Redust

First year demonstration tests – test results 2011

Content

- Demonstration tests – test results 2011
  - Action 1.2 Dust binding
  - Action 1.3 Street cleaning
  - Action 1.1 Traction control
    - Traction sanding material tests
    - Studded tyre tests
  - Emission factors based on the upwind-downwind measurements (Action 2)
  - Street specific emissions as Sniffer emissions on city routes (Action 2)
- Summary of the 2011 demonstration test results

Action 1.2: Dust Binding Practices

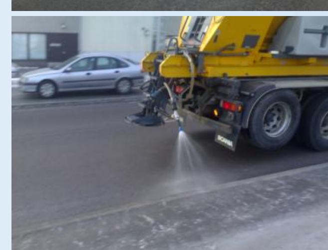
Demonstration test results 2011

Dust binding demonstration tests 2011 – 13-15 April 2011

- The general aim of the dust binding tests of REDUST is to demonstrate the PM_{10} reduction potential of dust binding equipment. Finnish cities use mainly $CaCl_2$ (10%-mass concentration) as the dust binder therefore it was used in the REDUST 2011 demonstration tests.
- The specific aim of the demonstration tests in 2011 was to test the effect of two dust binder dispersion systems:
  - to the whole area of the street surface
  - specifically to kerbside and between the lanes, which are expected to be areas of high dust load and potentially high PM_{10} emissions
- In 2011 the timing of the tests was chosen to be beginning of April, before other demonstration tests, since that is the common timing of such operations in the urban street networks in Finland
- The demonstration tests were conducted 13-15 April 2011

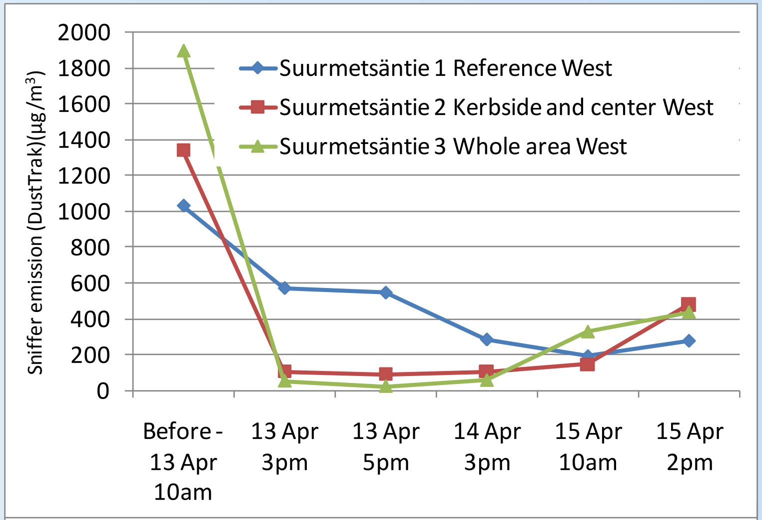
Dust binder spreading system

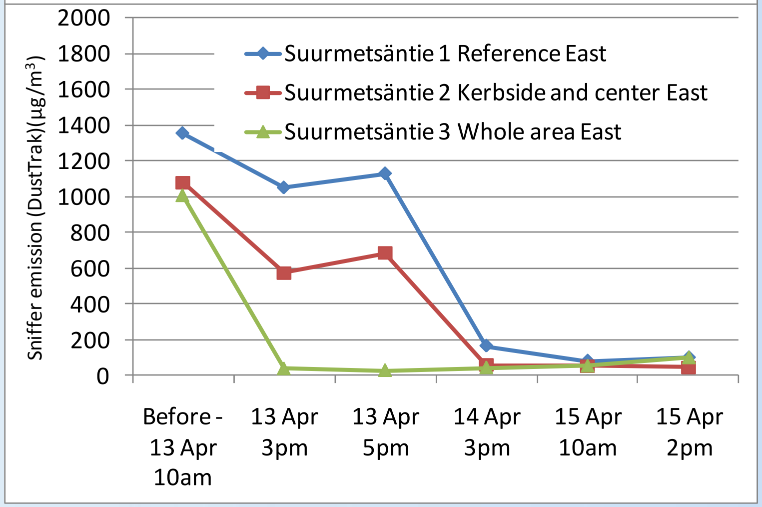
- The upper figure shows the dust binder spreading system of the city of Helsinki used in 2011 demonstration tests. The spreading system of the city of Helsinki is attached to the front of the truck (the tank for the binder solution is in the back – not visible in the figure). The spreading system is equipped with two high pressure nozzles that can be adjusted to spread the binder either to the sides of the vehicle or to the whole area.
- Center figure shows a street section on Vanha Porvoontie where the binder has been spread to the kerbside and the center of the lane. Cities of Espoo and Vantaa have designed their own systems, which have the spreading system in the back of the vehicle but they use the same principle (two lowest figures)
- The operation practices depend very much on the situation, e.g. location and street surface conditions at the time of the operation. In principle if the dispersant starts to flow out of the surface then the amount is too much. Approximate amounts:
  - 10-volume-% $CaCl_2$-solution
  - A typical truck can take up 8 m^3 of solution. The driver can adjust both the flow and pressure. The typical working pressure is 1.5 kpm/cm^2.
  - Spreading amount is approx. 20-30g/m^2 when there is no dust or dirt layer on the surface to suck up a dispersant but can be up to 100g/m^2 in street surface conditions with significant dirt layer that sucks up the dispersant



Sniffer emissions - DustTrak concentrations

- Suurmetsäntie: Both driving directions, east and west, experienced a significant decrease in average PM10 emissions of the reference stretch between 13 and 14 April, presumably due to moisture migrated from the washed streets nearby.
- Therefore only the test results of 13 April (especially eastbound) were considered valid for the evaluation of the dust binding effect





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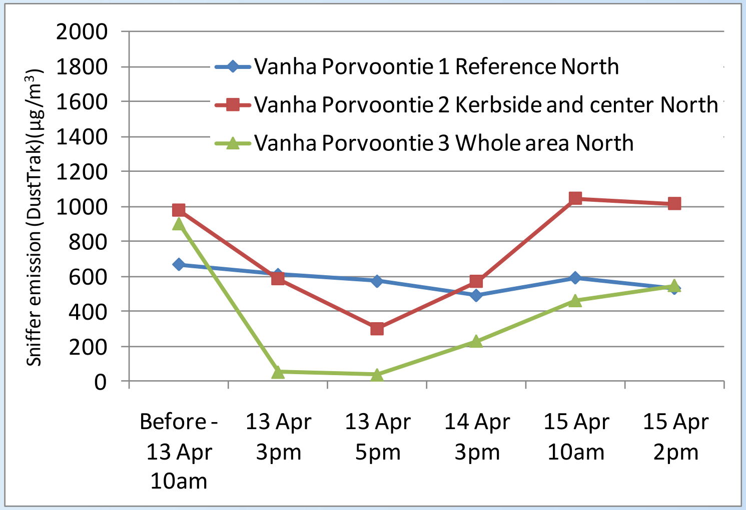
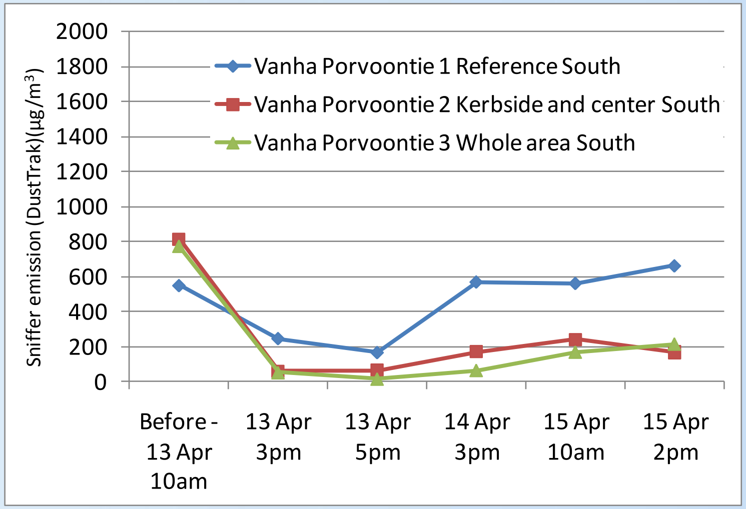
Sniffer-emissions - DustTrak concentrations

- Northbound: This is considered the most demonstrative demonstration dataset of the 2011 dust binding tests
- Southbound: Visual inspection on the measurement day indicated that the test sections 2 and 3 were wet throughout the measurements due to meltwaters from street side snow piles. Therefore this material was not used for estimating the effect of dust binding. However, the results from this section demonstrate well the dust binding effect of water and moisture when present on the surface.





Dust binding – reduction potentials

Summary of data sources used for estimating the reduction potential of dust binding in 2011

- Vanha Porvoontie northbound: whole dataset
- Suurmetsäntie eastbound: only 13 April results were considered valid
- Results from the other street sections were considered to be influenced by external factors such as meltwaters of streetside snow piles and moisture from washing of nearby streets (see figure)

Figure. Meltwaters from streetside snow on Vanha Porvoontie 13 April 2011

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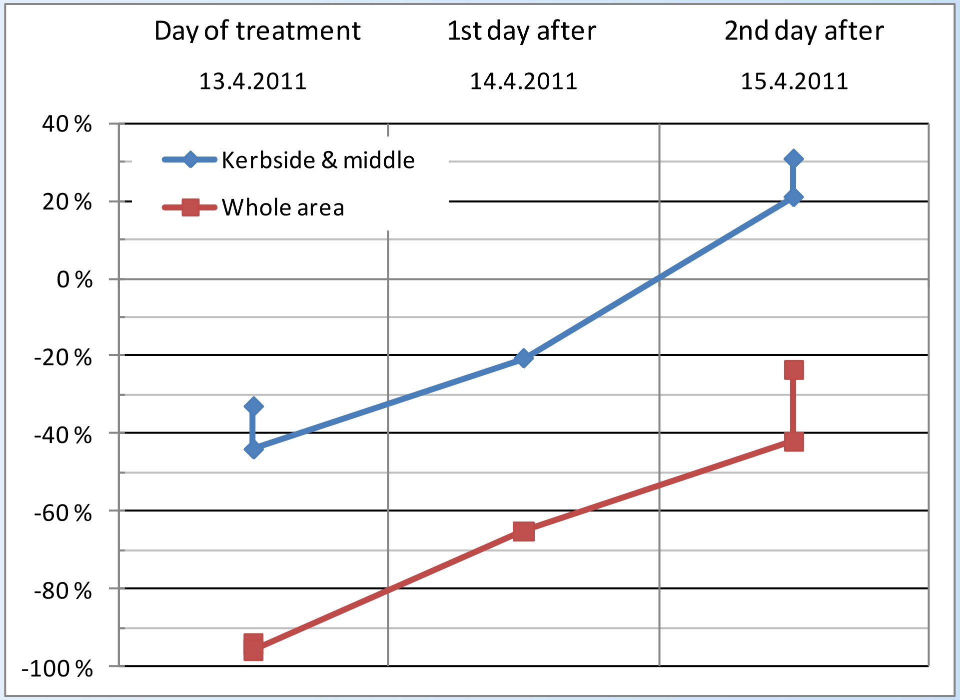
Reduction potential of dust binding – average reductions in the 2011 tests

- Figure shows the average reductions/changes relative to the reference
- Both treatments reduced the PM10 street surface emissions
- The treatment that dispersed kerbside and between the lanes did not bring as large reductions to PM10 emission levels than the system that dispersed the binder to the whole area of the street surface
- Relative humidity (RH) during the tests was between 50% and 77%



Dust binding tests 2011- reduction potentials, concluding remarks

- The tests demonstrated that both dispersion systems bring benefits for reducing street surface PM10 emissions
- The reductions with the system that dispersed the binder to kerbside and between the lanes did not bring as large reductions to PM10 emission levels and the effect was shorter-lived than that of the system that dispersed the binder to the whole area of the street surface. However, in these tests both systems used a binding solution with the same concentration, whereas the system that disperses the binder to kerbside and between the lanes could in theory use a more concentrated solution. This will be tested in demonstrations in the future. Additionally the system that disperses the binder to kerbside and between the lanes may bring savings in the amounts of binder needed.
- The system that dispersed the binder to the whole area of the street surface showed following reduction potentials:
  - On the day of treatment: PM10 emission reduction of 90% or more
  - 1.day after the treatment: 60% reduction
  - 2.day after the treatment: 30% reduction
  - 3.day after the treatment: no effect
- The system that dispersed the binder to kerbside and between the lanes showed following reduction potentials:
  - On the day of treatment: PM10 emission reduction of 40%
  - 1.day after the treatment: 20% reduction
  - 2.day after the treatment: no effect

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Action 1.3: Street Cleaning Practices

Demonstration test results 2011

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Street cleaning tests 18-21 April 2011 - results

- The general aim of the street cleaning demonstration tests in REDUST is to demonstrate the PM_{10} reduction potential of different street cleaning techniques.
- The specific aim of the demonstration tests in 2011 was to test the effect of following machines on street surface PM_{10} emissions
  - a street scrubber that combines high pressure water scrubbing of the surface with a subsequent suction of the formed sludge (upper figure)
  - a traditional street vacuum sweeper, which sucks the loose material from the surface. The systems is equiped with a nozzle that moists the pavement in order to reduce the resuspension of dust during operation (lower figure)
- In 2011 the timing of the street cleaning tests was chosen to be around mid-April, after the dust binding demonstrations, since that is the common timing of such operations in the urban street networks in Finland

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Summary of data sources used for estimating the reduction potential of street cleaning in 2011

- Suurmetsäntie: whole data, except 19 April afternoon results, which had been influenced by external factors (street surface moisture)
- Vanha Porvoontie: data was not used in the analysis of the reduction potential of street cleaning, because the cleaning operations were not completed following the common practice. Therefore the results from this location were not considered representative.

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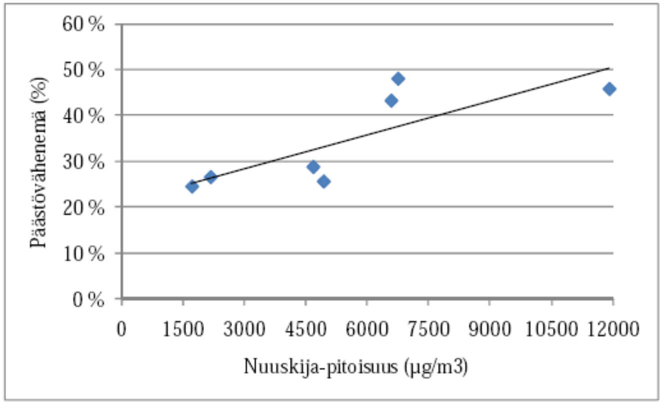
Emission level (Sniffer TEOM) before the cleaning tests (table) and earlier results from the KAPU-project (figure)

- The table shows the PM10 emission level before the street cleaning test as measured with the Sniffer vehicle (TEOM)
- The figure shows combined results from KAPU-projects (Kupiainen et al. 2009) and shows the reduction efficiencies of the street scrubber on different Sniffer emission levels. The results indicate that more efficient emission reductions are expected when the street dust load is high. The street dust load is indicated by the surface emission measured by the TEOM of the Sniffer vehicle.
- Combining the information in the table and the figure indicates that in the REDUST measurement at Suurmetsäntie in case of the street scrubber reduction efficiencies of 25% or less are expected due to a relatively low street surface emission level before the cleanings

Direction	Street_Section		PM10 (µg/m^3)
East	Suurmetsäntie_1	Reference	1798
	Suurmetsäntie_2	Street scrubber	2399
	Suurmetsäntie_3	Vacuum sweeper	1930
West	Suurmetsäntie_1	Reference	1852
	Suurmetsäntie_2	Street scrubber	2343
	Suurmetsäntie_3	Vacuum sweeper	2271



Kuva 39. Katukohtaiset Nuuskija-pitoisuudet vuosina 2008 ja 2009 ennen puhdistusta ja vastaavat puhdistuksen jälkeiset keskimääräiset päästövähenemät (usean päivän keskiarvo).

Figure from Kupiainen et al. 2009

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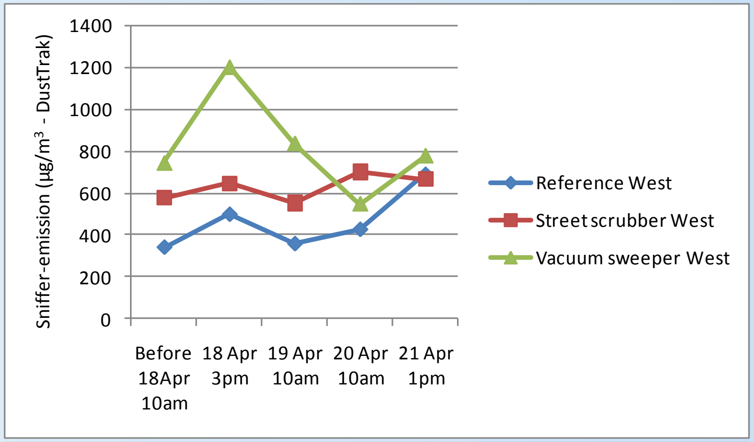
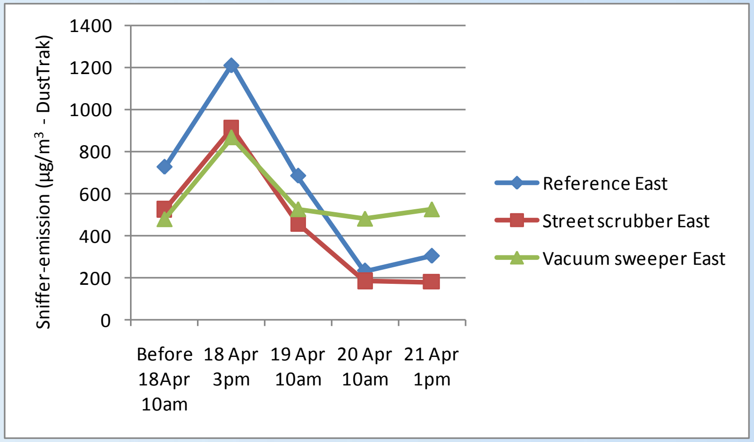
Sniffer emissions - DustTrak concentrations

- Figures show the Sniffer emissions as DustTrak concentrations on Suurmetsäntie during the street cleaning measurements





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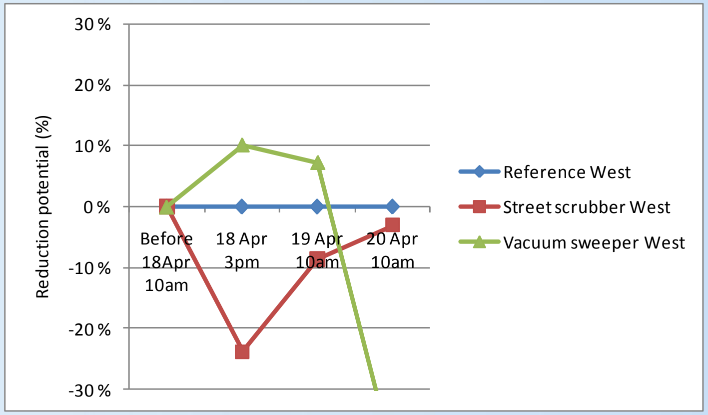
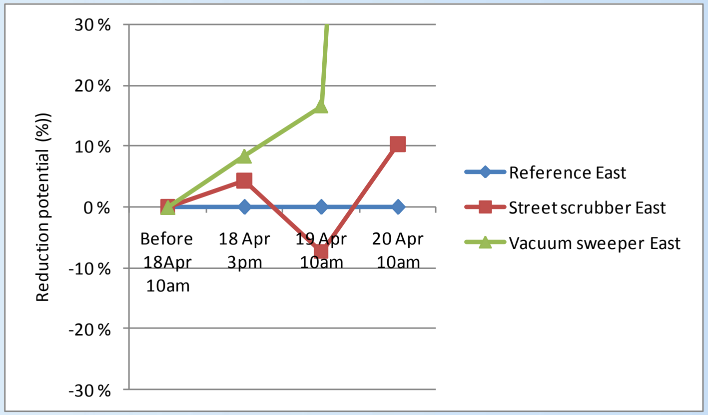
Street cleaning - reduction potentials in the 2011 demonstration tests

- Figure shows the reference corrected relative changes in the average emission levels during Suurmetsäntie street cleaning demonstration tests
- Variation in the average emission levels is significant depending on the street section and direction. Combining results from both directions (averages in the table) indicates in general:
  - There are no short-term PM10 reductions expected for the vacuum sweeper. In fact the vacuum sweeper seemed to increase the emission level. This is possible since the operation may mobilize dust from the surface and the moisture binds it to the surface (it is designed to reduce the dust emission during operation)
  - In case of the street scrubber there was some reduction in emission level during the study period
- The results here apply to the short-term influence (days) and a relatively low emission level of about 1500 to 2000 µg/m^3 (Sniffer-TEOM emission concentration)





	Day of treatment	1 day after	2 days after	3 days after
Street scrubber	0 %	-10 %	-8 %	4 %
Vacuum sweeper	0 %	9 %	12 %	88 %

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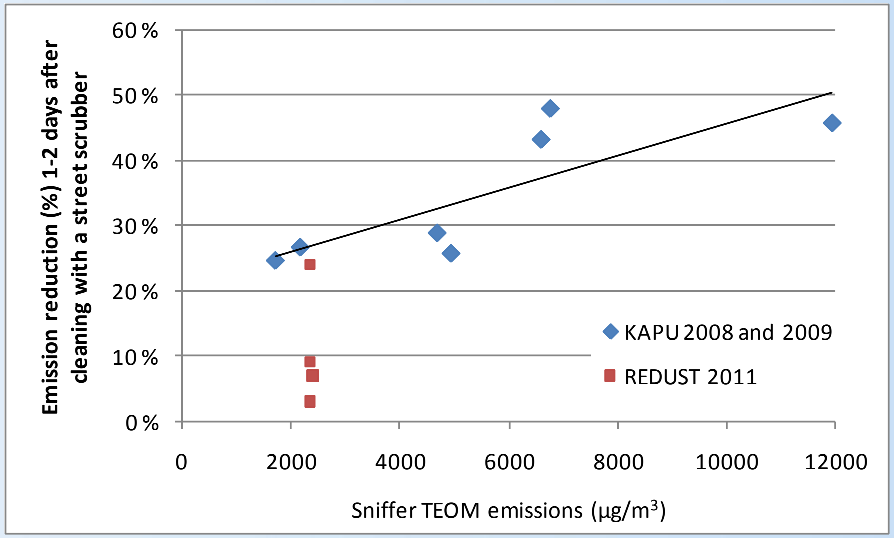
Street cleaning - reduction potentials

- The REDUST 2011 demonstration tests did not indicate short-term PM10 emission reductions for the vacuum sweeper at dust surface emission load of around 2000 µg/m³ (Sniffer-TEOM emission concentration)
- Figure shows the emission reductions after cleaning with the street scrubber in different street surface dust load situations. The figure shows the REDUST demonstration test data 4-48 hours after the cleaning (street section specific data, emission increase - not shown in the figure - was observed in two cases). The figure combines the REDUST results with those measured during the KAPU project measurements in Tikkurila during April 2008 and 2009.
- REDUST demonstration tests indicated lower emission reductions than KAPU measurements (figure). An average of all KAPU and REDUST data is 10-16% on emission level close to 2000 µg/m³ (Sniffer-TEOM emission concentration). The lower reduction-% includes the cases where the emissions increased and the high reduction-% does not include them.



Action 1.1: Traction control practices

Dust formation from traction control – Demonstration test results 2011:

Traction sanding material tests

Studded tyre tests

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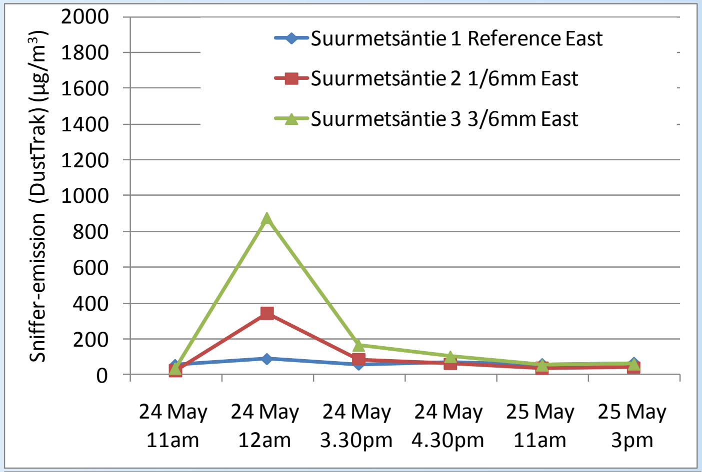
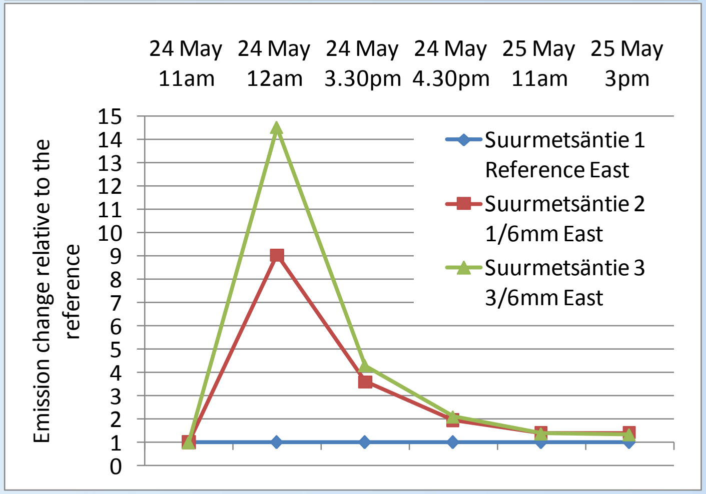
Traction sanding material tests 24-25 May 2011 - results

- The general aim of the sanding tests is to demonstrate the PM_{10} formation potential of different traction sanding materials.
- The specific aim of the demonstration tests in 2011 was to see the effect of the traction sand grain size on PM_{10} formation under the vehicle tyres. The benefits of a coarser grain size, i.e. 2/6 mm vs 1/6 mm wet sieved, have been demonstrated in laboratory conditions.
- The materials in the REDUST demonstration tests in May 2011 were:
  - 1/6 mm wet sieved
  - 3/6 mm wet sieved
- In 2011 the timing of the tests was chosen to be end of May, since then the dust load on street surfaces was expected to be low

Traction sanding - Suurmetsäntie - eastbound

- Half an hour after the traction sanding took place, the sanded sections had emissions 9 to 15 times higher compared with the emissions on the reference section
- The PM formation from traction sanding increased the emission level to that observed at the beginning of spring
- 5 hours after the traction sanding took place (16.30 measurement) the emissions had decreased significantly and were 2 times those measured on the reference section
- On 25 May, 11.00 the emissions were 35% higher on the sanded sections compared with the unsanded reference
- Eastbound, the 3/6mm material had higher dust formation compared with the 1/6mm material





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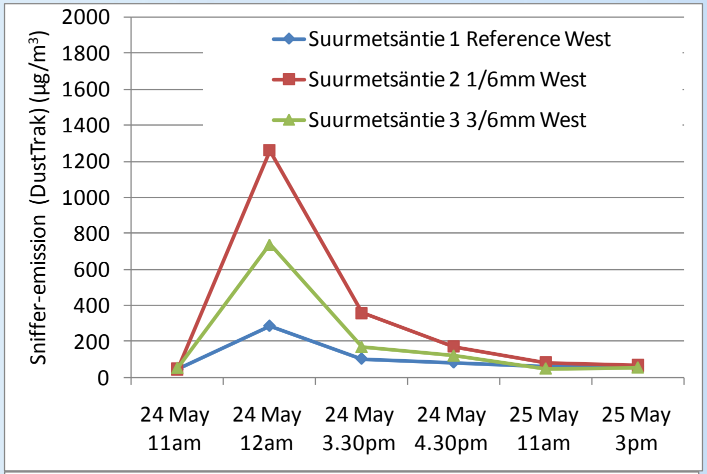
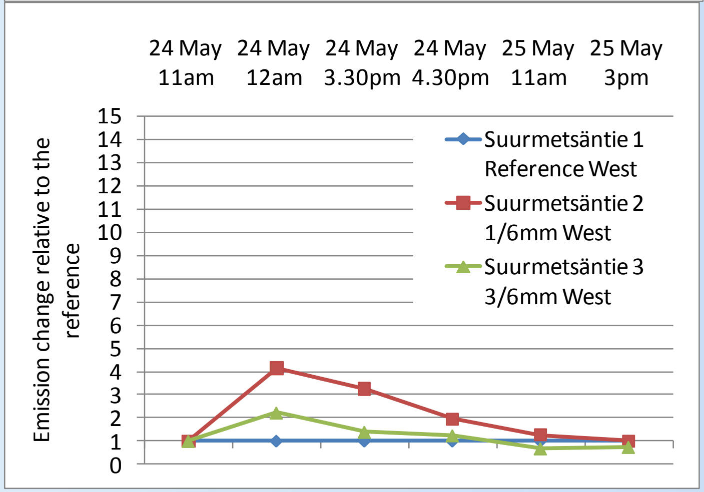
Traction sanding - Suurmetsäntie - westbound

- Half an hour after the traction sanding took place, the sanded sections had emissions 2 to 4 times higher compared with the emissions on the reference section
- The PM formation from traction sanding increased the emission level to that observed in the beginning of spring. Some increase in emissions was also observed on the reference section, which may indicate the migration of dust from the sanded sections to the reference.
- 5 hours after the traction sanding took place (16.30 measurement) the emissions had decreased significantly and were 1 to 2 times those measured on the reference section
- On 25 May, 11.00 the emissions were on the same level as on the unsanded reference.
- Westbound, the 1/6mm material resulted in higher formation of PM_{10} compared with the PM formation from the 3/6mm material.





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Traction sanding - conclusions

- The tests demonstrated that traction sanding increases significantly PM_{10} formation but the increase is limited in time and the emissions return to presanding levels in hours. The episodic nature of the PM_{10} formation from traction sanding should be taken into account when estimating emissions from this source.
- In contrast to the laboratory test conducted in earlier studies, the REDUST tests did not unambiguously demonstrate the benefits of a coarser grain size (3/6mm vs 1/6mm) to PM_{10} formation in real street conditions.
- Further demonstration test could revisit the grain size issue, and measure 2/6mm material (see Räisänen et al. 2005)

Studded tyre emission measurement results

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Studded tyres tested in 2011

”Market leaders”

Nokian Tyres: Hakkapeliitta 7

Michelin: X-ice North 2

Continental: Conti Ice Contact

Dimension: 205/55 R16

Tyres were driven 520km before the demonstration test (4.3.-9.3.2011)

Friction tyre Nokian Tyres Hakkapeliitta R (205/55/R16) served as a reference

Studded tyre measurement days 2011

- 31 March 2011 (high street surface dust load and consequent resuspension)
- 17 May 2011 (low street surface dust load and consequent resuspension)

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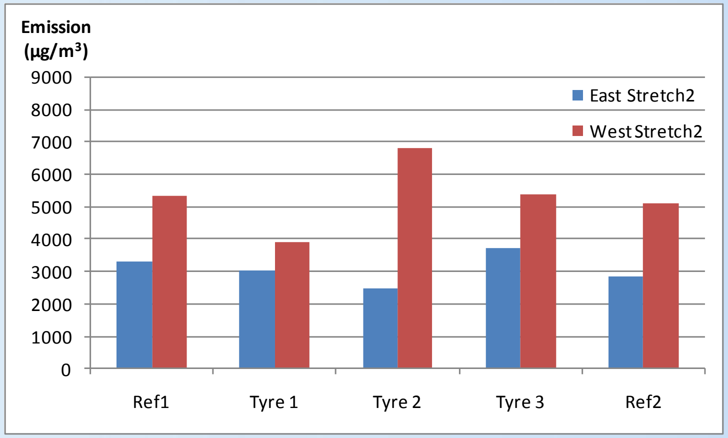
31 March 2011 (high street surface dust load and consequent resuspension)

- Figure shows the average concentrations on Suurmetsäntie Stretch 2 on 31 March 2011. The results demonstrate that when the street surface dust load and consequent resuspension is high, there are no significant differences between the tyres. The studless friction tyre (Ref1 and Ref2 in the figure) had emissions comparable to the studded tyres and there were no systematic differences between the studded tyres.
- This result was expected and demonstrates that in conditions with high street surface dust loads, (emission levels usually observed at the beginning of spring in the Finnish cities), the enhanced dust formation and emissions by tyre studs are masked by resuspension emissions.



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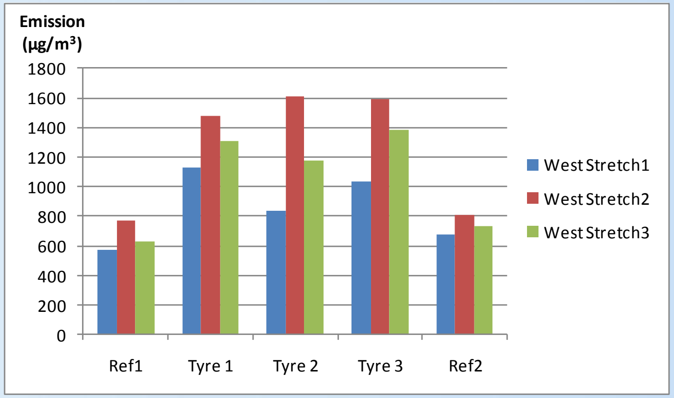
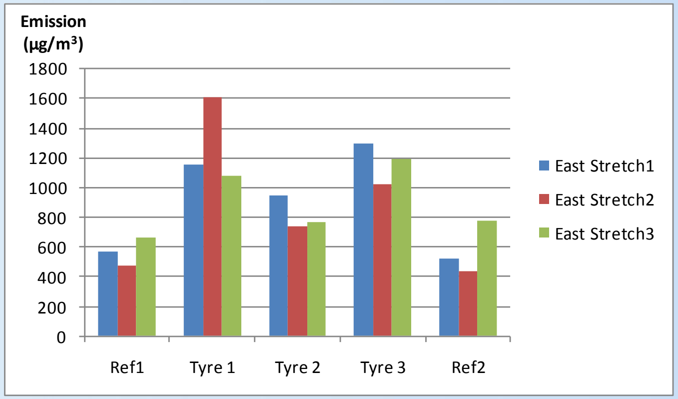
17 May 2011 (low street surface dust load and consequent resuspension)

- Figure shows the test tyre specific average emission concentrations on Suurmetsäntie on 17 May 2011. The results are shown as box-and-whisker plots on the next slide. The emission level on Suurmetsäntie 17 May 2011 was already low and corresponded to that observed in Finnish cities after the spring period in mid-May. However, in summertime the emissions may be lower.
- The results demonstrate that when the street surface dust load and consequent resuspension is low, stud wear becomes the dominant factor explaining the emissions behind the tyre. The studded tyre emissions were 2 to 3 times higher compared with the friction tyre emissions.
- There were indications of systematic differences between the tested tyres. The friction tyre that was the reference, had lowest emissions in all test sections.Of the studded tyres, the test tyre 2 had lower average emissions than the other studded tyres in all other sections than Stretch 2/westbound. Test tyres 1 and 3 had approximately similar emission levels.
- The comparison of the different studded tyres demonstrates that there are differences between the abrasive PM10 emissions of different tyre designs





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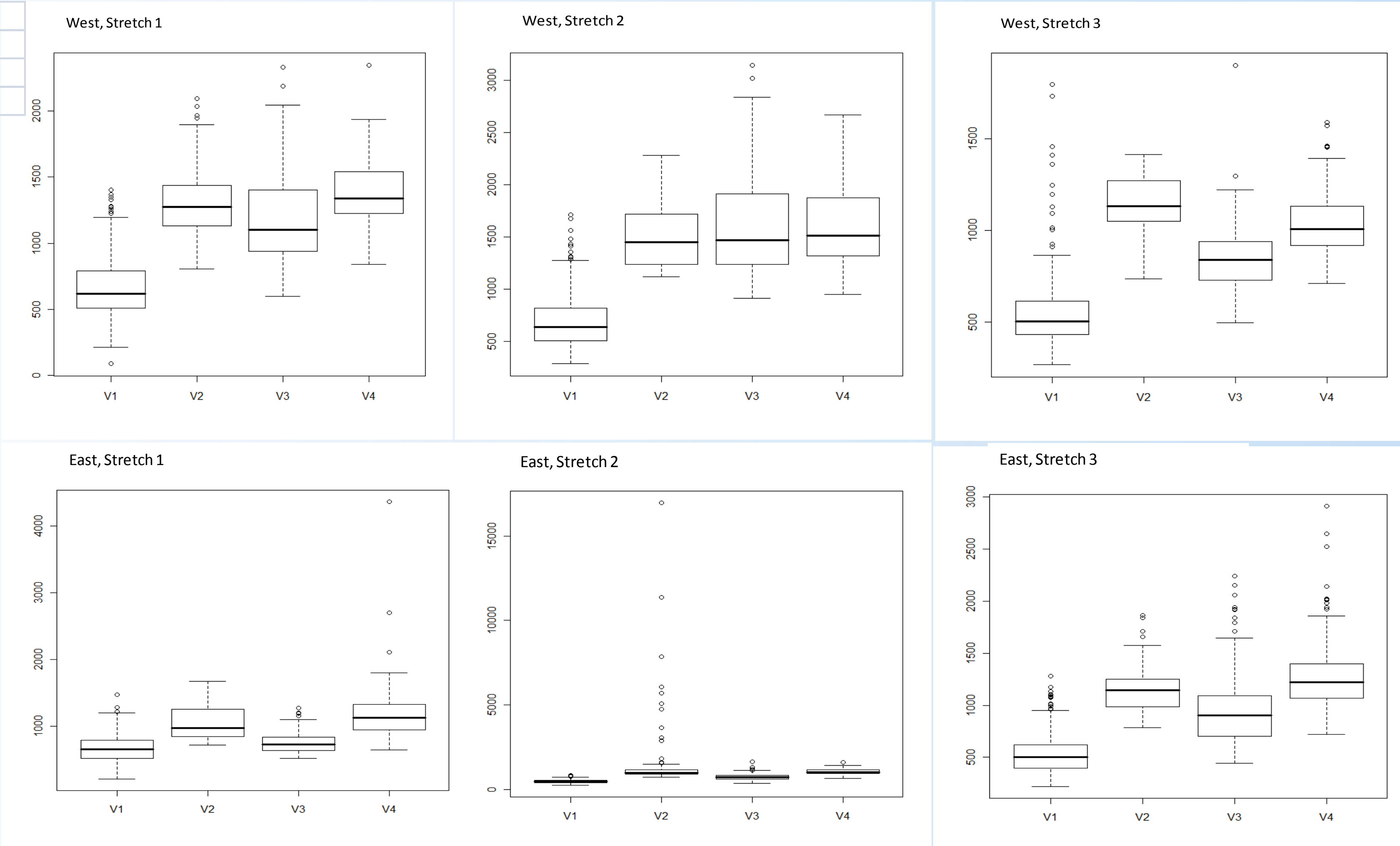
17 May 2011 (low street surface dust load and consequent resuspension)

Ref	V1
Tyre 1	V2
Tyre 2	V3
Tyre 3	V4



Action 2: Interpretation of the upwind-downwind measurement results to produce emission factors

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Emission factors – Upwind-downwind measurements

12 April 2011, Suurmetsäntie, Section 2

- In order to convert Sniffer emission signals to emission factors, a conversion function has to be estimated. This is done via upwind-downwind measurements, following the TRAKER methodology (Etyemetzian et al. 2003, Atm Env 37, 4559-4571; Gillies et al. 2005, Atm Env 39, 2341-2347; Gertler et al. 2006, Atm Env 40, 5976-5985)
- First upwind-downwind measurements for the Sniffer vehicle were conducted in 2006 and a conversion function was estimated (see equation in the lower figure).
- In the REDUST project the upwind-downwind measurements were repeated 12 April 2011 on Suurmetsäntie to demonstrate and test the validity of the equation.
- Results from the upwind-downwind measurements in 2011 on Suurmetsäntie demonstrate that the equation can be used for estimating the emissions factors in the REDUST project on Sniffer emission concentrations (TEOM) 2000 µg/m^3 and above (upper figure). Below that a linear behaviour is assumed (dashed line in the lower figure) until more measurements allow a better approximation.
- In the 12 April 2011 REDUST demonstration tests the average Vectra emission factor was 20% lower than the Sniffer emission factor (upper figure). This is based on 8 and 7 valid upwind-downwind emission plumes for Sniffer and Vectra, respectively. There was significant variation between the individual plumes and it is recommended that more upwind-downwind measurements are conducted in future years to demonstrate the relationship between Sniffer and Vectra emission factors on different emission levels.

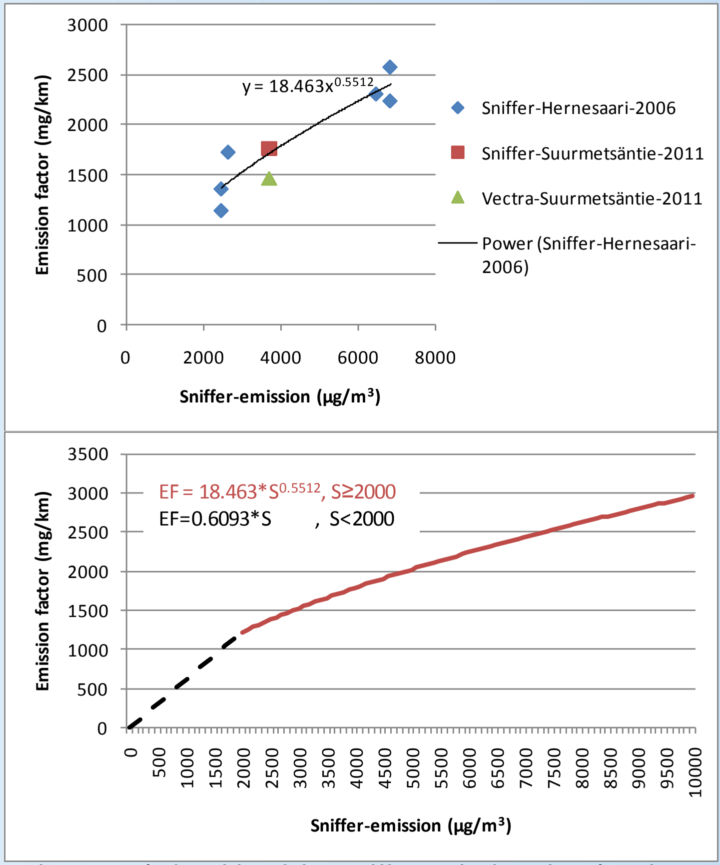

Figure. Relationship of the Sniffer emission signal and emission factor. Upper figure shows the average values in Hernesaari (2006) and on Suurmetsäntie (2011)

Action 2: Sniffer emissions on REDUST city routes in spring 2011

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Comparison between the average Sniffer PM_{10} emission levels on the REDUST urban routes in 2011

- Peak emissions were observed in all cities at the beginning of April
- During April the emissions decrease and reach summer time levels after mid-May

Sniffer-concentration (TEOM) (ug/m3)

	Helsinki	Espoo	Vantaa
7-Mar-11	563		
9-Mar-11	162		
17-Mar-11		1613	1845
23-Mar-11	1194	802	
25-Mar-11	711		
1-Apr-11	2447		
5-Apr-11			
11-Apr-11	1759	3667	4277
15-Apr-11	1380		
18-Apr-11		2028	2565
19-Apr-11			
20-Apr-11	1253		
21-Apr-11	1946		
26-Apr-11	947	2039	2395
27-Apr-11	1065		
29-Apr-11			
11-May-10			
13-May-10			
19-May-11	454	1264	
20-May-11	806	870	555
26-May-11	343	568	469
27-May-11			
31-May-11	529	432	
1-Jun-11			579
10-Jun-11			

Index	IndexColor	Conc. Range
25		0-300
50		300-1000
100		1000-2000
150		2000-5500
200		5500-8000
300		8000-12000
350		>12000

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Espoo

Spring 2011

Sniffer-concentration (TEOM) (ug/m3)

Street	17-Mar-11	23-Mar-11	11-Apr-11	19-Apr-11	27-Apr-11	20-May-11	26-May-11	27-May-11	1-Jun-11
Hevosenkenkä	4089	1075	1633	1238	1061	1448			265
Kalevantie	823	690	3115	1734	1903	818	644	613	646
Keha I	2984	1308	3283	1530	2607	1274	441	587	390
Koivu-Mankkaantie	955	1975	3995	2536	2039	434	860	640	480
Leppävaarankatu	2249	146	7375	3810	3783	3649	2258	958	865
Merituulentie	158	285	2740	1513	1075	481	401	303	209
Tapiolantie	34	131	3526	1835	1802	743	616	306	173
City Average	1613	802	3667	2028	2039	1264	870	568	432

- On March 17 and 23 some streets were partly wet due to meltwaters, which explains the low emission levels
- The last traction sanding days in Espoo: Kalevantie and Leppävaarankatu April 1., Koivu-Mankkaantie, Merituulentie and Tapiolantie March 31. The last salting for traction control took place on March 30 on Leppävaarankatu and March 28 on the other streets.
- Peak emissions occur in early April. Dust binding (with $CaCl_2$) also took place either on all streets or on specific streets with high dust load. The dates were 11-12 April, 14-15 April and 19 April. On Leppävaarankatu additionally 13 May.
- Street cleaning took place between 14 April and 5 May. On Leppävaarankatu the last street cleaning activities were performed on 14 May. There were altogether 7 cleaning occasions on Leppävaarankatu during the spring, whereas other streets were cleaned once.
- The higest emission level in Espoo in 2011 was measured on Leppävaarankatu.

Index	IndexColor	Conc. Range
25		0-300
50		300-1000
100		1000-2000
150		2000-5500
200		5500-8000
300		8000-12000
350		>12000

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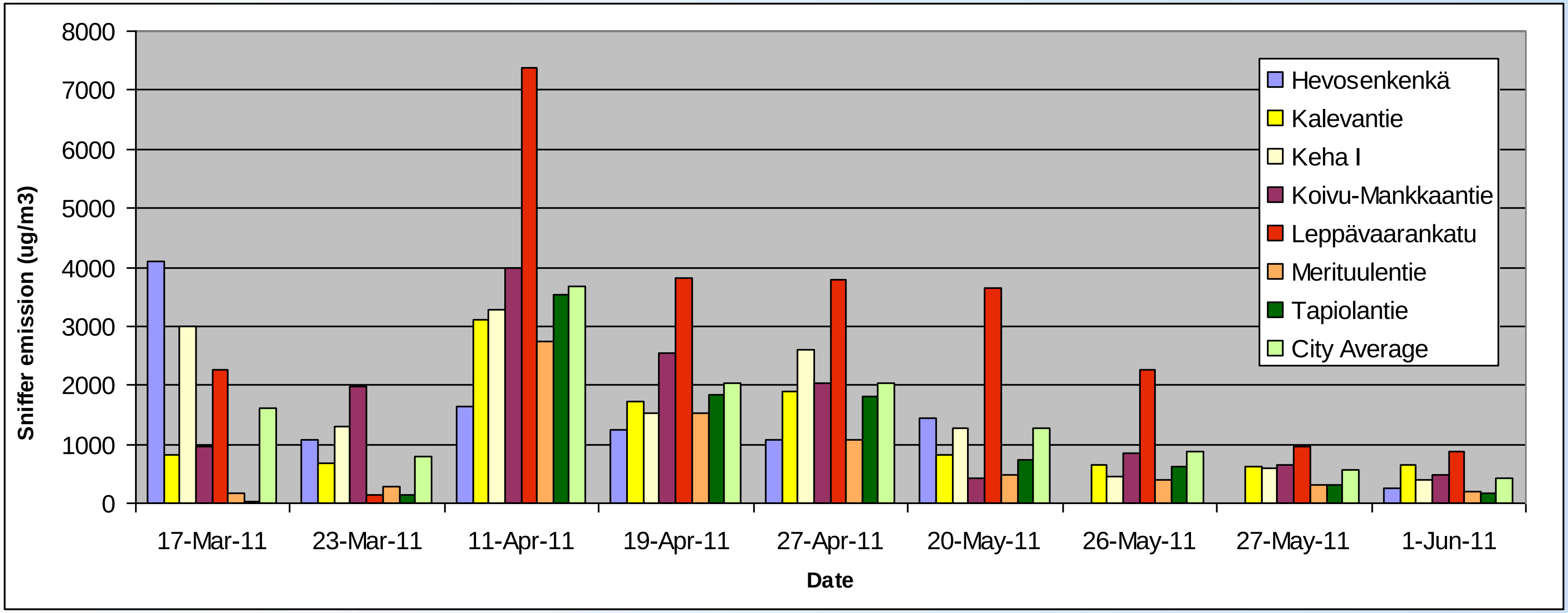
Street Specific Emissions as Sniffer Emission Concentrations (TEOM) in Espoo 2011



Street Specific Emissions as Sniffer Emission Factors in Espoo 2011

Emission factor (mg/km)									
Street	**17-Mar-11**	**23-Mar-11**	**11-Apr-11**	**19-Apr-11**	**27-Apr-11**	**20-May-11**	**26-May-11**	**27-May-11**	**1-Jun-11**
Hevosenkenkä	1807	655	995	754	647	883	0	0	162
Kalevantie	502	420	1556	1056	1160	499	393	373	393
Keha I	1519	797	1601	932	1410	776	269	358	237
Koivu-Mankkaantie	582	1203	1784	1389	1232	265	524	390	293
Leppävaarankatu	1300	89	2502	1738	1732	1697	1303	584	527
Merituulentie	96	174	1449	922	655	293	244	185	127
Tapiolantie	21	80	1666	1118	1098	453	375	186	105
City Average	1082	488	1702	1228	1231	770	530	346	264

The Sniffer emission concentrations (TEOM) were converted into emission factors using the equations presented on slide 59

Helsinki

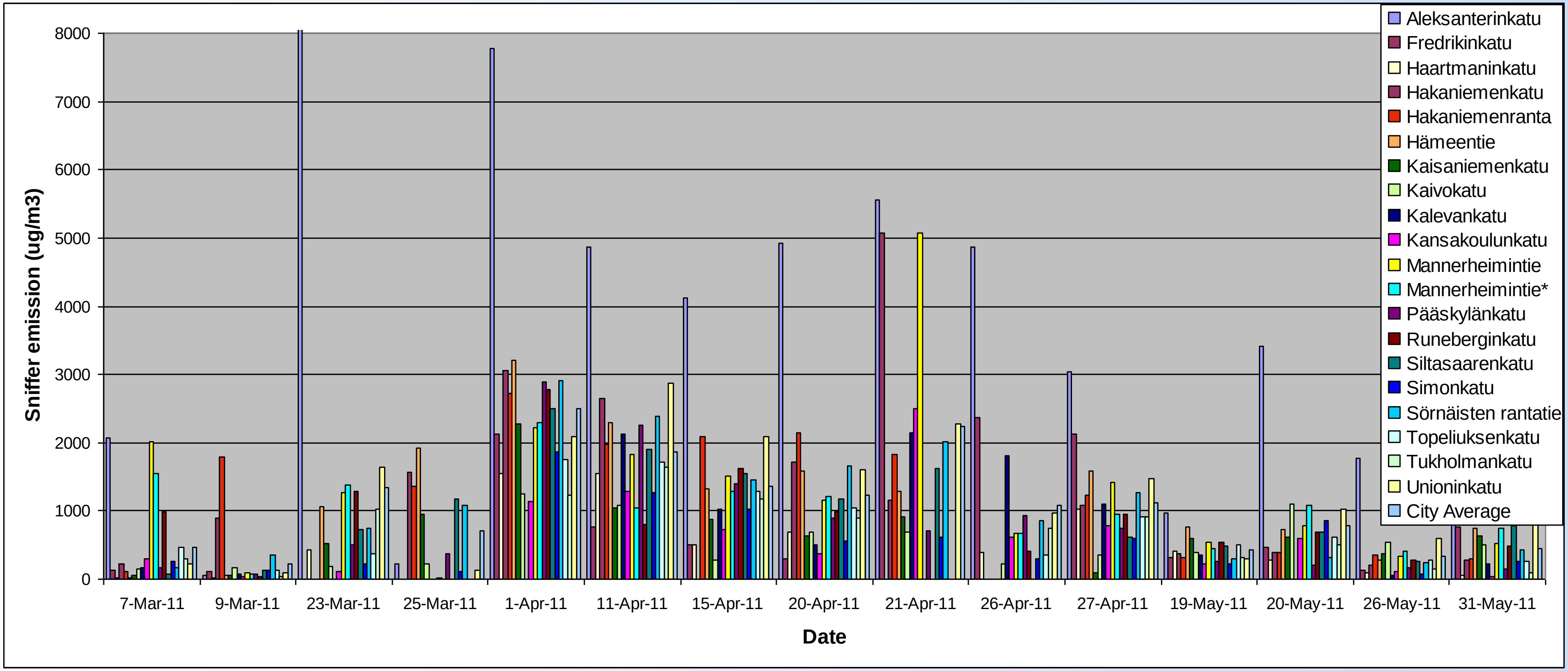
Spring 2011

Sniffer-concentration (TEOM) (ug/m3)

Street	7-Mar-11	9-Mar-11	23-Mar-11	25-Mar-11	1-Apr-11	11-Apr-11	15-Apr-11	20-Apr-11	21-Apr-11	26-Apr-11	27-Apr-11	19-May-11	20-May-11
Aleksanterinkatu	2076	53	10072	223	7778	4873	4118	4916	5552	4860	3048	965	3405
Fredrikinkatu	122	115			2122	770	509	302	5080	2369	2126	322	460
Haartmaninkatu	10	15	433		1547	1540	504	688		400	1028	408	274
Hakaniemenkatu	230	898		1575	3052	2650		1715	1159		1074	367	394
Hakaniemenranta	103	1794		1358	2717	1980	2096	2149	1833		1235	310	400
Hämeentie	18	56	1065	1920	3215	2296	1318	1578	1279		1583	764	732
Kaisaniemenkatu	63	61	522	943	2272	1038	882	634	917		94	601	610
Kaivokatu	140	177	181	227	1241	1090	272	694	694	224	352	396	1094
Kalevankatu	165	82				2134	1022	505	2146	1816	1093	348	
Kansakoulunkatu	305	38	119	7	1134	1293	735	376	2501	608	783	223	596
Mannerheimintie	2019	87	1275	25	2214	1819	1511	1151	5076	679	1409	541	775
Mannerheimintie*	1547	77	1374		2297	1038	1278	1206		669	944	450	1089
Pääskylänkatu	163	76	495	373	2884	2250	1403	903	701	928	740	264	199
Runeberginkatu	996	43	1289		2771	796	1620	979		403	952	546	693
Siltasaarenkatu	66	134	733	1184	2506	1900	1544	1178	1626		612	487	690
Simonkatu	269	135	233	118	1873	1264	1021	557	624	306	593	228	861
Sörnäisten rantatie	165	346	746	1076	2905	2382	1457	1654	2005	856	1262	307	312
Topeliuksenkatu	468	123	373		1744	1724	1283	1052		357	922	502	613
Tukholmankatu	292	36	1017		1235	1650	1178	888		743	911	314	498
Unioninkatu	228	102	1639	127	2086	2879	2091	1603	2273	962	1468	301	1020
City Average	472	222	1348	704	2505	1868	1360	1236	2231	1079	1111	432	775

- On 7, 9 and 23 March some streets were partly wet due to meltwaters, which explains the low emission levels. In addition to this, on 25 March a light snow fall interfered with the measurements and only part of the route was measured.
- The blanks indicate that the street has not been measured
- Peak emissions occur in the first weeks of April
- Peak emissions in 2011 on the Helsinki-route were measured on Aleksanterinkatu. Aleksanterinkatu in the centre of Helsinki is a heated street (district heating pipes go under the surface of the street).
- The street canyons in the Helsinki city center were treated with $CaCl_2$ 16-18 March
- On Hakaniemenkatu, Hakaniemenranta, Pääskylänkatu, Siltasaarenkatu and Sörnäisten rantatie streets dust binding $CaCl_2$ took place 12-15 March as well as 18 April and 26-27 April

Street Specific Emissions as Sniffer Emission Concentrations (TEOM) in Helsinki 2011



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Street Specific Emissions as Sniffer Emission Factors in Helsinki 2011

Emission factor (mg/km)

Street	**7-Mar-11**	**9-Mar-11**	**23-Mar-11**	**25-Mar-11**	**1-Apr-11**	**11-Apr-11**	**15-Apr-11**	**20-Apr-11**	**21-Apr-11**	**26-Apr-11**	**27-Apr-11**	**19-May-11**	**20-May-11**
Aleksanterinkatu		32	2971	136	2576	1991	1814	2000	2139	1988	1537	588	1634
Fredrikinkatu	74	70	0	0	1259	469	310	184	2037	1338	1260	196	281
Haartmaninkatu	6	9	264	0	943	938	307	419	0	244	627	249	167
Hakaniemenkatu	140	547	0	960	1538	1423	0	1045	706	0	654	224	240
Hakaniemenranta	63	1093	0	828	1443	1206	1250	1268	1117	0	753	189	244
Hämeentie	11	34	649	1170	1583	1315	968	1069	780	0	965	465	446
Kaisaniemenkatu	38	37	318	575	1307	632	776	647	559	0	57	366	372
Kaivokatu	85	108	110	139	756	664	406	680	423	137	214	241	667
Kalevankatu	101	50	0	0	0	1263	842	570	1267	1107	666	212	0
Kansakoulunkatu	186	23	72	4	691	788	448	229	1378	371	477	136	363
Mannerheimintie	1225	53	777	15	1289	1108	1044	701	2036	414	858	330	472
Mannerheimintie*	943	47	837	0	1315	632	952	735	0	408	575	274	663
Pääskylänkatu	99	46	301	227	1491	1300	1002	550	683	565	451	161	121
Runeberginkatu	607	26	785	0	1458	485	1085	597	0	246	580	333	422
Siltasaarenkatu	40	82	447	721	1380	1158	1056	718	1087	0	373	297	421
Simonkatu	164	82	142	72	1141	770	841	339	380	186	361	139	525
Sörnäisten rantatie	101	211	454	655	1770	1342	1023	1008	1220	522	769	187	190
Topeliuksenkatu	285	75	228	0	1063	1050	954	641	0	218	562	306	373
Tukholmankatu	178	22	620	0	752	1006	910	541	0	453	555	191	303
Unioninkatu	139	62	999	77	1247	1489	1249	977	1307	586	895	184	622
City Average	288	136	821	429	1379	1138	829	753	1294	657	677	263	472

The Sniffer emission concentrations (TEOM) were converted into emission factors using the equations presented on slide 59

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Vantaa
Spring 2011

Sniffer-concentration (TEOM) (ug/m3)							
Street	**17-Mar-11**	**11-Apr-11**	**18-Apr-11**	**26-Apr-11**	**20-May-11**	**26-May-11**	**1-Jun-11**
Kielotie	863	2758	1729	1691	246	256	101
Lummetie	2478	5092	3439	2643	462	436	297
Ratatie	2888	6570	4257	2942	1129	871	1586
Talkootie*	132	7076	3660	3470	824	586	711
Talvikkitie	2314	4298	1883	2083	550	389	583
Talvikkitie*	3196	3884	2218	2745	482	325	592
Tikkurilantie	1445	1902	1582	946	346	296	672
Tikkurilantie*	2903	2805	2104	2673	467	445	357
Urheilutie	388	4103	2216	2359	486	618	316
City Average	1845	4277	2565	2395	555	469	579

Index	IndexColor	Conc. Range
25		0-300
50		300-1000
100		1000-2000
150		2000-5500
200		5500-8000
300		8000-12000
350		>12000

- 17 March some streets were partly wet due to meltwaters, which explains the low emission levels
- The last traction sanding days in Vantaa: 16 February (Kielotie, Lummetie, Talkootie, Tikkurilantie and Urheilutie) and 3 March (Ratatie and Talvikkitie). The street specific numbers of sanding occasions were: Talkootie 6, Kielotie 9, Lummetie/Tikkurilantie 10, Ratatie/Talvikkitie 12, and Urheilutie 18.
- The last salting for traction control took place on March 30. The street specific numbers of sanding occasions were: Talkootie 16, Kielotie/Tikkurilantie 18, Lummetie/Ratatie/Talvikkitie 17, Urheilutie 31.
- Peak emissions occur in early April. Dust binding (with $CaCl_2$) took place on 5 April, 12 April and 14 April (1-3 times depending on the section).
- Street cleaning took place between 13 April and 3 May
- Higest emission level in Vantaa in 2011 was measured on Talkootie, followed by Ratatie

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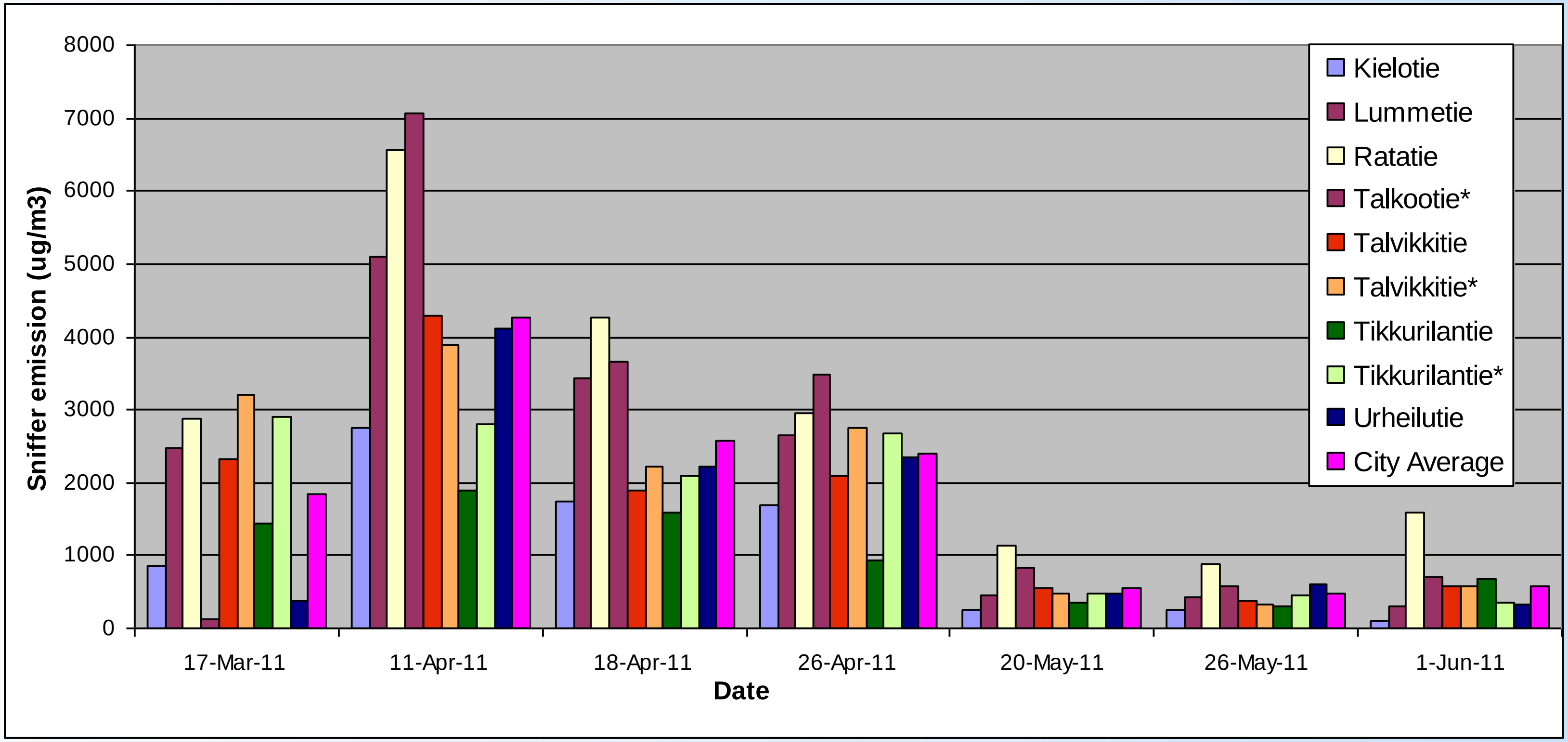
Street Specific Emissions as Sniffer Emission Concentrations (TEOM) in Vantaa 2011



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Street Specific Emissions as Sniffer Emission Factors in Vantaa 2011

Emission factor (mg/km)							
Street	**17-Mar-11**	**11-Apr-11**	**18-Apr-11**	**26-Apr-11**	**20-May-11**	**26-May-11**	**1-Jun-11**
Kielotie	526	1455	1053	1030	150	156	62
Lummetie	1371	2040	1643	1421	282	266	181
Ratatie	1492	2347	1848	1507	688	531	966
Talkootie*	80	2445	1700	1651	502	357	433
Talvikkitie	1321	1858	1148	1246	335	237	355
Talvikkitie*	1578	1757	1290	1451	294	198	361
Tikkurilantie	880	1159	964	576	211	180	409
Tikkurilantie*	1496	1468	1253	1430	285	271	218
Urheilutie	236	1811	1289	1335	296	377	193
City Average	1124	1853	1398	1346	338	286	353

The Sniffer emission concentrations (TEOM) were converted into emission factors using the equations presented on slide 59

Summary of the 2011 demonstration test results

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Summary of Action 1 and 2 results from the demonstration tests

- For estimating the PM_{10} emission factors, it is recommended to use Sniffer emission measurements and to transfer the TEOM emission concentration to an emission factor using equations on slide 59 (lower figure). For cars, the emission factor was adjusted down by 20%.
- The tests demonstrated that the traction control methods increase the formation of PM_{10} particles that add to the dust load of the street surfaces. The resuspension level determines what is the relative emission increase (Kupiainen & Pirjola, 2011);
  - In the 2011 demonstration tests the studded tyres resulted in 2 to 3 times higher dust formation levels in low resuspension conditions comapared with the friction tyre, but there were no significant differences in conditions with high resuspension
  - In low resuspension street surface conditions traction sanding resulted in an episodic increase with a relative increase of 2 to 15 times, depending on the material and location, compared with the situation before sanding. The emission levels reduced back to presanding levels in 24 hours.
- There were emission reductions after dust binding and street cleaning with a street scrubber. The table shows the emission reductions in 2011 and the duration of one treatment

		Treatment day	1 day after	2 days after	3 days after
Dust binding	Whole street	90%	60%	30%	No effect
	Kerbside & center	40%	20%	No effect	No effect
Street cleaning	Street scrubber	10% to 40% depending on the dust load of the surface (see slide 37)			
	Vacuum sweeper	No effect	No effect	No effect	No effect

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