The Impact of Select Pollutant Sources on Air Quality for Ostrava and the Moravian-Silesian Metropolitan Region by the Positive Matrix Factorization model

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ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV

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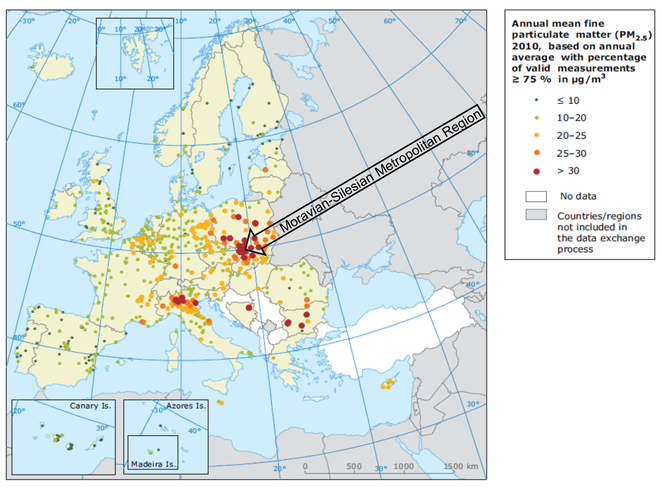
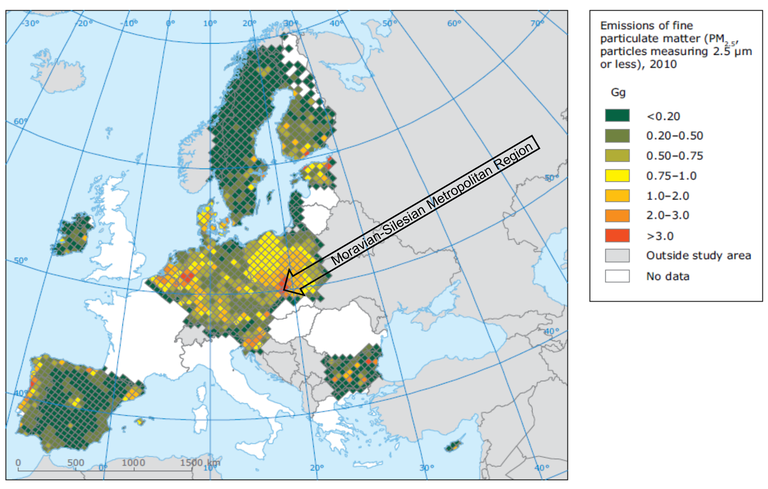
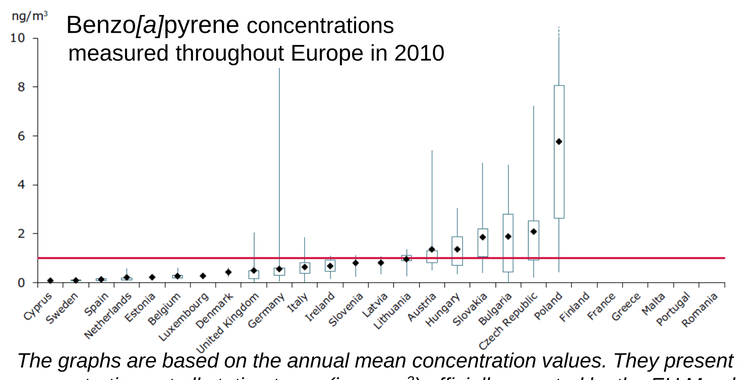
EPA United States Environmental Protection Agency

Area of Interest

The Ostrava region of the Moravian-Silesia metropolitan area of the Czech Republic represents one of the most highly industrialized areas in Eastern Europe with a large number of coke oven plants, blast furnaces, steel plants, and rolling mills being present. Ostrava is the third largest city in the Czech Republic containing 214 km^2 and with the country's third largest population (app. 300K). This equates to a population density of about 1400 inhabitants/km^2. Its documented history dates back to the period of the 13th century. The discovery of high quality black coal in the mid 1700's and its access to four major river systems established the future direction of the area with respect to its industrial development. The primary metropolitan area is bordered by the Beskydy and Jeseniky mountain ranges. The presence of the large number of coal-related industries in addition to geographical conditions often results in weather-related pollution inversions which have a serious impact on local air quality. The region is connected with the Silesian voivodship in Poland, which has among the highest levels of air pollution from particulate matter and benzo*[a]*pyrene in Europe.







The graphs are based on the annual mean concentration values. They present the range of concentrations at all station types (in ng.m^{-3}) officially reported by the EU Member States and how the concentrations relate to the target value set by EU legislation (marked by the red line). The diagram indicates the lowest and highest observations, the means and the lower and upper quartiles. The lower quartile splits the lowest 25 % of the data and the upper quartile splits the highest 25 % of the data. Based on a minimum of 15 % data coverage.

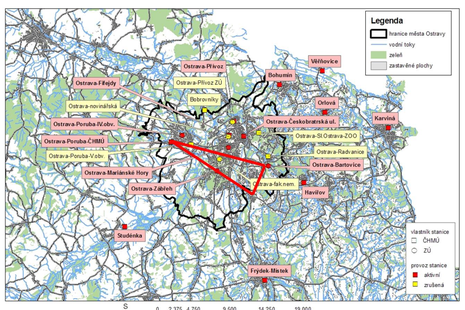
Source of pictures:
Air quality in Europe - 2012 report. EEA Technical report 4/2012. European Environmental Agency, Copenhagen, 2012. ISBN: 978-92-9213-328-3, http://www.eea.europa.eu/publications/air-quality-in-europe-2012.
European Union emission inventory report 1990–2010 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). EEA Technical report 8/2012. European Environmental Agency, Copenhagen, 2012. ISBN 978-92-9213-321-4, http://www.eea.europa.eu/publications/eu-emission-inventory-report-1990-2010.

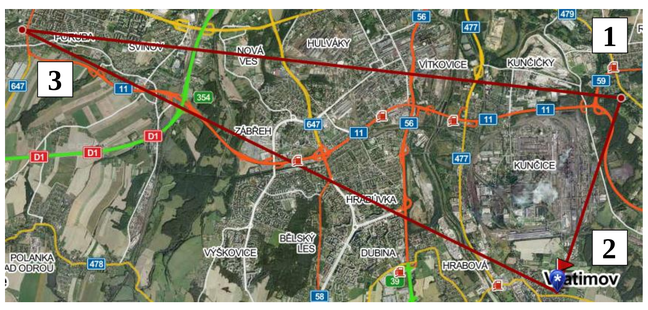
Sampling

The Czech Hydrometeorological Institute (CHMI) worked collaboratively with the U.S. Environmental Protection Agency (EPA) to design a source apportionment study to determine the impact of regional as well as local sources on overall air quality for Ostrava and the Moravian-Silesian Metropolitan Region.

Daily **12-hr day-night samples** were collected of fine particulate matter (**$PM_{2.5}$**) for elemental speciation, semi-volatile organic compounds (**SVOCs**), polycyclic aromatic hydrocarbons (**PAHs**) and organic and elemental carbon (**OC/EC**). **Pollutant gases** and **meteorology** were monitored for approximately a seven week period during the **late spring/early summer** and the **late fall/early winter** of 2012. Sampling was conducted at **three primary monitoring locations**: site #1 Ostrava-Radvanice - industrial suburban, downwind of prevailing winds from large industrial source; site #2 Vratimov - residential area upwind of prevailing winds from the same large industrial source, site #3 Ostrava-Poruba - background suburban in residential area. The distance between sites #1 and 2 is app. 4,4 km, #1-3 and #2-3 is app. 13 km. All the locations are highly polluted by PM and PAHs.

QA/QC were guaranteed: use of reference and equivalent methods, sampling and analysis in compliance with ČSN EN ISO/IEC 17025:2005, interlaboratory comparisons, manufacturer and field blanks, duplicate sampling.



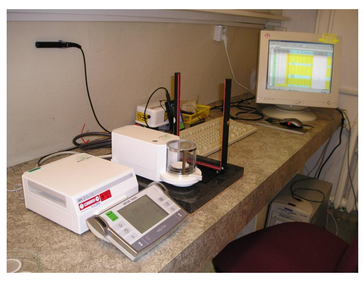


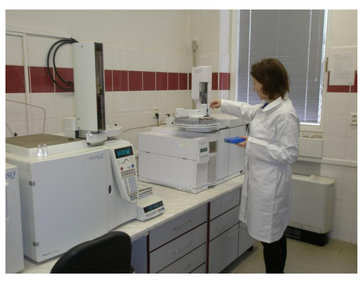
Results of Analysis

The results of analysis show the following:

- Large **difference between day and night** concentrations in terms of concentrations and content as well.
- Typically **higher concentrations during the fall/early winter** sampling period.
- Strong **dependence of concentrations on wind speed and direction.**
- **The dominance of most of the species at the site #1 Ostrava-Radvanice** compared to the other two sites. Some particular concentrations are many times higher, especially during the fall/early winter sampling season.
- The **most regional nature of species like black carbon and sulfur.**

Average concentrations	$PM_{2.5}$	PM_{10}	OC	EC	B*[a]*P	Ca	Cl	Cr	Fe	K	Mn	Na	Pb	Rb	S	Se	Si	Ti	SO_2	NO_X	benzene	toluene
	[µg.m^{-3}]				[ng.m^{-3}]														[µg.m^{-3}]			
Late spring/early summer																						
#1 Radvanice	17	33	5.3	0.7	2.2	131	142	2.2	805	320	29	166	34	2.4	1145	2.0	218	4.7	7.5	17	1.2	1.3
#2 Vratimov	16	27	4.8	0.5	0.9	86	31	1.3	296	146	12	104	16	1.3	1153	1.8	227	5.1	6.2	15	0.6	0.7
#3 Poruba	15	20	4.9	0.5	0.4	56	18	0.9	132	90	5.7	75	10	0.8	949	2.0	177	3.8	3.4	-	-	-
Late fall/early winter																						
#1 Radvanice	49	70	18	2.1	12	206	1512	7.9	2780	681	104	255	80	4.0	1532	2.0	181	3.3	18	46	5.7	4.8
#2 Vratimov	40	49	17	1.6	6.9	50	697	1.5	345	325	14	126	22	1.4	1321	2.1	116	2.7	12	38	3.2	2.5
#3 Poruba	35	43	13	1.6	6.1	62	608	1.2	147	290	6.9	113	18	1.1	1297	1.5	160	2.5	3.9	-	-	-

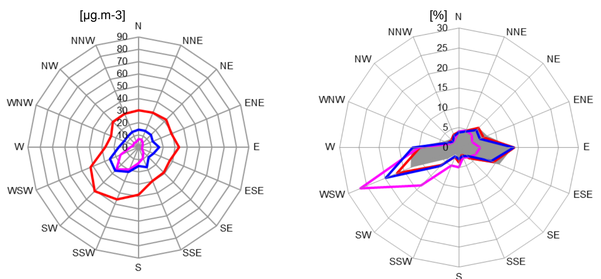




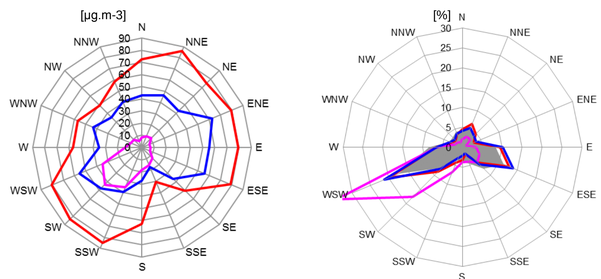
Average concentrations [µg.m^{-3}] and concentration load [%] in dependence on wind direction

#1 Radvanice

Late spring/early summer

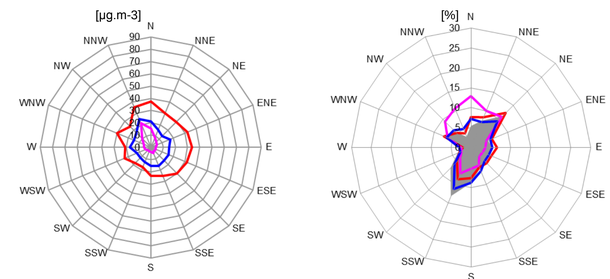


Late fall/early winter

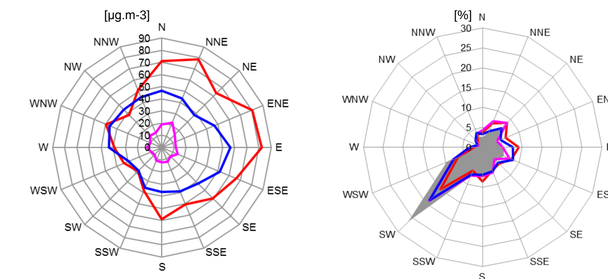


#2 Vratimov

Late spring/early summer

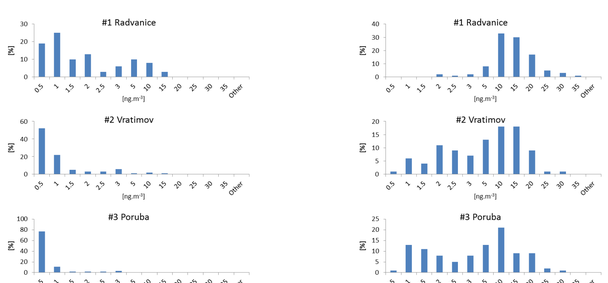


Late fall/early winter

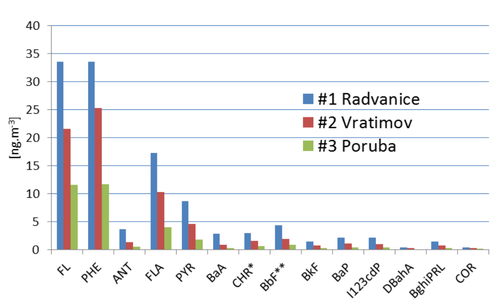


wind rose PM10 SO2 NOx

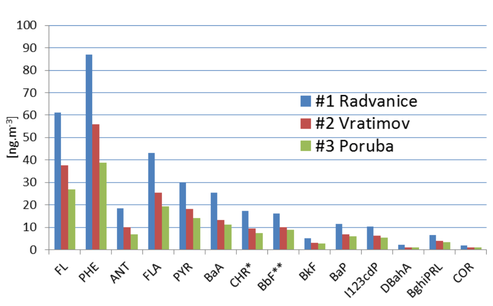
Benzo*[a]*pyrene
Frequency [%] of 12-hr concentrations [ng.m^{-3}]
Late spring/early summer Late fall/early winter



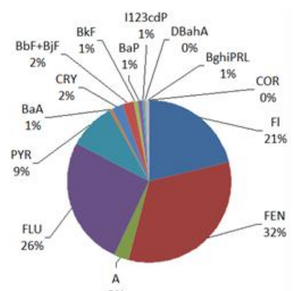
PAHs
Average concentrations [ng.m^{-3}]
Late spring/early summer

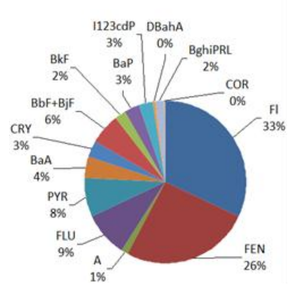


Late fall/early winter

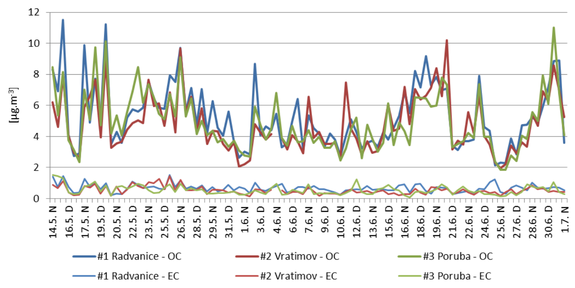


PAHs, #1 Radvanice, 27. 5. 2012
Day: PM2,5 = 15,26 µg.m^{-3} PAHs = 44,4 ng.m^{-3} **Night:** PM2,5 = 19,58 µg.m^{-3} PAHs = 191,2 ng.m^{-3}

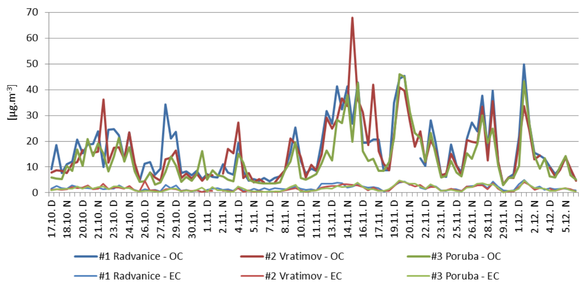




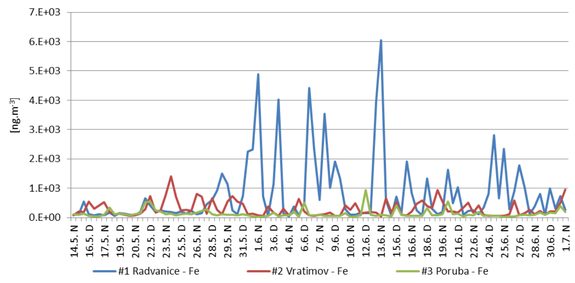
OC/EC
12-hr concentrations [µg.m^{-3}]
Late spring/early summer



Late fall/early winter



Iron
12-hr concentrations [ng.m^{-3}]
Late spring/early summer



Late fall/early winter