

Development of technical Guides on source apportionment with Receptor and Source oriented and Models

European Guide on Air Pollution Source Apportionment (SA) for estimating Particulate Matter (PM) source contributions
with Source oriented Models (SMs) and combined use of SMs and Receptor Models (RMs)

Mihaela Mircea, Giuseppe Calori, Guido Pirovano, Claudio Belis,



FAIRMODE ROAD MAP 2017-2019

The future activities of the WG3 will focus on the following aspects:

-Develop comprehensive guidelines for RM and CTM approaches on the basis on the inter-comparison exercise and other scientific evidence.

-Promote the integration between RM and CTM in order to take advantages of the strengths of both approaches.

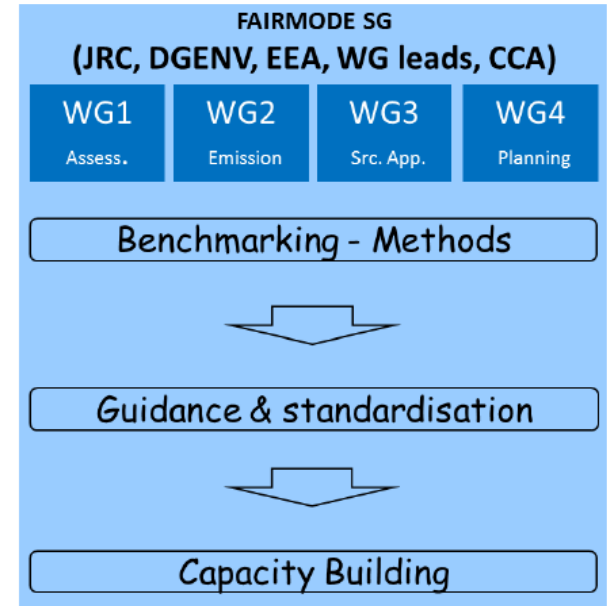
- Develop methodologies to support the evaluation o CTM models, with a particular focus on spatial issues.

- Support to the e-Reporting process (built-in SHERPA report facility)

- Support pilot regions/cities in their source-apportionment estimates (first stage of an air quality plan)

- Perform training activities to disseminate harmonized best practices

- Interact with CEN to take advantage of synergies and contribute to standardization



Scope and aims



In the beginning there was the Law...

The AQD states and demand:

...to **identify** and **quantify** the **contributions** from main pollution sources with the purpose to provide understanding on what **measures** should be taken to address them.

...to identify the main **causes** that determine concentrations to raise above the AQD limit values (e.g. because of site-specific dispersion characteristics, adverse climatic conditions or transboundary contributions,...)

...to provide information on **concentrations** and **sources** and the evidence demonstrating that the exceedances are attributable to **natural sources**.

Why using receptor models (RMs) and source oriented models (SMs) for SA?



Because there is not a «unique recipe» for everything!

IDENTIFYING SOURCES...

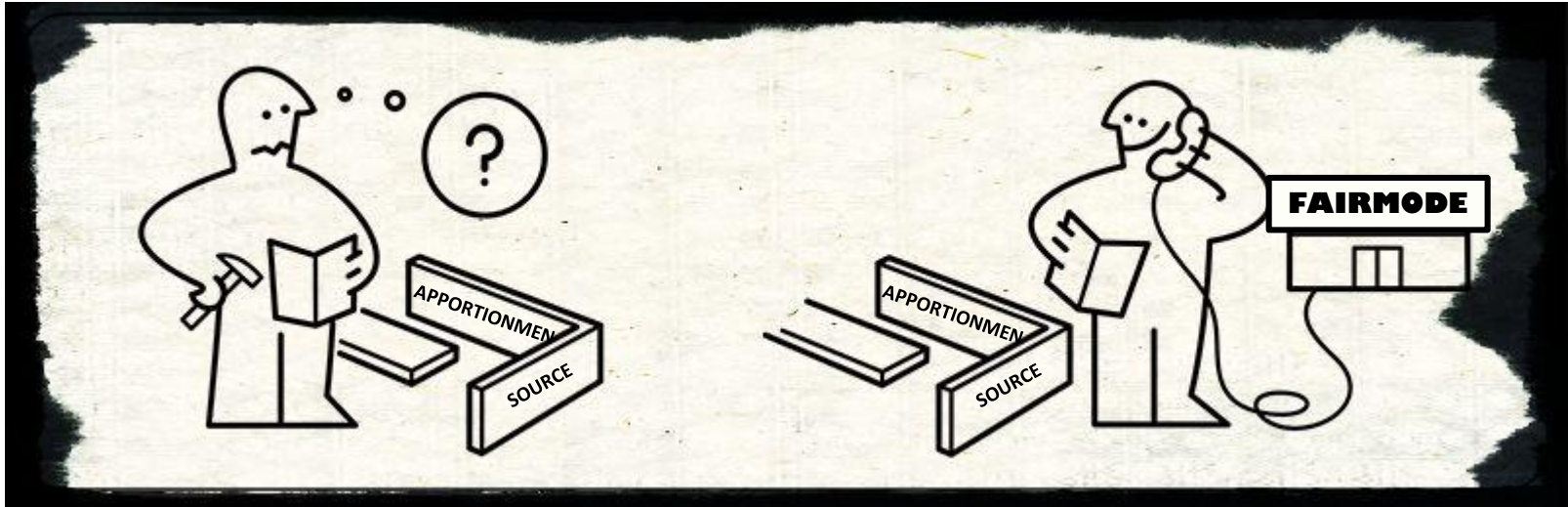
QUANTIFYING SOURCES...

NATURAL SOURCES...

EFFECTIVENESS OF EMISSION REDUCTION...

TRANSBOUNDARY POLLUTION...

What are we selling you?



This is a (draft)
«Instructions manual»
that gives you some advices on...

**«HOW TO IMPLEMENT A SOURCE
APPORTIONMENT METHOD»**

What we are NOT selling you!

This document can help you



«TO ASSEMBLE THE
WARDROBE»

«BUT NOT TO DECIDE
WHERE TO PLACE IT»

Table of contents

1. Introduction

2. Estimation of source contributions with SM approaches

3. Combined use of SMs and RMs

4. Intercomparison between SMs and between SMs and RMs

References

Appendix 1: Applications of SMs and SMs-RMs for estimating particulate matter source contributions in Europe

Introduction

1.1 Scope and aims

1.2 Target audience

1.3 Why using receptor models (RMs) and source oriented models (SMs) for SA

1.4 Techniques for SA using RMs

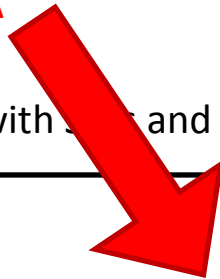
1.5 Source oriented air quality models

1.6 SM approaches for SA

1.7 European SA studies with RMs and with SMs-RMs: survey results

**SENSITIVITY ANALYSIS
(EMISSION REDUCTION
POTENTIAL)**

TAGGING METHODS



Estimation of source contributions with SM approaches

2.1 Modelling and validation of PM - base case of SM approaches

2.2 Sensitivity analysis methods

2.3 Tagged species methods

SHORT RECAP OF MAIN STEPS IN MODELLING SETUP

SOME PRACTICAL HINTS ON SENSITIVITY AND TAGGING METHODS

Combined use of SMs and RMs

3.1 Source categories association and species/compound association for PM validation

3.2 Comparison of source contributions from SMs and RMs



**EMISSION PROFILES (SMs) AND
EMISSION SOURCE PROFILES (RMs)**



BRIEF LITERATURE REVIEW

**LINK BETWEEN FACTORS IN RMs AND
SOURCE CATEGORIES IN SMs**

LOCAL SCALE MODELS

ORGANIC AEROSOL

**SOURCE APPORTIONMENT
&
PLANNING**

NATURAL SOURCES?

“VALIDATION” OF SA RESULTS?

MERGING OF RM AND SM?



European Guide on Air Pollution Source Apportionment with Receptor Models REVISION 2019

REVISION COMMITTEE

Olivier Favez (editor), Claudio A. Belis (chair and co-editor), Mihaela Mircea, Evangelia Diapouli, Manousos-Ioannis Manousakas, Stergios Vratolis, Stefania Gilardoni, Marco Paglione, Stefano Decesari, Grisa Mocnik, Dennis Mooibroek, Pedro Salvador, Satoshi Takahama

INERIS, JRC, ENEA, NCSR-DEMOKRITOS, CNR-ISAC, Josef Stefan Institute (JSI), TNO, CIEMAT



in collaboration with



Current version (2014)

PART A: INTRODUCTION TO SOURCE APPORTIONMENT WITH RECEPTOR MODELS	13
PART B: HARMONISED RECEPTOR MODEL PROTOCOL	21
B1. PRELIMINARY EVALUATION OF THE STUDY AREA	21
B2. DEFINING A METHODOLOGICAL FRAMEWORK	23
B3. EXPERIMENT DESIGN - CRITERIA FOR SITE AND SPECIES SELECTION AND ESTIMATION OF MINIMUM NUMBER OF SAMPLES	25
B4. DATA COLLECTION / FIELD WORK / CHEMICAL ANALYSIS	31
B5. KNOWING YOUR DATASET: BASIC STATISTICS	35
B6. PRELIMINARY DATA QUALITY CHECKS	39
B7. INPUT DATA UNCERTAINTY CALCULATION	43
B8. CHEMICAL MASS BALANCE MODELS	47
B9. FACTOR ANALYSIS I: SELECTION OF THE NUMBER OF FACTORS AND DEALING WITH ROTATIONAL AMBIGUITY (PMF)	51
B10. FACTOR ANALYSIS II: EVALUATION OF SOURCE CONTRIBUTION ESTIMATION AND MODEL PERFORMANCE INDICATORS	55
B11. FACTOR ANALYSIS III: CRITERIA FOR FACTOR ASSIGNMENT	59
B12. TESTS FOR MODEL PERFORMANCE VALIDATION	61
B13. REPORTING RESULTS AND METHODOLOGY	65
PART C: ADVANCED MODELS	67
C1. WIND AND TRAJECTORY ANALYSIS IN SOURCE APPORTIONMENT	67
C2. THE USE OF PMF and ME-2 IN AEROSOL MASS SPECTROMETER DATA PROCESSING	71
C3. THE AETHALOMETER MODEL	75
C4. APPORTIONMENT OF THE PM CARBONACEOUS FRACTION: RADIOCARBON AND TRACER ANALYSIS	79
C5. CONSTRAINED AND EXPANDED MODELS IN FACTOR ANALYSIS	85



Guide on RMs used world-wide!

- Cited 42 times in scientific literature
- Used in policy documents

Asian city air quality improvement
Guide frame

Guidance Area 2: Source List and Model Simulation

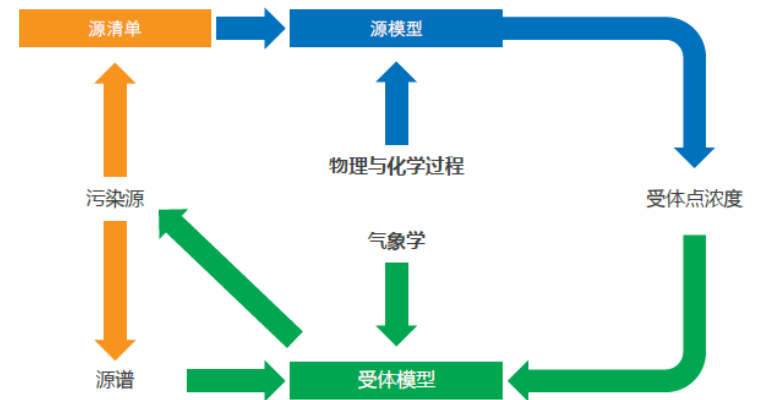
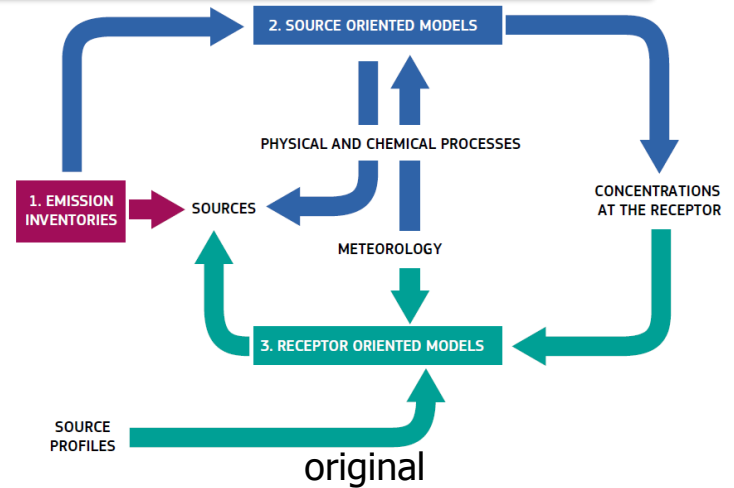


图 3.1 源解析由上至下方法与由下至上方法关联的示意图

图片引自欧盟委员会, 2013.

Source parsing The top-down method is associated with the bottom-up method. Image taken from the European Commission



REVISED VERSION 2019

INTRODUCTION TO SOURCE APPORTIONMENT WITH RECEPTOR MODELS	17
1. PRELIMINARY EVALUATION OF THE STUDY AREA	28
2. DEFINING A METHODOLOGICAL FRAMEWORK	32
3. EXPERIMENT DESIGN - CRITERIA FOR SITE AND SPECIES SELECTION AND ESTIMATION OF MINIMUM NUMBER OF SAMPLES	34
4. DATA COLLECTION / FIELD WORK / CHEMICAL ANALYSIS	43
5. KNOWING YOUR DATASET: BASIC STATISTICS	49
6. PRELIMINARY DATA QUALITY CHECKS	55
7. INPUT DATA UNCERTAINTY CALCULATION	61
8. CHEMICAL MASS BALANCE MODELS	65
9. FACTOR ANALYSIS I: SELECTION OF THE NUMBER OF FACTORS AND DEALING WITH ROTATIONAL AMBIGUITY (PMF)	70
10. FACTOR ANALYSIS II: EVALUATION OF SOURCE CONTRIBUTION ESTIMATION AND MODEL PERFORMANCE INDICATORS	76
11. FACTOR ANALYSIS III: CRITERIA FOR FACTOR ASSIGNMENT	81
⇒ 12. FACTOR ANALYSIS IV: CONSTRAINED AND EXPANDED MODELS	83
⇒ 13. FACTOR ANALYSIS V: DATA PROCESSING OF IN SITU THERMO-DESORPTION ELECTRON IMPACT AEROSOL MASS SPECTROMETRY	89
⇒ 14. AETHALOMETER MODELS	101
⇒ 15. RADIOCARBON AND TRACER ANALYSIS FOR THE APPORTIONMENT OF THE PM CARBONACEOUS FRACTION	109
⇒ 16. PROTON-NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY FOR THE SOURCE APPORTIONMENT OF WATER SOLUBLE ORGANIC CARBON	116
⇒ 17. SOURCE APPORTIONMENT BY FOURRIER-TRANSFORM INFRARED (FTIR) ANALYSIS	121
⇒ 18. WIND AND TRAJECTORY ANALYSIS IN SOURCE APPORTIONMENT	128
19. TESTS FOR MODEL PERFORMANCE VALIDATION	156
20. REPORTING RESULTS AND METHODOLOGY	168

MAIN CHANGES

	VERSION 2014	VERSION 2019
PAGES	88	174
SECTIONS	3 - Introduction - Harmonised protocol - Advanced methods	No sections The advanced methods are now common practice
CHAPTERS	18	20
		6 chapters about advanced methods were thoroughly revised and reordered 2 new chapters: Proton nuclear magnetic resonance and fourrier transformed infrared (FTIR) techniques

OPEN REVIEW

The drafts can be downloaded here:

<http://source-apportionment.jrc.ec.europa.eu/downloads.aspx>

The drafts are now open for comments mainly by the WG3 experts until end of February (remarks from all experts are welcome)

Considering the novelty and cross-cutting nature of the topic, the draft guide (handbook) on SM will be then open for comments from all FAIRMODE experts for a longer time and the final draft will be discussed in the next Fairmode technical meeting



The screenshot shows the homepage of the Source Apportionment website. At the top, there is a navigation bar with the European Commission logo and the text 'JOINT RESEARCH CENTRE Source Apportionment'. Below this, a breadcrumb trail reads 'European Commission > EU Science Hub > SA'. The main heading is 'Source Apportionment'. A horizontal menu contains 'Dashboard', 'About this site', 'Forgot password', and 'Register'. The main content area is divided into several sections: 'The source apportionment' with an image of industrial sites; 'SPECIEUROPE Database' with a red background and a download icon; 'Download documents' with a green background and a download icon, which is highlighted by a red arrow; 'News and updates' with a green background and a snippet of a report; 'DeltaSA' with a yellow background and a description of an online tool; 'Contact us' with a blue background and an envelope icon; 'Workshops' with a blue background and a group of people icon; and 'Links' with an orange background and a list of links including 'DG Environment', 'Global database on SA', and 'FAIRMODE'. A 'Joint Research Centre' logo is visible in the bottom right corner.