

Supplement of Atmos. Chem. Phys., 19, 12975–12992, 2019  
<https://doi.org/10.5194/acp-19-12975-2019-supplement>  
© Author(s) 2019. This work is distributed under  
the Creative Commons Attribution 4.0 License.



*Supplement of*

## **Contributions of Nordic anthropogenic emissions on air pollution and premature mortality over the Nordic region and the Arctic**

**Ulas Im et al.**

*Correspondence to:* Ulas Im (ulas@envs.au.dk)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

The Danish Air Quality Monitoring Programme consists of an urban monitoring network that includes stations in the four largest Danish cities (Aalborg, Aarhus, Copenhagen and Odense) and two background stations in rural areas (Keldsnor and Risø). The design of the Danish air quality monitoring network is based on location of one or more pairs of stations in each of the four cities (Ellermann et al., 2015). In each city one of the stations is located at a pollution hot spot close (at the sidewalk) to a street lane with a high traffic density. The other station is located within a few hundred meters from the street station. It is placed so that it is not influenced by emissions from a single or a few streets or other nearby sources and hence is representative for the urban background pollution. In most cases the background stations are placed on rooftops. In addition, rural stations monitor the pollution outside city areas.

The measurement data for Finland represents regional and urban background levels. Data from the global and regional background stations are reported to European Monitoring and Evaluation Programme (EMEP) under the CLRTAP (Convention on Long-range Transboundary Air Pollution, <http://www.unece.org/env/lrtap>), and are available at <http://ebas.nilu.no>. The data for the urban background stations are reported at the ‘Air Quality in Finland’ web pages by the Finnish Meteorological Institute (<https://en.ilmatieteenlaitos.fi/air-quality>).

The measurement dataset from Norway is from the national monitoring program of air pollutants financed by the Norwegian Environment Agency (Aas et al, 2018), and also reported to European Monitoring and Evaluation Programme (EMEP) under the CLRTAP (Convention on Long-range Transboundary Air Pollution, <http://www.unece.org/env/lrtap>). The data is openly available at <http://ebas.nilu.no>. The data from the city background stations is reported to European Environmental Agency (EEA: <http://www.eea.europa.eu/>) as required in the EU air quality directive (EU, 2008) and it is available at <http://www.luftkvalitet.info>.

The measurement dataset for Sweden were extracted from the openly available Shair data base (<http://shair.smhi.se/portal/concentrations-in-air>), which includes most national environmental data and is financed by the Swedish Environmental Agency. The observation sites used here were carefully selected to represent urban background at rooftop level, rural or regional background, and to have known good quality.

Table S1. Geographical information of the measurement stations used for model evaluation.

Station Name	Longitude	Latitude	Station Type	Pollutants
Denmark				
Anholt	11.52	56.72	Regional background	NO <sub>2</sub>
Ulborg	8.43	56.29	Regional background	NO <sub>2</sub> , O <sub>3</sub>
Keldsnor	10.74	54.75	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub>
Risø	12.09	55.69	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Odense Rådhus	10.39	55.40	Urban background	NO <sub>2</sub> , O <sub>3</sub>
Aarhus Botanical Garden	10.19	56.16	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>2.5</sub>
Aalborg Østerbro	9.93	57.05	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>2.5</sub>
Copenhagen HCØ	12.56	55.70	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Finland				
Luukki	24.68	60.31	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>2.5</sub> , SO <sub>2</sub>

Oulanka	29.40	66.32	Regional background	NO <sub>2</sub> , O <sub>3</sub> , SO <sub>2</sub>
Sammaltunturi	24.11	67.97	Regional background	NO <sub>2</sub> , O <sub>3</sub> , SO <sub>2</sub>
Uto	21.37	59.78	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>2.5</sub> , SO <sub>2</sub>
Virolahti	27.67	60.53	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub>
Ahtari_2	24.19	62.59	Regional background	NO <sub>2</sub> , O <sub>3</sub>
Kallio_2	24.95	60.19	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , SO <sub>2</sub>
Kasarmipuisto	27.67	62.89	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Kisapuisto	25.65	60.99	Urban background	NO <sub>2</sub>
Norway				
Birkenesobservatoriet	8.25	58.39	Regional background	O <sub>3</sub>
Haukenes	9.49	59.20	Regional background	NO <sub>2</sub> , O <sub>3</sub>
Hurdal25	11.07	60.37	Regional background	O <sub>3</sub>
Kårvatn	8.88	62.78	Regional background	O <sub>3</sub>
Lommedalen	10.49	59.95	Regional background	O <sub>3</sub>
Prestebakke	11.53	59.00	Regional background	O <sub>3</sub>
Sandve	5.20	59.20	Regional background	O <sub>3</sub>
Tustervatn	13.91	65.83	Regional background	O <sub>3</sub>
Grønland	10.76	59.91	Urban background	NO <sub>2</sub> , O <sub>3</sub>
Lillehammer	10.47	61.12	Urban background	NO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Rådhuset	5.33	60.39	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Sofienbergparken	10.77	59.92	Urban background	NO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Torvet	10.40	63.43	Urban background	NO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Vaaland	5.73	58.96	Urban background	NO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Sweden				
Aspvreten	17.38	58.80	Regional background	O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Bredkalen	15.34	63.85	Regional background	O <sub>3</sub> , PM <sub>2.5</sub>
Esränge	21.07	67.88	Regional background	O <sub>3</sub>
Raao	11.91	57.39	Regional background	O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Vavihill	13.15	56.03	Regional background	O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Grimso	15.47	59.73	Regional background	O <sub>3</sub>
Norra_Kvill	15.56	57.81	Regional background	O <sub>3</sub>
Norr_Malma	18.63	59.83	Regional background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub>
Ostad	12.40	57.95	Regional background	O <sub>3</sub>
Vavihill	13.15	56.03	Regional background	O <sub>3</sub> , PM <sub>10</sub> , PM <sub>2.5</sub>
Vindeln	19.77	64.25	Regional background	O <sub>3</sub>
Goteborg_Femman	11.97	57.71	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub>
Malmo_Raadhuset	13.00	55.61	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub>
Stockholm_Torkel_Knutssongatan	18.06	59.32	Urban background	NO <sub>2</sub> , O <sub>3</sub> , PM <sub>10</sub>

Table S2. Model evaluation for the daily mean concentrations of NO<sub>2</sub> and SO<sub>2</sub> for all the available stations in the Nordic countries.

	NO <sub>2</sub>					SO <sub>2</sub>				
	<i>r</i>	<i>Obs.</i> (µg m <sup>-3</sup> )	<i>MB</i> (µg m <sup>-3</sup> )	<i>NMB</i> (%)	<i>RMSE</i> (µg m <sup>-3</sup> )	<i>r</i>	<i>Obs.</i> (µg m <sup>-3</sup> )	<i>MB</i> (µg m <sup>-3</sup> )	<i>NMB</i> (%)	<i>RMSE</i> (µg m <sup>-3</sup> )
Denmark	0.55	10.10	-4.57	-0.33	5.59	N/A	N/A	N/A	N/A	N/A
Finland	0.61	5.75	-3.60	-0.47	3.96	0.80	0.58	-0.19	-0.25	0.42
Norway	0.42	17.24	-15.20	-0.82	16.29	N/A	N/A	N/A	N/A	N/A
Sweden	0.63	11.45	-7.52	-0.56	7.92	N/A	N/A	N/A	N/A	N/A

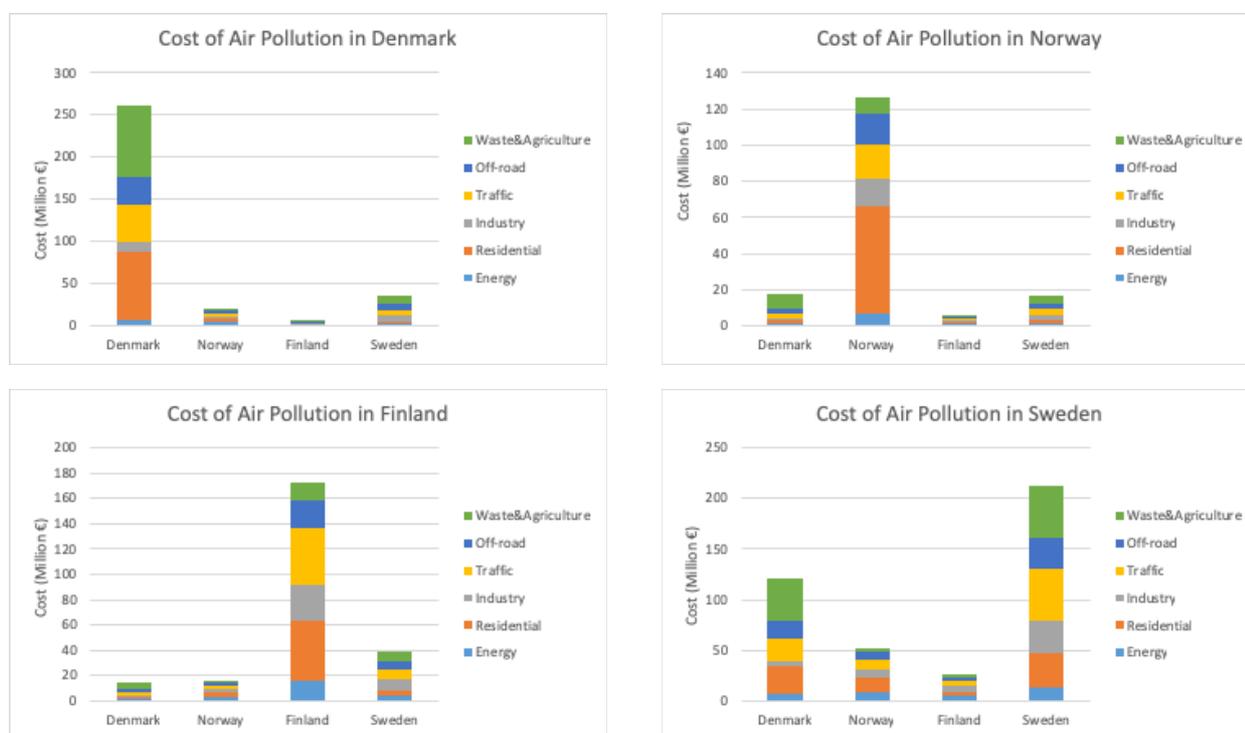


Fig. S1. Sectoral contribution of emissions to health-related costs in a) Denmark, b) Norway, c) Finland, and d) Sweden.