

Forskningsprogram <input type="checkbox"/>		<input type="checkbox"/>	
SNAP <input checked="" type="checkbox"/>		REPROSAFE <input type="checkbox"/>	
		FLIPP <input type="checkbox"/>	
		Inriktning: Ekonomiska styrmedel <input type="checkbox"/>	
		Inriktning: Informationssystem och indikatorer IPP	
Projekttitel (svensk): Betydelsen av långdistanstransporterade luftföroreningar för hälsoeffekter observerade i Stockholms län			
Projekttitel (engelsk): Comparing health effects due to local and imported air pollution in Stockholm (IMPORT)			
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## Miljöforskningsnämnden

### Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

Sammanfattning på svenska strukturerad enligt följande: 1) Projektets betydelse för programmet  
2) Miljörelevans och förväntad betydelse för miljöpolitiken 3) Mål och hypotes 4) Metodik och genomförande  
5) Kommunikationsinsatser i relation till programmet:

1. En stor del av luftföroreningshalterna i Sverige beror på utsläpp i andra länder. För att förstå orsakssambanden mellan luftföroreningshalter i utomhusluften och hälsoeffekter och kunna särskilja olika föroreningars effekter, behövs mycket omfattande statistiskt underlag så att olika hälsoutfall kan relateras till föroreningsepisoder med olika blandningar av föroreningar. Speciellt under senvintern och våren kan höga halter av partiklar uppkomma p g a intransport. Ozonhalterna i Sverige, som också till stor del är som högst under våren, beror på utsläpp av kväveoxider och kolväten i andra länder samt på nerblandning av stratosfäriskt ozon. I centrala delarna av Stockholm är ozonhalterna lägre än utanför staden. Den långdistanstransporterade luftföroreningsmixen varierar beroende på ursprung och tid på året. Detta gör även de lokala utsläppen — lokalt genererade grova partiklar maximeras under våren. Projektet möjliggör en utvärdering av hälsoeffekter associerade med olika luftföroreningar i omgivningsluften så att en kvantitativ bedömning kan göras av betydelsen av lokala respektive regionala föroreningar.

2. Sett utifrån miljömålen är det viktigt att kunna ange hur stor del av hälsoeffekterna som beror på lokala utsläpp i svenska städer respektive utsläppen utanför landets gränser. Det är också viktigt att förstå om det snarare handlar om föroreningsblandningar än om enskilda ämnen.

3. Målsättningen är att kvantifiera skillnaderna i olika hälsoutfall i Stockholms län, beroende på huvudsakligen lokala föroreningar respektive huvudsakligen intransporterade. Hypotesen är att de långdistanstransporterade luftföroreningsepisoderna har stor betydelse för vissa hälsoutfall samt att blandningen av föroreningar kan vara viktig, inte enbart enskilda ämnen.

4. Studien bygger på historiska data avseende luftföroreningshalter och hälsostatistik. Till grund för analysen av andelen lokalt respektive i Stockholms län regionalt ligger mätdata i länet samt från bakgrundsstationen Aspveten. Ursprunget till föroreningarna bestäms med hjälp av trajektorieanalys (4 dygns bakåtrajektorier). Dessa beräkningar genomförs med dygnsupplösning för ca 10 års mätdata och meteorologiska data. För de sista tre åren genomförs även spridningsberäkningar med MATCH-modellen på Europaskala inklusive en aerosolmodul. Modellen ger bidraget från långtransport till partikelhalter inklusive storlek uppdelat i en sekundär oorganisk fraktion, havssalt, och en primär antropogen fraktion. Även gasformiga föroreningar beräknas. För vissa typiska trajektorier används resultaten från MATCH-modellen för att karaktärisera utvecklingen av partikelegenskaperna mer i detalj längs trajektorian. Tidsserierna av luftföroreningsdata analyseras sedan tillsammans med tidsserier av hälsoutfall som hämtas från slutenvårds-, dödsorsaks- och hjärtinfarktregistren

5. Resultaten rapporteras vid SNAP's seminarier/konferenser samt i form av en slutrapport. Arbetet kommer till stor del att genomföras av en doktorand vid ITM och SMHI och kommer att publiceras i vetenskaplig tidskrift.

	År 2004	År 2005
Summa sökta medel per år i kr:	1 126 633	994 519

**Miljöforskningsnämnden**  
**Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram**

<b>Sökta projektmedel fördelade på kostnadsslag</b>	<b>År 2004 (k)</b>	<b>År 2005 (k)</b>
Personalkostnad inkl. soc. avgifter *		
ITM Stockholms univ (doktorand 31%, docent 6%)	403 000	131 750
SMHI (forskare 22%)	325 500	108 500
AMM (forskare 6%, doktorand 33%)	170 500	403 000
Se Projekt beskrivning ang personal.		
Övriga omkostn exkl moms (förbrukningsmtrl, analyser, resor etc) **		
Resor ITM		30 000
Resor SMHI		30 000
Resor AMM		40 000
Hälsodata		20 000
<b>Delsumma av ovanstående poster:</b>	<b>899 000</b>	<b>743 250</b>
Förvaltningspåslag:		
ITM (23%)	93 093	37 364
SMHI (23%)	74 865	31 855
AMM (35%)	59 675	162 050
<b>Totalsumma per år: (införs sid. 1):</b>	<b>1 126 633</b>	<b>994 519</b>

\*) Specificera namn, tjänst \*\*) Specificera

**Samtliga övriga miljörelaterade projekt för vilka de sökande har beviljats anslag eller söker anslag för 2004-2006. OBS Även EU-finansiering.**


Projekttitel	Finansiär	Tidsperiod	Sökt kr	Beviljat kr
Utv. & validering av modell för beräkning av PM10 i urban miljö (CJ)	Vägverket	2002-04		1 487 000
Partiklar i stadsmiljö — utsläpp, spridning och hälsoeffektskattningar med dos- respons samband (CJ)	SNAP	2001-04		2 100 000
Att skatta exponering – jämförelse mellan mätningar och beräkningar baserade på spridningsmodellering (EXPOSE) (CJ/SLB)	SNAP	2004-05	2 832 000	
Kvantifiering av relativa betydelsen av dubbdäck, sandning/saltning och vägmateriäl för PM10 halten längs vägarna (CJ/ITM)	Vägverket	2004-05	1 957 000	
Direktmätningar bakom fordon på väg av ultrafina avgaspartiklar och sot från olika fordonstyper (CJ/ITM)	Vägverket	2004-06	2 459 000	
Kvantifiering av urbana partikelemissioner för bättre skattning av regionala och globala klimateffekter (CJ/ITM)	Vägverket	2004-06	1 643 000	

**Miljöforskningsnämnden**  
**Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram**

Miljörelaterade projekt för vilka sökande har beviljats anslag för 2000-2003

**OBS Även EU-finansiering**

Projekttitel	Finansiär	Tidsperiod	Beviljat Kr
Partiklar i stadsmiljö — utsläpp, spridning och hälsoeffektskattningar med dos- responssamband (CJ)	Vinnova	2001-03	1 868 000
Flöden till luften av partiklar och metall Stockholm (CJ)	Vinnova	2001-03	608 760
ALVA (TB)	NV/Formas	2001-03	1 320 000
SENSI (TB)	NV/SNAP	2003	499 969
Airgene (TB)	EU	2003	979 560
Luftkvalité i små barns inomhusmiljö	NV/SNAP	2002-03	859 916
Cohort Feasability	NV/SNAP	2002-03	297 000
INDEX	Vägverket	2000	333 333
ONSET	NV/SNAP	2002-03	500 000

<p>Datum och sökandes underskrift, vilken samtidigt ger Naturvårdsverket tillåtelse att publicera sökandes namn på sin webbplats:</p>   <p>Christer Johansson</p>	<p>Datum och underskrift av prefekt eller motsvarande med namnförtydligande:</p>   <p>HC Hansson</p>
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Ansökan skall bestå av detta formulär jämte högst sex sidor lång projektbeskrivning på **engelska** (strukturerad som den svenska sammanfattningen samt en redovisning av kunskapsläget). Referenser till egna publikationer ges med sifferhänvisning till CV. Andra referenser ges i löpande text. Sökandes och eventuell medsökandes CV får omfatta högst två sidor. Inga bilagor kommer att beaktas vid bedömningen. Ansökan (max 10 A4-sidor, 12 punkters teckenstorlek) skall inlämnas i **original + 15 kopior samt elektroniskt** till [ansok@naturvardsverket.se](mailto:ansok@naturvardsverket.se). Häfta ihop ansökan och använd hålat papper. Ansökan skall ha inkommit senast den 15 oktober 2003 till Naturvårdsverket, Forskningssekretariatet, 106 48 STOCKHOLM.

# Comparing health effects due to local and imported air pollution in Stockholm (IMPORT)

Project co-ordinator: Christer Johansson, Institute of Applied Environmental Research, Stockholm university

*Keywords: PM10, PM2.5, Ozone, , long range transport, daily mortality, hospital admissions*

## Background & importance for the SNAP programme

It is well known that a substantial fraction of the levels of air pollutants observed in Swedish cities is due to transport from source regions outside the country. The relative importance of local versus long-range transported (LRT) air pollutant contributions varies depending on compound and on season. For ozone there are no local sources, all ozone is formed during horizontal transport from western or central European countries or transported downwards from the stratosphere. For particulate matter the relative importance of local versus LRT depends the size of the particles. A Swedish network for monitoring PM<sub>2.5</sub> /PM<sub>10</sub> has been set up providing data for regional background, urban background and street sites in five urban areas and at two rural background sites. This network shows a dominant influence of long-range transported particles. The fine particle mass fraction (PM<sub>2.5</sub>) is mainly imported, only close to densely trafficked streets during the spring local traffic is dominating PM<sub>2.5</sub>. For PM<sub>10</sub> the local influence becomes even more important during the spring period, but LRT may still be as important as local sources during other periods of the year. The ultrafine particle fraction is mainly due to local sources, but during spring and summer new particle formation (nucleation events) in background air masses may be important as well.

The relations between the occurrence of mixtures of air pollutants and human health are not well understood. There is, for example, limited evidence that particle mass is the actual property harmful to human health. There are indications that several other characteristics of air pollution are harmful such as certain gases and chemical components in particles. Other parameters suggested are particle number and particle surface area.

Trajectory calculations have been used to predict air quality (eg Buchanan et al 2002, Schlink et al 2003), and have been shown to differentiate between particulate matter with different experimental toxicity (Godleski et al 2000). However, categorisation of geographical origin of air pollution has not so far been used in the study of short-term effects on human health.

The separation of adverse effects on human health according to geographical origin of air pollution is important both from a scientific and a regulatory view. It will contribute to the understanding of what properties of air pollution that are responsible for the health effects, and it will give policy makers sharper tools when designing protective systems.

## Goals of the project

The aim of this project is to assess the relative importance for health effects of local versus categories of long-range transboundary air pollution. Since the local air pollution mix is different from the long range transported, this evaluation will also provide insights into the question of which parameters are most important for the health effects. Is it enough to consider only one parameter or is it the mix of air pollutants that need to be evaluated? Since it is expected that the characteristics of air pollution coming from eastern Europe will differ significantly from air pollution of western Europe, different health impact might be seen that are not related to the absolute levels, but rather to the chemical composition.

## Methodology & implementation

Daily information on air quality and health will be collected for approximately 10 years (1994 – 2003). A database with all information will be created so that different statistical methods can easily be applied to assess the relations between health impact and air pollution. The data base will also contain information on meteorological conditions.

### ***Air pollution data***

Historical data on air pollution mainly from the monitoring network in Stockholm county and from the background station Aspvreten will be used to quantify the local versus long-range transported part of the air pollution (some of these data are shown online, <http://slb.nu>).

The main parameters will be PM<sub>10</sub>, PM<sub>2.5</sub>, total particulate carbon, NO<sub>2</sub> and ozone. Since about 3 years there are data at these sites on the total number of particles and the particle size distribution (the data from Aspvreten is part of the ASTA programme; see [www.ivl.se](http://www.ivl.se)) and the data from Stockholm is part of the PASTA project of SNAP. There is also the possibility to include daily Black smoke values from some of the cities of the urban air quality network.

### ***Tracing the origin of the air pollution and describing the meteorological conditions***

The long range transported air pollution will be classified according to its origin. The origin may be determined based on trajectory analysis. Daily back trajectories will be calculated and classified in terms of source regions.

The European emission data of EMEP on sulfur, oxidized and reduced nitrogen and primary anthropogenic particulate matter will be used to divide Europe with respect to source regions. Western European sources are relatively more influenced by exhaust from new vehicles. In Eastern Europe a large fraction of the vehicles are still old without catalysts and there are industrialised areas with relatively high emissions and several large power plants using coal as main fuel. We therefore expect to find quite significantly different air pollutant composition depending on the air mass origin, its trajectory and time spent in different regions.

It will also be necessary to characterise the days in terms of meteorological conditions described as temperature (day and nighttime mean values), solar radiation, relative humidity, wind speed and precipitation. SMHI will provide complementary data to the measurements in Stockholm. The methods for confounding control of meteorology in time-series studies are debated (eg Keatinge & Donaldson 2001) and subject of an ongoing EU-funded study

(“PHEWE”, PI Paola Michelozzi). The results of the latter will be incorporated in our analysis.

### ***Detailed classification of the air pollution***

Both the long range transported air mass and the local influence on air pollution will be characterised in terms of chemical composition and absolute levels. This analysis include PM10, PM2.5, total particle numbers and particle size distribution, total particulate carbon, NO<sub>2</sub> and ozone.

The MATCH model (Robertson et al. 1999) has recently been extended with an aerosol module. At present the module contains a size resolved description of secondary inorganic PM (sulfate, nitrate, ammonia), seasalt and primary anthropogenic PM currently without chemical speciation. The model can be applied on the European scale to calculate the long-range transport of PM to Scandinavia. For at least the last three years of the study period the MATCH model will be used to calculate the daily contribution from long-range transport to particulate matter in Stockholm. This characterisation will include particle size distribution and chemical composition. For some typical air mass trajectories the MATCH model will be used to characterise the history of the air pollution in more detail by examining the evolution the aerosol characteristics along the trajectories.

### ***Health data***

The health data that will be used include daily mortality and hospital admissions in Stockholm county 1994-2003. The data, which builds on previous SNAP projects (HEAPSS, ONSET, SENSI), come from the national in-patient, cause of death and myocardial infarction registers. The main health outcomes will be hospital admissions due to cardiovascular and pulmonary disease and total non-violent deaths. Also cause specific mortality and specific admissions diagnoses will be analysed.

### ***Exposure-response relations***

The relation between exposure variables and health outcome will be analysed with time series methods such as Poisson regression, with updated control for meteorological parameters. In the analysis we will be able to separate between the effects of pollution that are mainly transported in from sources outside of the study area (e.g. PM2.5 and Ozone) and the effects of pollution from local, especially traffic-related sources (e.g. NO<sub>2</sub>). With the additional information on origin of the LRT pollution, this separation can be done in a more precise fashion than what has previously been possible. We will also have to possibility to separate between the health effects of different sources of the same pollutant. Potentially sensitive subgroups will be identified from previous in-patient registries. It will build on the similar ongoing SNAP studies. Collaboration will be sought with other similar SNAP projects (eg PASTA) in order to include this new time series of trajectories in other future analyses of short-term health effects.

### ***Reports and time plan***

Since the project is based on historical data the analysis can commence early 2004. The project will be reported according to the general agenda for projects of SNAP, with a final report at the end of 2005.

A validated air pollution database including air mass classification and meteorology will be created during 2004. After the trajectory analysis and classification of air masses have been conducted the MATCH model will be used to obtain the more detailed characterisation. This work need be finished by the beginning of 2005.

Beginning in 2004 the health statistics will be gathered and then the main statistical analysis can be performed mainly in 2005. After the first original publications on the development of this exposure metric and its application to health data, the produced time series will be made freely available to other researchers, also outside the SNAP program.

## Personnel

The project will be co-ordinated by Christer Johansson, who will also be responsible for the assessment of the local versus regional air pollution contributions based on measurement data from the air pollution monitoring networks of Stockholm. Joakim Langner will be responsible for the air mass trajectories and characterisation of regional air pollution. The main work will be done by a PhD student at Stockholm university, supervised in this project jointly by Joakim Langner and Christer Johansson.

Tom Bellander and his PhD student will be responsible for the health evaluation and statistical analysis. The main part of their work will be performed in 2005.

## References

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## **CV of Christer Johansson**

*Christer Johansson* is associate professor (docent) in chemical meteorology at Stockholm university. He got his PhD 1989 at the Department of Meteorology, Stockholm university. He has a research position (universitetslektor) at the Air Pollution Laboratory of the Institute of Applied Environmental Research (Stockholm university; <http://www.itm.su.se>). He is also employed as environmental officer at the Environment and Health Protection Administration of the city of Stockholm (<http://www.slb.nu>). He has long experience of both air pollution measurements and dispersion modelling of air pollutants and has published more than 20 papers in peer-reviewed scientific journals. At Stockholm university he work as lecturer in graduate and undergraduate courses in atmospheric chemistry, biogeochemical cycles and dispersion modelling. He is currently supervisor of three PhD students and responsible for several research projects dealing with urban air pollution.

## **CV of Joakim Langner**

*Joakim Langner* leads the Air Quality research group at SMHI (<http://smhi.se>) with a staff of eight and has a Ph.D. in meteorology from Stockholm University. He is specialised in atmospheric dispersion modelling and atmospheric chemistry and has been working for more than 10 years with development and application of atmospheric dispersion models, including atmospheric chemistry and particulate matter, on regional to local scales. The Ph.D. work was done within the framework of a European research project and dealt with modelling of the dispersion of sulfur compounds on global scale and its impact potential on climate. The work at SMHI has been focused on development and operational application of a regional, three-dimensional transport/chemistry/deposition model called MATCH for nuclear emergency response, surface ozone forecasts, regional and local air pollution, deposition assessments and other environmental studies.

## **CV of Tom Bellander**

*Tom Bellander* was born in 1950, obtained MSc in 1976 and PhD in 1987. His previous line of research was occupational hygiene and epidemiology (1974-1997). His current interest is in environmental epidemiology and in particular the exposure characterisation in population studies. TB holds a position as assistant director of the Unit of Environmental Health within the Department of Occupational and Environmental Medicine, Stockholm County Council, and is also associate professor at the Institute of Environmental Medicine, Karolinska Institutet, Stockholm. One of his doctorate students has obtained the doctoral degree and TB is currently the main tutor of two doctorate students. TB has repeatedly served as temporary expert at the WHO. TB has been involved in a leading role in many national and international research projects, and has co-authored more than 40 original papers.