

Long Term Aerosol Composition Measurements at the CESAR Tower at Cabauw, NL

Patrick Schlag



Energie & Umwelt/
Energy & Environment
Band/ Volume 25 1
ISBN 978-3-95806-037-1

Forschungszentrum Jülich GmbH
Institut für Energie- und Klimaforschung
Troposphäre (IEK-8)

Long Term Aerosol Composition Measurements at the CESAR Tower at Cabauw, NL

Patrick Schlag

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment

Band / Volume 251

ISSN 1866-1793

ISBN 978-3-95806-037-1

Contents

1. Introduction	1
2. Experimental section	9
2.1. The Aerosol Mass Spectrometer	10
2.1.1. Quantification with the AMS	13
2.1.1.1. Mass concentration measurement and ionization efficiency calibration	16
2.1.1.2. AMS fragmentation table	18
2.1.1.3. Particle size measurement and calibration	18
2.1.1.4. Elemental analysis of HR-ToF-AMS data	19
2.1.1.5. Inorganic and organic nitrate fractions	20
2.1.1.6. Aerosol ion balance	21
2.2. The Aerosol Chemical Speciation Monitor	21
2.2.1. Quantification with the ACSM	24
2.2.1.1. ACSM fragmentation table	26
2.2.1.2. Aerosol ion balance	28
2.3. The TD-PTR-ToF-MS	28
2.3.1. TD-PTR-ToF-MS data treatment	31
2.3.1.1. Elemental analysis of TD-PTR-MS data	34
2.4. Measurement site: Cabauw, NL	34
2.4.1. The Cabauw Experimental Site for Atmospheric Research (CESAR) tower	35
2.4.1.1. Supplementary instruments at the CESAR tower	38
2.4.2. Experimental set-ups of the HR-ToF-AMS at the CESAR tower	38
2.4.2.1. November 2011	38
2.4.2.2. May to July 2012	39
2.4.3. Experimental set-up of the TD-PTR-MS at the CESAR tower	40
2.4.4. Experimental set-up of the ACSM at the CESAR tower	40
2.5. Statistical methods of organic aerosol data analysis	40
2.5.1. Application of PMF to AMS data	44

Contents

2.5.2.	Application of PMF/ME-2 to ACSM data	45
2.5.3.	Application of PMF to TD-PTR-ToF-MS data	46
3.	Observations	49
3.1.	AMS Campaign 2011	49
3.1.1.	Meteorological conditions and aerosol composition as observed with the AMS	49
3.1.1.1.	Inorganic and organic nitrate fractions	56
3.1.1.2.	Aerosol ion balance and Excess-NH ₄	57
3.1.1.3.	Chemical size distribution	59
3.1.2.	Comparison of measurements of total PM ₁ mass	60
3.1.3.	Comparison of organic aerosol mass measurements	62
3.2.	AMS Campaign 2012	65
3.2.1.	Meteorological conditions and aerosol composition as observed with the AMS	65
3.2.1.1.	Inorganic and organic nitrate fractions	70
3.2.1.2.	Aerosol ion balance and Excess-NH ₄	71
3.2.1.3.	Chemical size distribution	73
3.2.2.	Comparison of measurements of total PM ₁ mass	73
3.2.3.	Comparison of inorganic aerosol mass	75
3.2.4.	Comparison of organic aerosol mass measurements	77
3.3.	ACSM campaign 2012-2013	79
3.3.0.1.	Aerosol ion balance	84
3.3.1.	Comparison of measurements of total PM ₁ mass	85
3.3.2.	Comparison of inorganic aerosol mass	87
3.3.3.	Comparison of measurements of PM ₁ chemical contribution	89
4.	Discussion	93
4.1.	Analysis of organic aerosol	93
4.1.1.	PMF results for AMS data in 2011	93
4.1.2.	PMF results for AMS data in 2012	97
4.1.3.	PMF results for TD-PTR-MS data	102
4.1.3.1.	Campaign 2011	103
4.1.3.2.	Campaign 2012	107
4.1.4.	Factor analysis of ACSM data	112
4.1.5.	Summary and conclusions from organic aerosol analysis	120
4.2.	Aerosol composition during specific periods	124
4.2.1.	High mass periods	124

4.2.2. Precipitation events	127
4.3. Organic nitrates	130
4.4. Excess ammonium	131
5. Summary and Outlook	137
A. Appendix	171
A.1. AMS calibration results and data analysis: November 2011	171
A.1.1. Calibration results	171
A.1.2. Data analysis	172
A.2. AMS calibration results and data analysis: May to July 2012	174
A.2.1. Calibration results	174
A.2.2. Data analysis	175
A.3. Detection limits of the AMS and the ACSM	177
A.4. TD-PTR-MS data analysis	178
A.5. Observations	206
A.5.1. Campaign 2011	206
A.5.2. Campaign 2012	210
A.5.3. ACSM campaign 2012 - 2013	214
A.5.4. PMF results for AMS data in 2011	219
A.5.5. PMF results for AMS data in 2012	221
A.5.6. PMF results for TD-PTR-MS data 2011	224
A.5.7. PMF results for TD-PTR-MS data 2012	225
A.5.8. PMF/ME2 results for ACSM data 2012 - 2013	226
A.5.9. Aerosol composition during special events	227

**Energie & Umwelt /
Energy & Environment
Band / Volume 251
ISBN 978-3-95806-037-1**

