

### Varför är det så höga NO<sub>2</sub>-halter (speciellt i Göteborg)?



Marie Haeger-Eugensson, Erik Fridell, Jana Moldanova, Martin Fern IVL Svenska Miljöinstitutet samt Maria Holmes Göteborgs Miljöförvaltning



Erik Fridell, 100420

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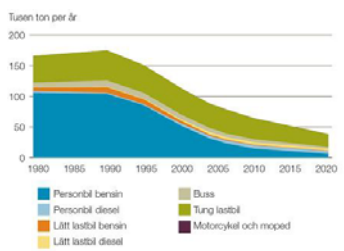
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### Vägtrafikens utsläpp av kväveoxider (NO<sub>x</sub>) i Sverige 1980-2020 (källa: Vägverket, 2007).



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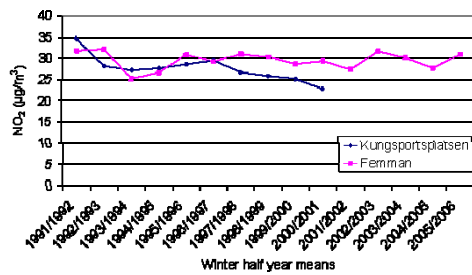
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### NO<sub>2</sub> koncentrationen minskar inte



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### FEAT mätningar




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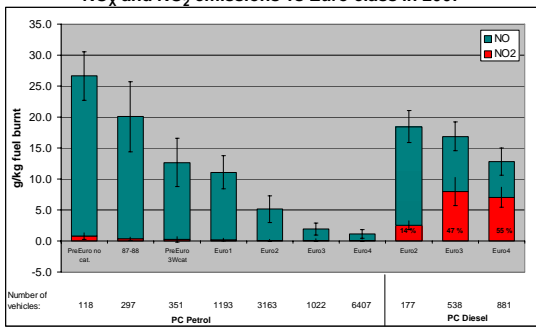
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### Gasoline and diesel passenger cars – NO<sub>x</sub> and NO<sub>2</sub> emissions vs Euro class in 2007




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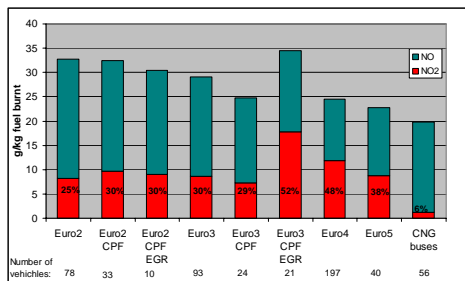
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### City buses and coaches – NO<sub>x</sub> and NO<sub>2</sub> emissions vs Euro class in 2007




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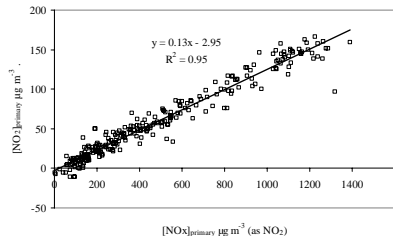
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**NO<sub>2</sub> primär vs NO<sub>x</sub> primär i Lundbytunnel  
Ca 13% NO<sub>2</sub>**




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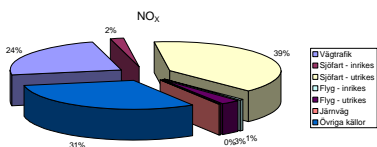
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**De fyra trafikslagens andel av Sveriges totala utsläpp av kväveoxider (NO<sub>x</sub>) år 2005 (källa: Naturvårdsverket, 2007)**




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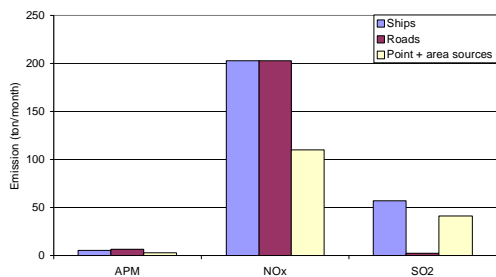
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**Fördelning av olika typer av emissioner i Gbg  
Emissioner från alla källor TAPM**




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### NO<sub>x</sub> emissioner i EU

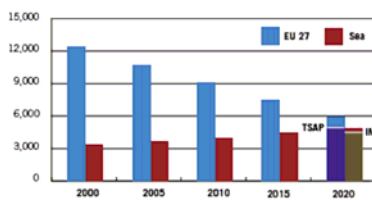


Figure 2: Emissions of NO<sub>x</sub> 2000-2020 (ktonnes).

Estimated emissions of nitrogen oxides from landbased sources and shipping in EU27 for 2005-2020 (thousands of tonnes annually).  
 TSAP –EU-target  
 IMO – expected outcome after IMO agreement

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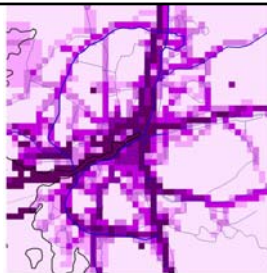
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**Totala**  
 emissioner för  
 Göteborgs-  
 området  
 d v s  
 - vägar/fartyg  
 - punktkällor  
 - areakällor



NO<sub>x</sub> [ton/år]  
 < 0.5  
 0.5 - 1  
 1 - 2  
 2 - 5  
 5 - 10  
 > 10

0 2000 4000 Kilometers

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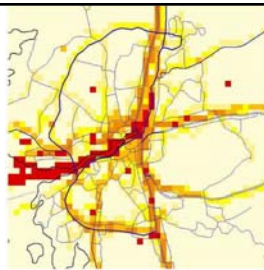
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**Totala**  
 emissioner för  
 Göteborgs-  
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 - areakällor



SO<sub>2</sub> [kg yr<sup>-1</sup>]  
 < 10  
 10 - 25  
 25 - 50  
 50 - 100  
 100 - 500  
 > 500

0 2000 4000 Kilometers

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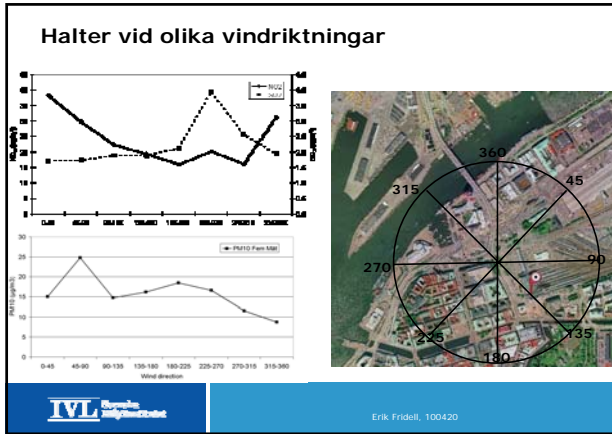
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### Passiv provtagning

Table 2. Average concentrations between 2008-10-01 and 2008-10-22 in  $\mu\text{g m}^{-3}$  at STP (20°C, 1013 mbar).

Place	NO <sub>2</sub>	SO <sub>2</sub>	O <sub>3</sub>
Arendal	9.8	25.0	57.5
Länsmansgården	9.0	1.8	53.7
Mölnåls centrum	12.4	0.6	43.4
Kielterminalen	16.9	3.2	43.4
Järntorget	23.9	3.4	42.9
Suckarnas kaj	21.1	1.7	41.7
Amerikaskjulet	22.9	3.5	40.8
Joten (Söderleden)	10.8	0.7	
Masthuggskyrkan	12.3	2.9	

SO<sub>2</sub> halterna högst nära hamnen

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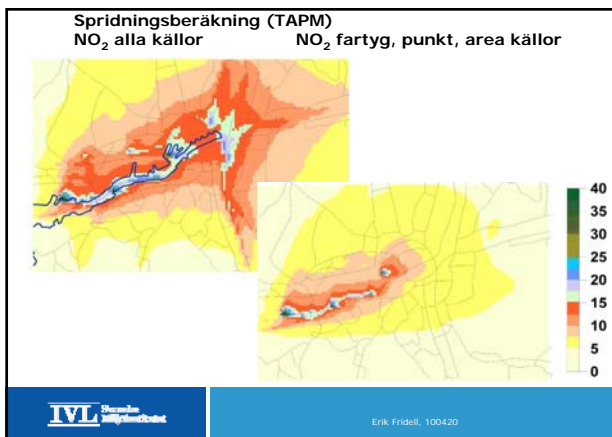
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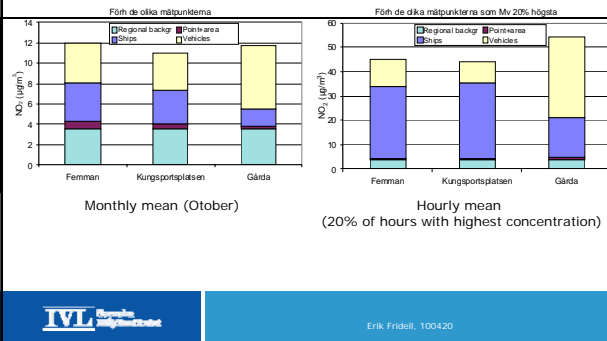
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## Spridningsberäkning Bidragen från olika källor




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Röken hög skorsten - ovanför inversionen följer regional vindriktning.  
Rök låg skorsten - under inversionen följer lokal vindriktning (här omlandsbris in mot Göteborg)




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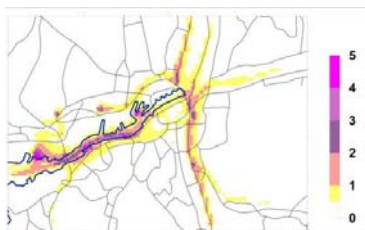
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Skillnad i modellerad NO<sub>2</sub> halt (µg/m<sup>3</sup>) med 20% resp 5% primärfraktion NO<sub>2</sub> av NO<sub>x</sub> (för alla emissioner)




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### Några slutsatser

- NO<sub>x</sub> emissionerna från vägtrafik minskar men NO<sub>2</sub> andelen går upp
- Sjöfarten bidrar signifikant till vissa halter
- Komplicerade spridningsförutsättningar i Göteborg vilket i högre grad påverkar lokalt emitterade föroreningar – såsom NO<sub>2</sub>.

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### Framtiden

- NO<sub>2</sub> emissionerna från vägtrafik
- Sjöfartens NO<sub>x</sub>-emissioner kommer att gå ner
- Ozonbakgrund?

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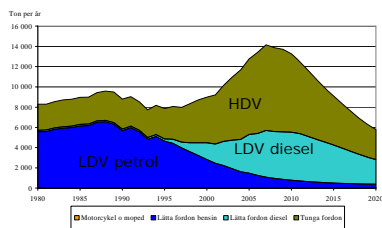
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### Predicted emissions of NO<sub>2</sub>, calculated from FEAT data (from H. Johansson, Vägverket)



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## Acknowledgements

- EMFO
  - The Traffic and Public Transport Authority of the City of Göteborg
  - Stiftelsen IVL
  - CFs miljööfönd
  - The Swedish Environmental Protection Agency
- Åke Sjödin, Martin Jerksjö, Marylaine Thomar

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## Tack

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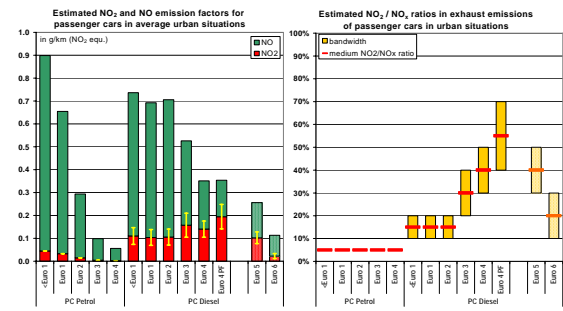
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## IFEU-study (Germany)




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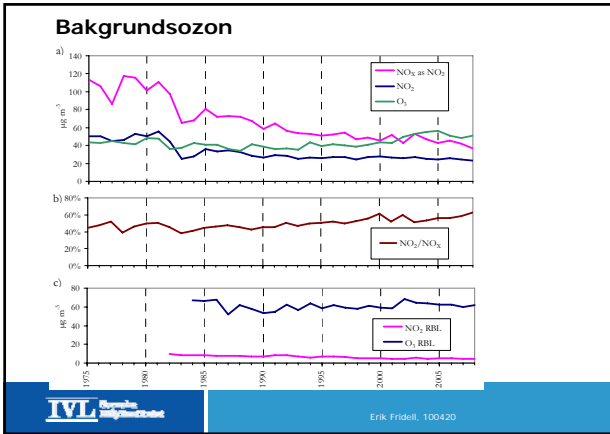
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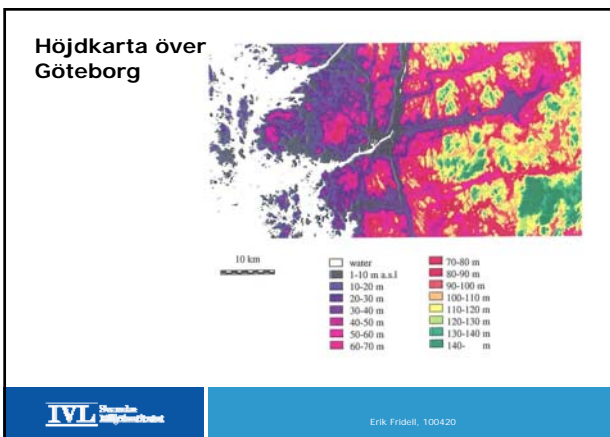
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### Stora variationer av NO<sub>2</sub>-halten i Göteborg

	Beräknade halter	
	Femman	Stadsbibloteket
Medelvärde	18	14
98%-il timme	64	53

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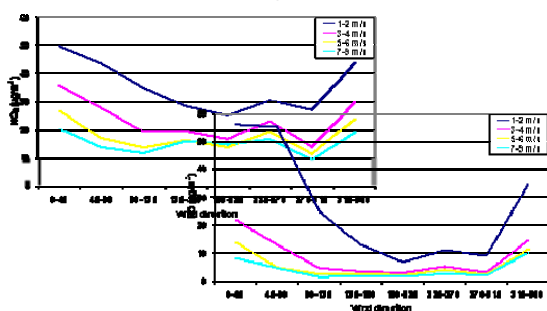
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### Uppdelat på vindhastighet




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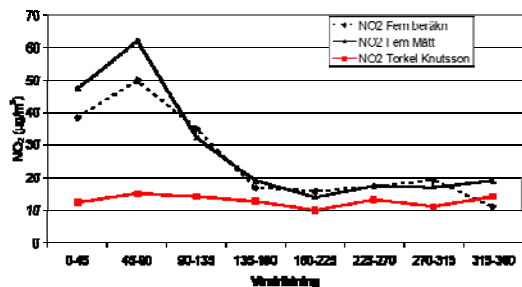
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### Jämförelse Göteborg och Stockholm




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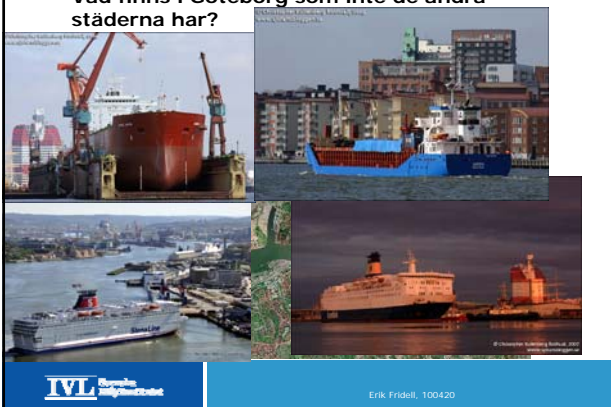
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**Vad finns i Göteborg som inte de andra städerna har?**




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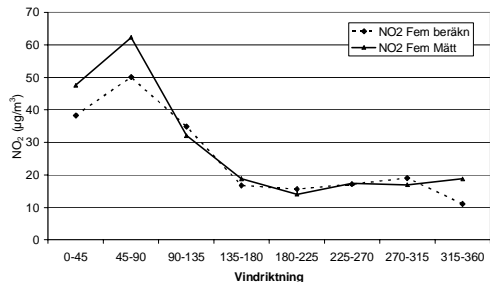
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**Jämförelse uppmätta och spridningsberäknade halter vid Femman**




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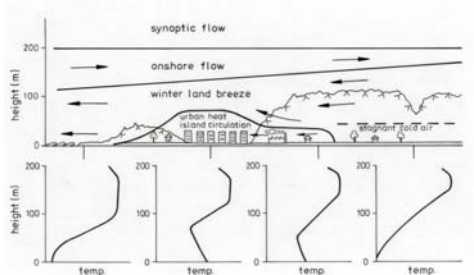
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**Extremt komplicerat vindmönster i Göteborg**




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**Verifiering av ARTEMIS - FEAT-mätningar**




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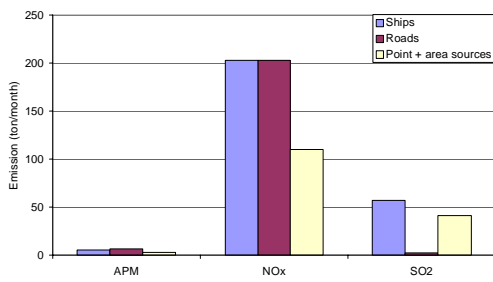
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**Fördelning av olika typer av emissioner i Gbg**

Emissioner från alla källor TAPM




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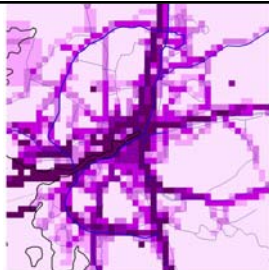
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**Totala emissioner för Göteborgs-området**  
d v s  
- vägar/fartyg  
- punktkällor  
- areakällor




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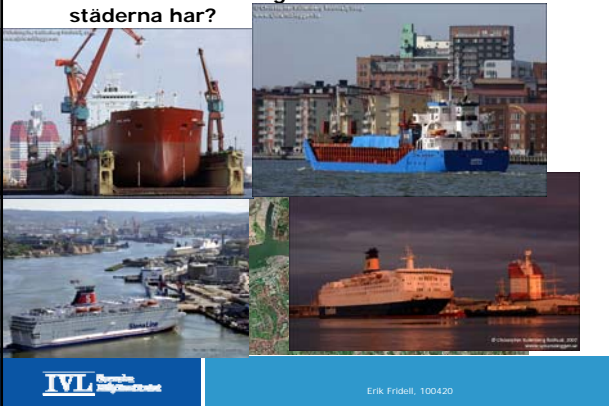
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Vad finns i Göteborg som inte de andra städerna har?



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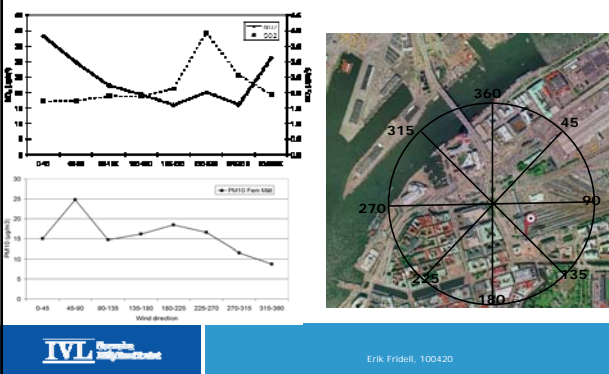
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Hur skall man se om det beror på fartygen?



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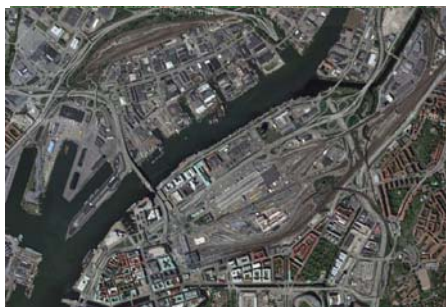
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vad finns det i nord till ostlig riktning?



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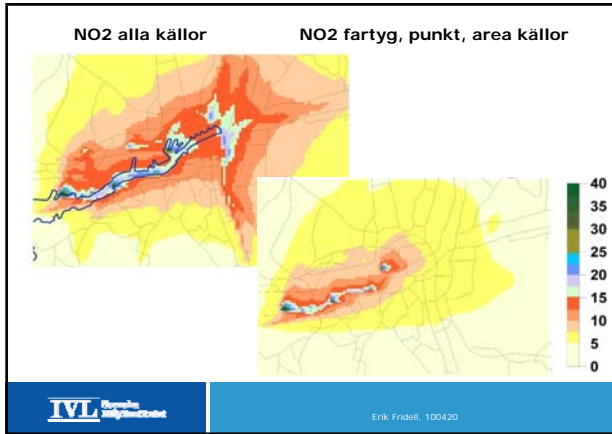
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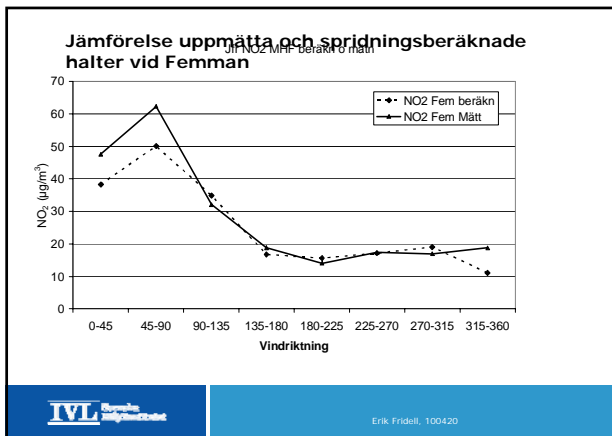
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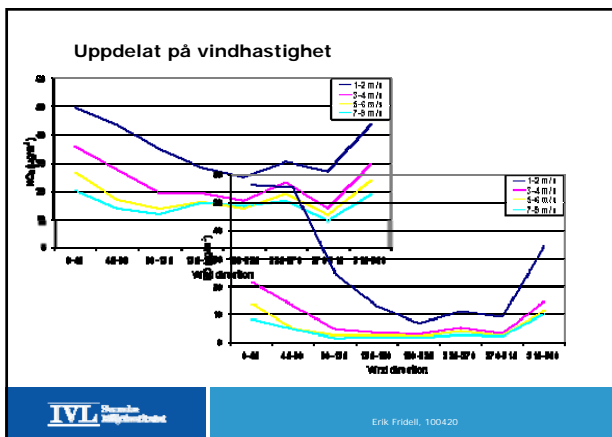
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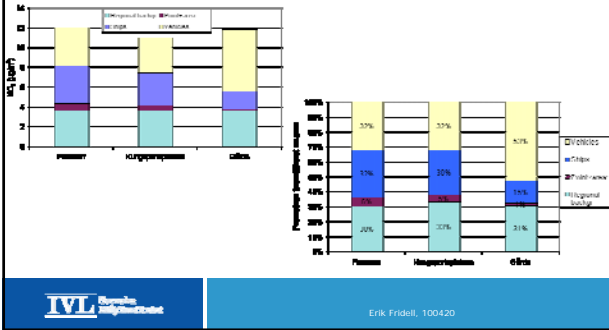
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### Bidragen från olika källor




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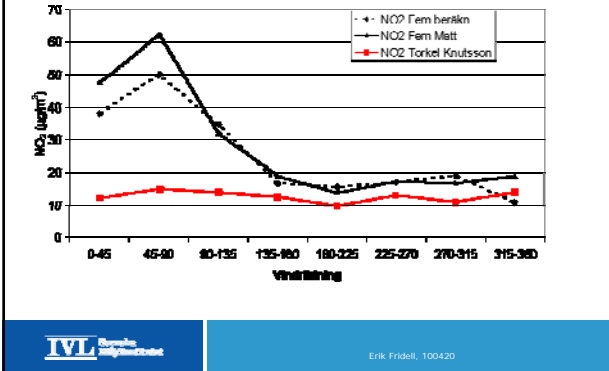
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### Jämförelse Göteborg och Stockholm




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### Stora variationer av NO2-halten i Göteborg

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Röken hög skorsten - ovanför inversionen följer regional vindriktning.  
 Rök låg skorsten - under inversionen följer lokal vindriktning (här  
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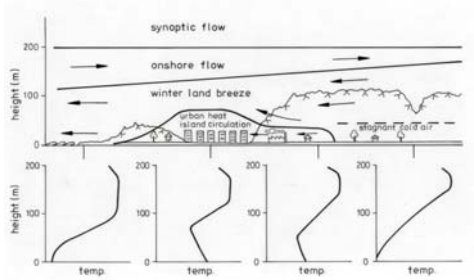
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### Extremt komplicerat vindmönster i Göteborg



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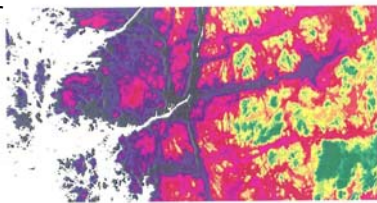
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### Höjdkarta över Göteborg



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**Ingen entydlig förklaring men några tänkbara:**

- Påverkan från fartyg - speciellt vid Femman
- Mycket nära till höga trafikemissioner
- Komplicerade spridningsförutsättningar vilket i högre grad påverkar lokalt emitterade föroreningar – såsom NO<sub>2</sub>.
- Finns teorier att dagens bilpark generellt kan vara en orsak till de högre NO<sub>2</sub>-halterna, till följd av primärt emitterad NO<sub>2</sub>. Detta borde dock påverka alla tätorter på liknande sätt....

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Nitrogen dioxide from traffic

Erik Fridell

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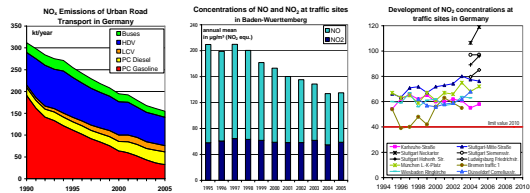
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German data (from Erank Dünnebell, Udo Lambrecht  
Institut für Energie- und Umweltforschung Heidelberg)



- NO<sub>x</sub> emissions from urban road transport have decreased.
- Measured NO<sub>x</sub> concentrations (NO+NO<sub>2</sub>) at traffic sites decreased considerably.
- Only slight reduction or even increase of measured NO<sub>2</sub> concentrations at traffic sites.

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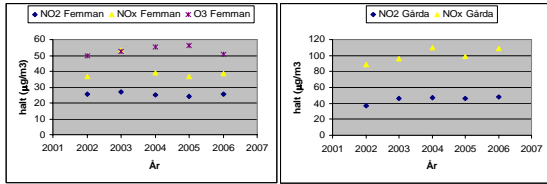
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### Yearly averages in Göteborg




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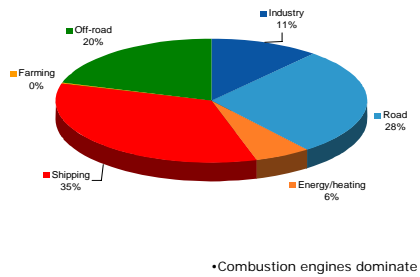
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### Sources of nitrogen oxides in Göteborg 2003




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### FEAT measurements of tailpipe emissions




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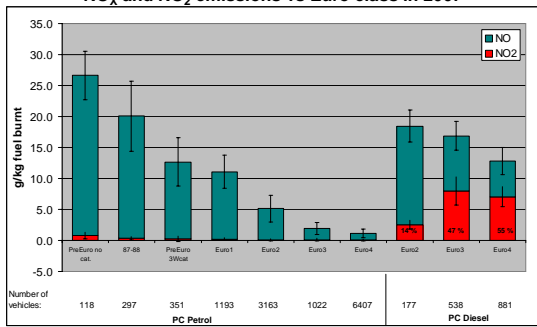
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**Gasoline and diesel passenger cars –  
NO<sub>x</sub> and NO<sub>2</sub> emissions vs Euro class in 2007**



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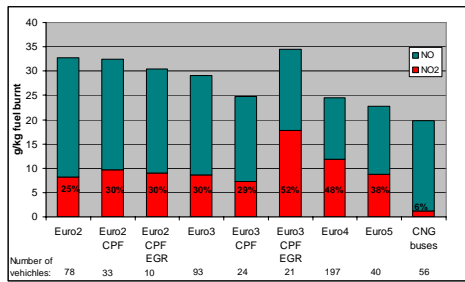
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**City buses and coaches –  
NO<sub>x</sub> and NO<sub>2</sub> emissions vs Euro class in 2007**



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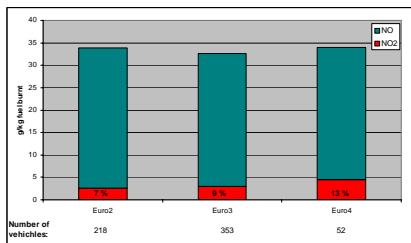
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**Heavy duty diesel trucks –  
NO<sub>x</sub> and NO<sub>2</sub> emissions vs Euro class in 2007**



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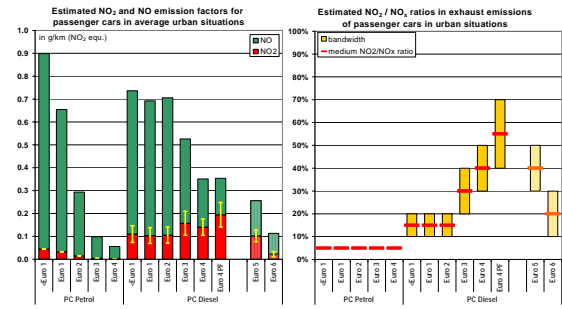
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### IFEU-study (Germany)



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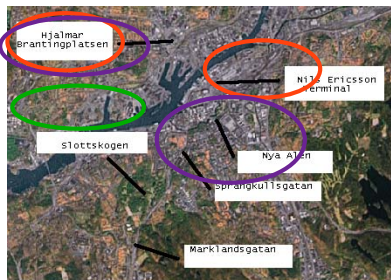
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### Passive sampling of NO, NO<sub>2</sub> and O<sub>3</sub>



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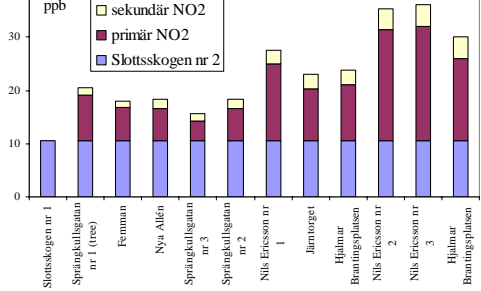
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### NO<sub>2</sub> results

secondary NO<sub>2</sub> obtained from O<sub>3</sub> decrease under background



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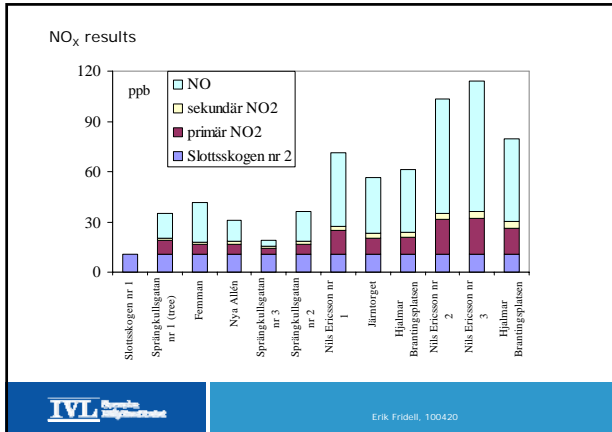
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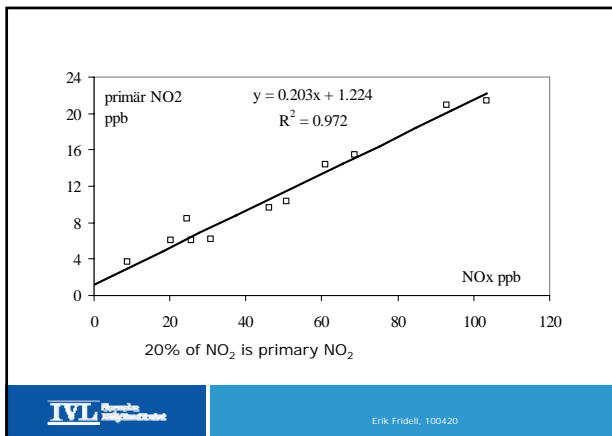
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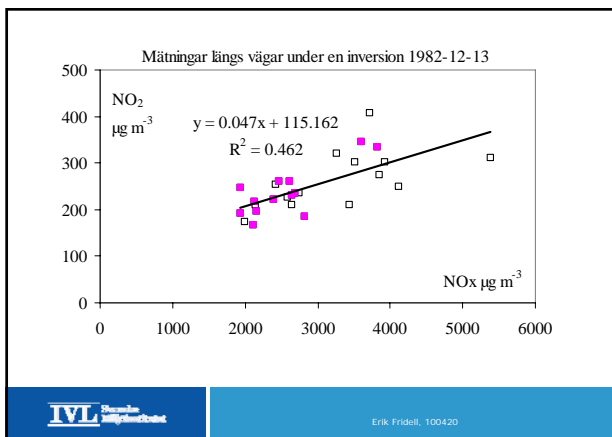
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### Ozon

- Summan av NO<sub>2</sub> och Ozon relativt konstant.  
Ozonhalterna ökar om NO emissionerna går ned.

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### Frågeställningar

- Hur har primäremissionerna av NO<sub>2</sub> och NO ändrats?
- Hur beror de av efterbehandlingsutrustning?
- Beroende av hastighet mm?
- Hur långt från en väg fås förhöjda NO<sub>2</sub> halter?
- Hur påverkar ozon och andra ämnen?

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