rhine Valley (Oberrheingraben)</i>   | 26 | <i>the Cantabrian Mountains</i>                           |
| 11 | <i>Deutsches Mittelgebirge (Central German Uplands)</i>   | 27 | <i>the central Iberian mountains</i>                      |
| 12 | <i>Bohemian Massif (Böhmerwald, Erzgebirge, Sudeten, Böhmischo-Mährische Schwelle, Mühl- and Waldviertel)</i>                 | 28 | <i>the southern Iberian mountains</i>                     |
| 13 | <i>the north-eastern Austrian lowlands (Weinviertel) and Moravia</i>  | 29 | <i>the central Iberian planes</i>                         |
| 14 | <i>the Pannonian Plain</i>  | 30 | <i>the Guadalquivir basin</i>                             |
| 15 | <i>the south-eastern pre-alpine foothills (Austria, Slovenia, Croatia)</i>  | 31 | <i>the Portuguese coast</i>                               |
| 16 | <i>the Dinaric Alps</i>   | 32 | <i>the Maritza basin</i>                                  |
|    |   | 33 | <i>the Thessalian plain</i>                               |
|    |   | 34 | <i>the south-east European mountains</i>                  |
|    |   | 35 | <i>the uplands between the Balkans and the Danube</i>     |
|    |   | 36 | <i>the Balkan and Rhodope mountains</i>                   |
|    |   | 37 | <i>the mountainous parts of the UK</i>                    |
|    |   | 38 | <i>Ireland</i>  |
|    |   | 39 | <i>the low and hilly parts of Scandinavia</i>             |

*Figure 1 Proposed delimitation of large-scale topographic/climatic regions in Europe<sup>9</sup>*

<sup>9</sup>

Figure designed by Umweltbundesamt based on large-scale geographic features.

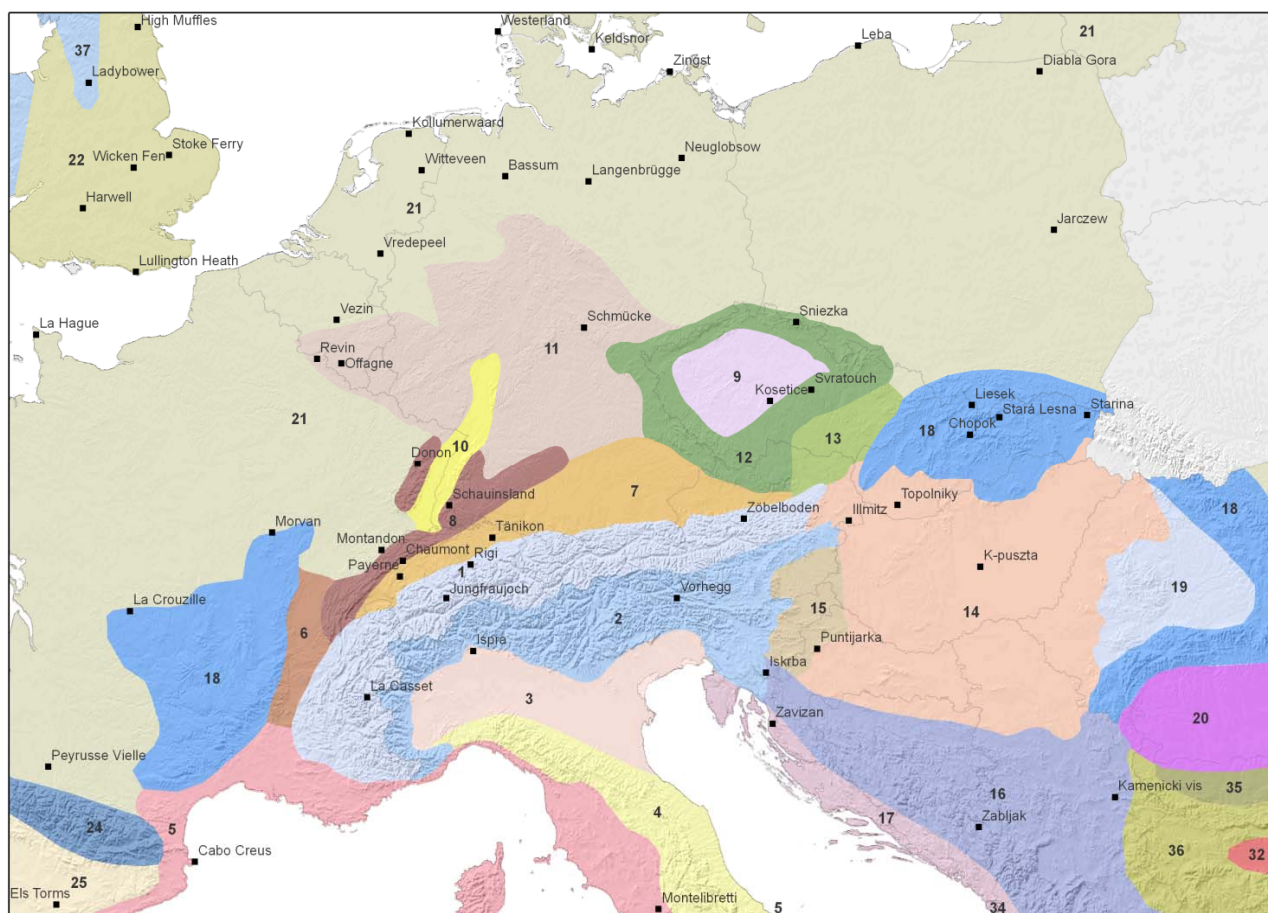


Figure 2: Proposed delimitation of large-scale topographic/climatic regions in central Europe and EMEP sites with PM measurements (for the legend see Figure 1)

#### 4.4. Recommended criteria for the large-scale representativeness of PM background measuring stations

Based on the analysis and discussion of (a) representative areas of PM<sub>10</sub> monitoring stations (UMWELTBUNDESAMT 2007) and (b) siting of EMEP PM<sub>10</sub> measuring stations (see Figure 2) the following minimum criteria for the representativeness of PM<sub>2.5</sub> background measuring stations are recommended:

- The station and the area to be represented should be in the same climatic-topographic region.
- Maximum distance between the station and the area to be represented should be about 200 km (this would correspond to about 125 000 km<sup>2</sup> in case of a circular representative area). However the area of representativeness can also be smaller.

## 5. ADMINISTRATIVE ASPECTS

### 5.1. Agreement between Member States

It is recommended that Member States that share a common measuring station draw up an agreement which should cover the following points:

- the location of the measuring station

- an estimation of the coverage of the representativeness area in each of the Member States
- the compounds to be analysed to characterize the chemical composition of PM<sub>2.5</sub> and related data quality objectives
- the duration of the agreement
- the institution(s) responsible for sampling measurement chemical analysis and quality assurance including type approval and any demonstration of equivalence where necessary
- the institution responsible for reporting to the European Commission and the EEA
- procedures for reporting and exchange of measuring data recorded at the common station between the Member States.

## **5.2. Information and Reporting**

### *5.2.1. Information for the European Commission and the EEA*

The Member States having agreed on the operation of a common PM<sub>2.5</sub> background measuring station under Article 6(5) of Directive 2008/50/EC shall inform the European Environment Agency and the European Commission on the following main points:

- the Member States involved in the agreement
- the location of the representative area of the common measuring station and the size of the territory and population covered in each Member State
- the institution(s) responsible for reporting on the common measuring station
- the name – and if already available EoI code – of the measuring station
- the time period for which the common measuring station is designated
- the sampling and measurement method for PM<sub>2.5</sub>
- the list of compounds<sup>10</sup> to be analysed to characterize the chemical composition of PM<sub>2.5</sub> including documentation of analytical techniques and quality assurance.

The initial information is necessary to ensure clear interpretation of the provisions of the Directive for all Member States involved. All further modifications such as upgrading of the analytical techniques etc. are subsequently provided through the regular reporting by the Member State in which the common station is located.

### *5.2.2. Reporting*

Under the EU legislation only the Member State in which the common station is located should report the measurement data including meta-information about the station and the measurement configuration. Standard reporting dataflows (currently annual assessment questionnaire and Exchange of Information mechanism) are to be used.

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<sup>10</sup> According to Annex IV of Directive 2008/50/EC the chemical analysis shall at least cover sulphate nitrate ammonium elemental carbon organic carbon Na<sup>+</sup> Ca<sup>2+</sup> K<sup>+</sup> Mg<sup>2+</sup> and Cl<sup>-</sup>.

All Member States involved in the agreement should however include the station in the description of their assessment regime (station identification in Form 3 and if appropriate a comment in relevant Form 16 of the current assessment questionnaire based on 2004/461/EC decision).

## **6. REFERENCES**

NILU (2001): EMEP Manual for Sampling and Chemical Analysis. EMEP/CCC Report 1/95 Revision November 2001. Norwegian Institute for Air Research.

UMWELTBUNDESAMT (2007): Spangl W. Schneider J. Moosmann L. & Nagl C.: Representativeness and classification of air quality monitoring stations – final report. Service contract to the European Commission – DG Environment Contract No. 07.0402/2005/419392/MAR/C1. Reports Bd. REP-0121. Umweltbundesamt Wien.

YTTRI K.-E.; AAS W.; TARRASON. L. ET AL. (2007): Transboundary particulate matter in Europe – Status report 2007. Joint CCC & MSC-W Report. Norwegian Institute for Air Research Kjeller Norway. <http://www.nilu.no/projects/ccc/reports.html>.



## **ANNEX**

### **ANNEX A: COMMON MEASURING STATIONS FOR SMALL COUNTRIES**

Section 3.2 describes considerations for common PM<sub>2.5</sub> background stations intended especially for small countries. Here a few examples of possible common stations for small Member States are given.

Luxembourg could well utilize a background measuring station in Belgium, France or Germany.

Malta could use – if available – a background measuring station in the coastal area of (southern) Sicily.

If Cyprus could use a background station in Greece, a site in the south-eastern Aegean e.g. in Rhodes or Crete may be appropriate. Such option should be thoroughly analysed with respect to the large-scale distribution of PM<sub>2.5</sub> concentrations and chemical composition in the eastern Mediterranean Sea. A station at Cyprus could still be preferential to cover different objectives including validation of local modelling or identification of natural contributions.

## **ANNEX B: DISCUSSION OF THE SPATIAL COVERAGE OF EMEP SITES**

The PM<sub>2.5</sub> EMEP measuring network shows quite different spatial distributions in each country (see Figure 2 in Chapter 4.3). The three Austrian EMEP sites are distributed across different large-scale geographical units the Pannonian Plain the Northern and the Southern Alps. In the Czech Republic both EMEP sites are located in a quite a central position Svratouch (737 m) in the Bohemian Massif and the allocation of Kosetice to either the Bohemian Massif or the central Bohemian Basin is open to discussion. In Slovakia four sites are crowded together in the mountainous north-eastern part at quite different altitudes and site types. Switzerland operates five EMEP sites at different locations. Hungary which covers most of the Pannonian Plain operates the site K-Puszt in the centre of the country.

There seems to be a general tendency to locate EMEP sites at higher altitudes which corresponds to the requirement of low emission densities in the vicinity of EMEP sites a criterion which can more easily be met in mountainous areas.

Considering the large-scale geographical units with different topographic and climatic conditions, as shown in Figure 2, the EMEP sites are not at all equally distributed across these regions. The Alps – north and south – are covered by EMEP sites in Austria and Switzerland but not in France and Italy. The Bohemian Massif is covered by EMEP stations in the Czech Republic and in Poland. The region 'Jura Vosges Schwarzwald Alb' hosts four EMEP sites (Montandon, Donon, Chaumont, Schauinsland) in three countries.

On the other hand there are no EMEP sites e.g. in the region 'Weinviertel and Moravia' and in the Upper Rhine Valley and there are no EMEP sites in the Northern alpine foothills in Austria and Germany but there are two stations in Switzerland.

The EMEP site Ispra is seen as representative of hilly terrain in the transition area between the Po Valley and the Southern Alps. But it should be kept in mind that the station is not there because of the representativeness (or remoteness) of this site but because of the presence of the Joint Research Centre in Ispra.

More information on the spatial distribution of the EMEP measuring sites and the implications can be found in the EMEP PM Status Report (YTTRI et al. 2007).

As discussed in Section 4.3 and in UMWELTBUNDESAMT (2007) the representativeness of measuring stations is of course not confined by national borders but rather by climatic and topographic conditions.

For example the representative area of Illmitz covers not only parts of eastern Austria but parts of Hungary and Slovakia as well. On the other hand Illmitz is representative of only a small part of the national territory of Austria (about 5%) and definitely not of mountainous areas.

Similarly the EMEP sites in northern Slovakia are also very likely to be representative of the Carpathian Mountains in Poland but not of the Pannonian area.

Schauinsland is assumed to be representative of the Vosges mountains in France and the Jura mountains in Switzerland but not of the Upper Rhine plain.