European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

INTERNATIONAL WG1-WG4 MEETING on

New Sensing Technologies and Modelling for Air-Pollution Monitoring

Institute for Environment and Development - IDAD

Aveiro, Portugal, 14 - 15 October 2014

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 3: 2014-15 (*Ongoing Action*)

Assessing Human Exposure to Air Pollution in Health Assessment Studies in Europe

Aarhus University

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Function in the Action: (WG3 Chair)

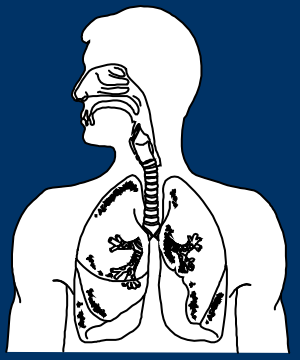
Aarhus University, Denmark

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

Measurements from routine monitoring programmes often used in dose-response studies: six cities study etc.

Particulate matter responsible for most of the negative health effects



Ozone believed to be the second most Health hazardous compound

Since the 1990ties focus on short-term but also long-term effects

Personal exposure monitoring:
APHEA, APHEA-2, EXPOLIS, CITI-SENSE etc

Simple proxies like distance to road:
Brunekref et al.

Modelling based on US studies in many European assessments:
Künzli et al., etc

Modelling includes both Chemistry-Transport Models (CTM) and Land-use regression (LUR) models

RAINS/GAINS & Danish EVA system:
Applies most recent dose-response

Long term effects according to Hoek et al. (2013)

Health effects	PM_{10} per 10 µg/m³	$PM_{2,5}$ per 10 µg/m³	EC/BC per 1 µg/m³	NO_2 per 10 µg/m³
Total deaths	3,5 % (0,4 % -6,6%)	6,2 % (4,1% - 8,4%)	6,1 % (4,9 % - 7,3 %)	5,5 % (3,1 % - 8 %)
Cardiovascular deaths	2 % to 8 % ($PM_{10-2,5}$)	15 % (4 % - 27 %)	4 % to 11 %	-2 % to 36 %
Respiratory deaths	4% to 67%	2,9% (-6% -13%)	11 %	3 % to 197 %

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Danish approach in AIRPOLIFE similar to the one applied in cancer assessment within ESCAPE (and COMPRISE in case of funding):

Mix of measurements and model calculations in dose-response determination

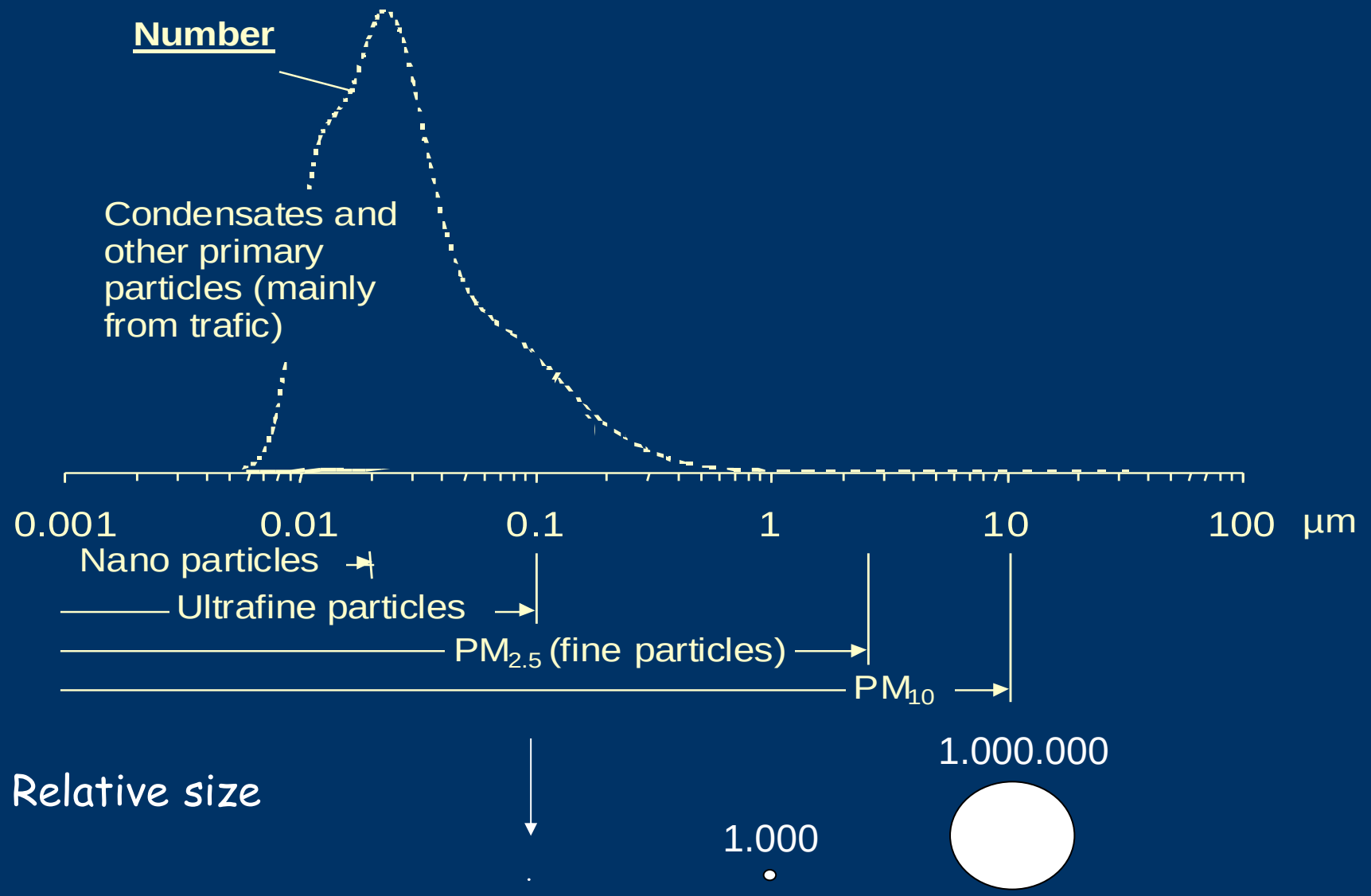
Measurements generally used in assessment of short-term effects – dose-response

Model calculations used in long-term effects – dose-response – AirPOLIFE and EGEA-2, ECRHS-I & II

Recent health assessments indicate that carbon black and possibly also organic carbon may be better indicators of health effects compared with $PM_{2.5}/PM_{10}$

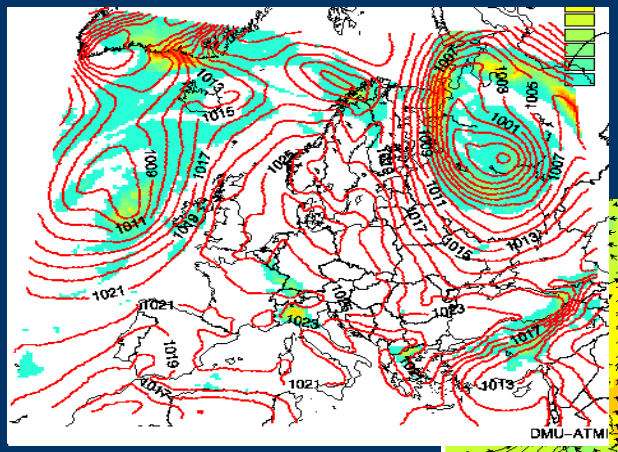
(Jannsen et al. 2012)
(Rohr & Wyzga, 2012)

(WHO, 2012)


Number
Condensates and other primary particles (mainly from trafic)
0.001
0.01
0.1
1
10
100
µm
Nano particles
Ultrafine particles
PM2.5 (fine particles)
PM10
Relative size
1.000.000
1.000

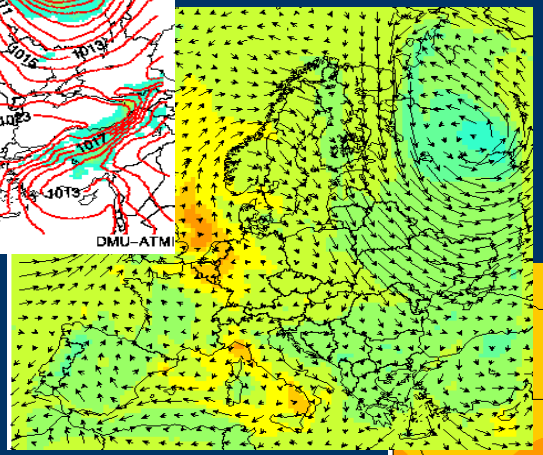

Concentration
Regional
Distance
City area

The coupled series of models in the THOR system

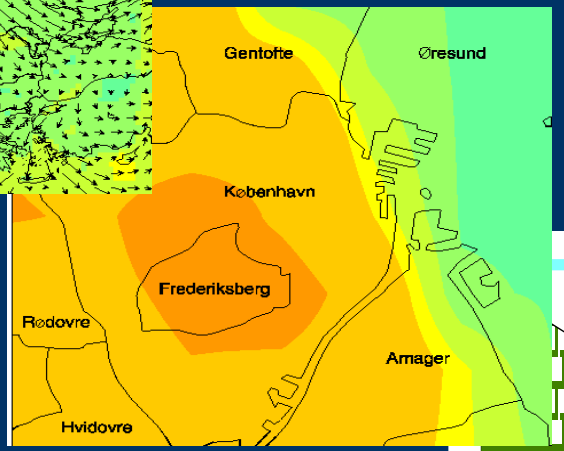


Weather

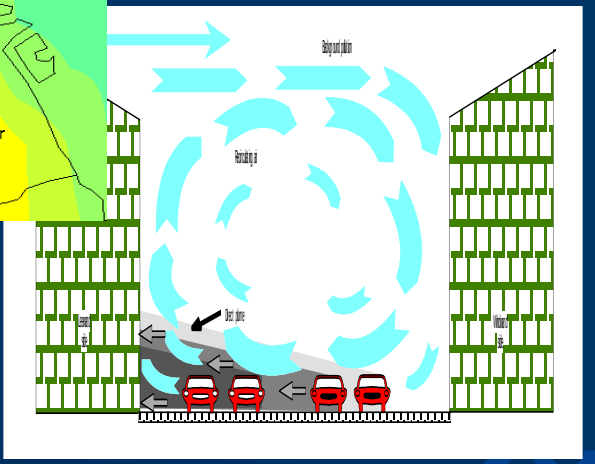
Long range transport



Urban scale

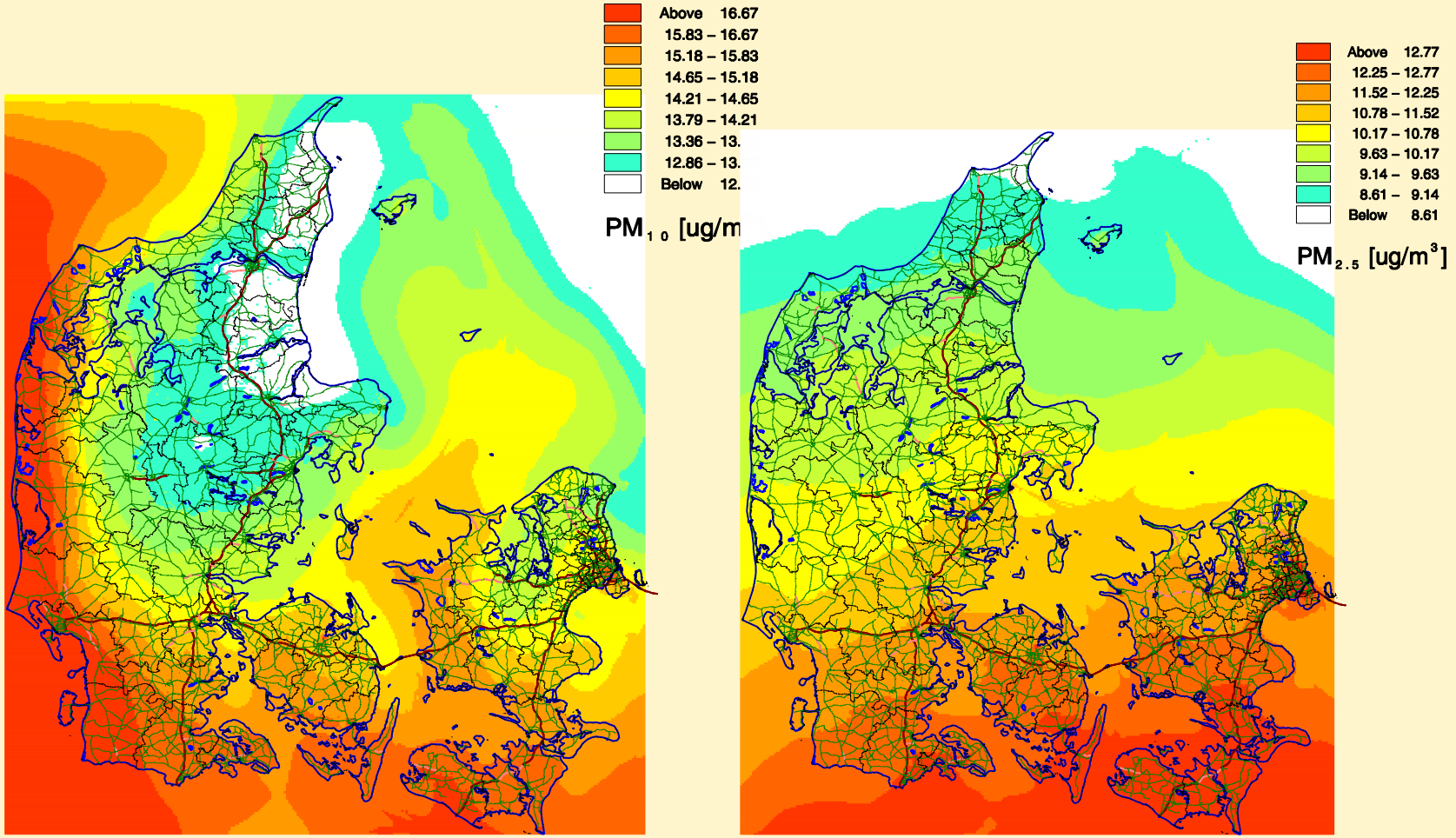


Street scale



Run 3-days pollution forecasts
4 times a day with the THOR system

Modelled PM10 and PM2.5 using UBM model



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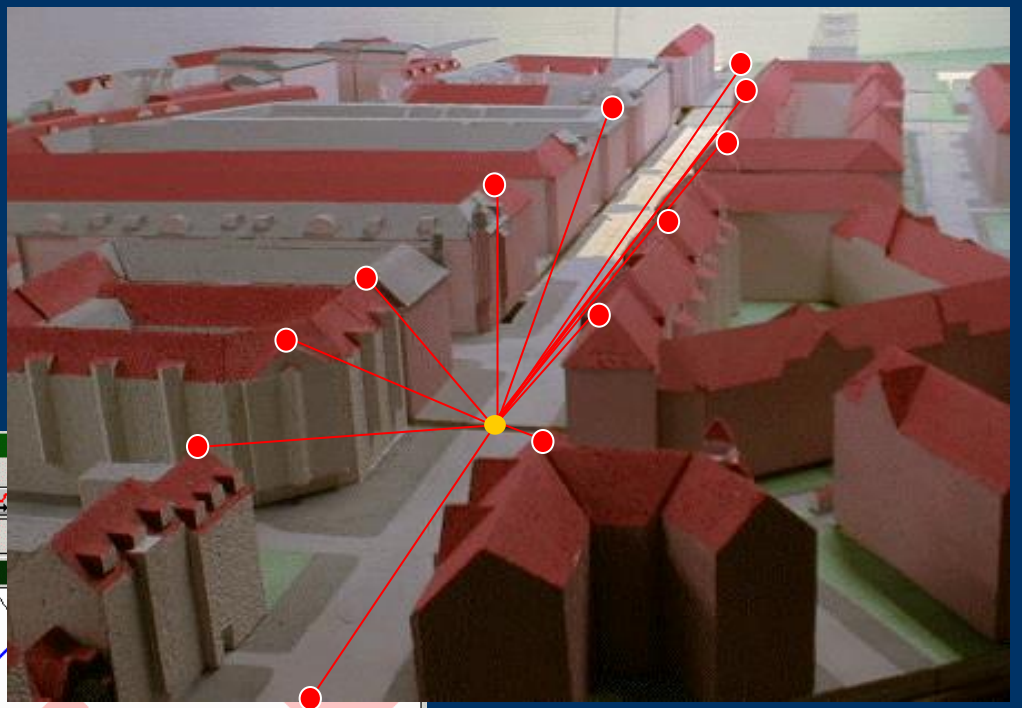
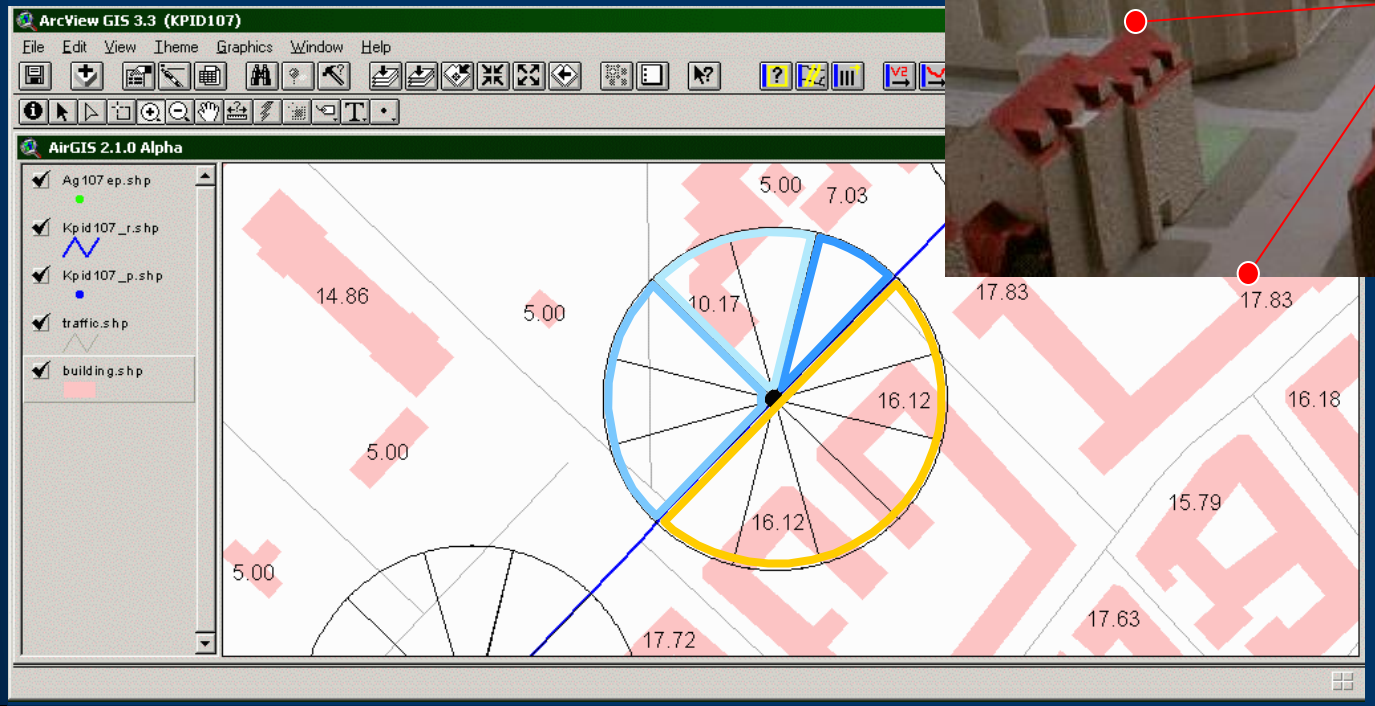
AirGIS automatic generation street configuration

Calculations for the nutrition, cancer, health cohort of 50.000 people & 200.000 addresses
Currently mapping all Danish addresses





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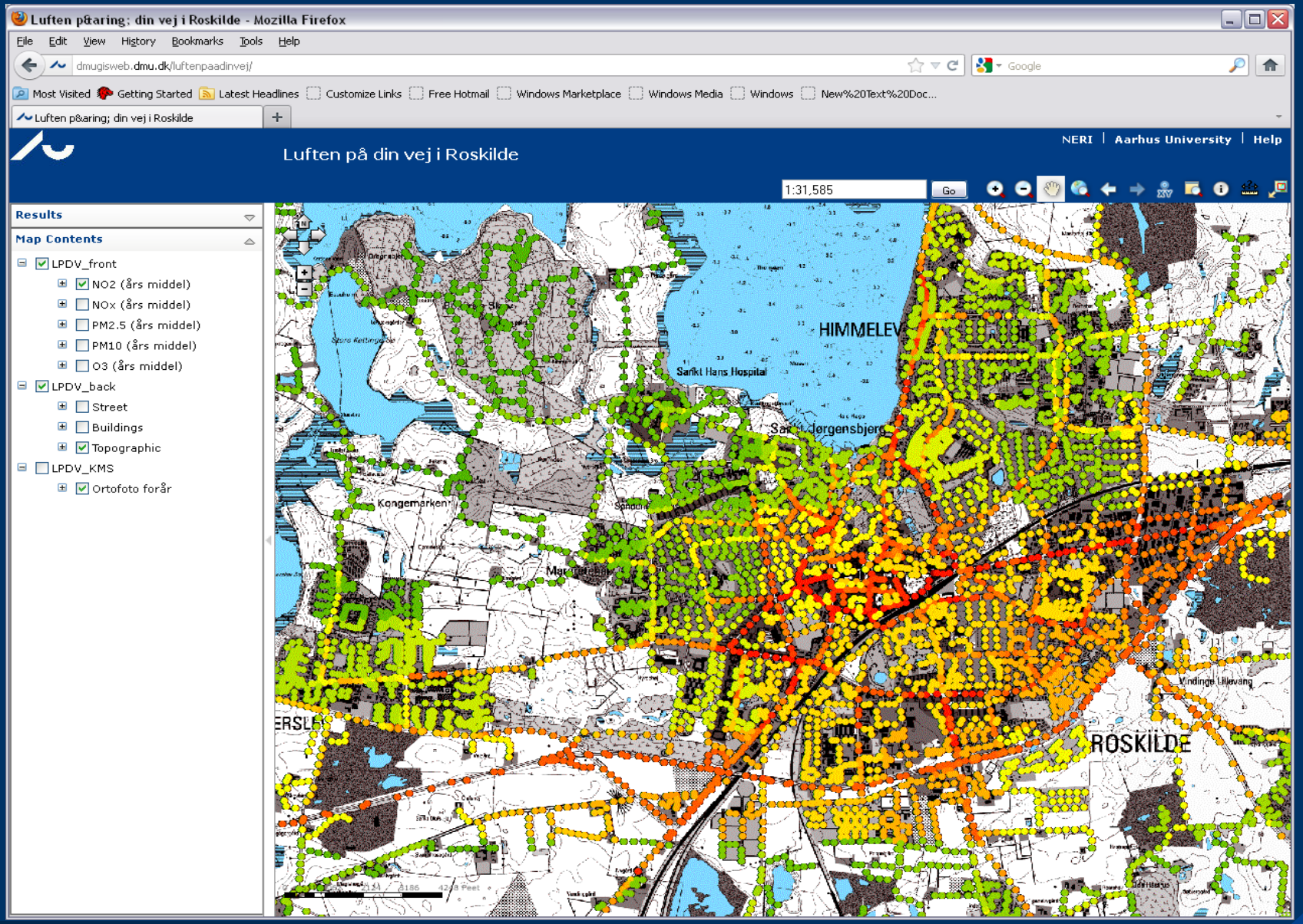
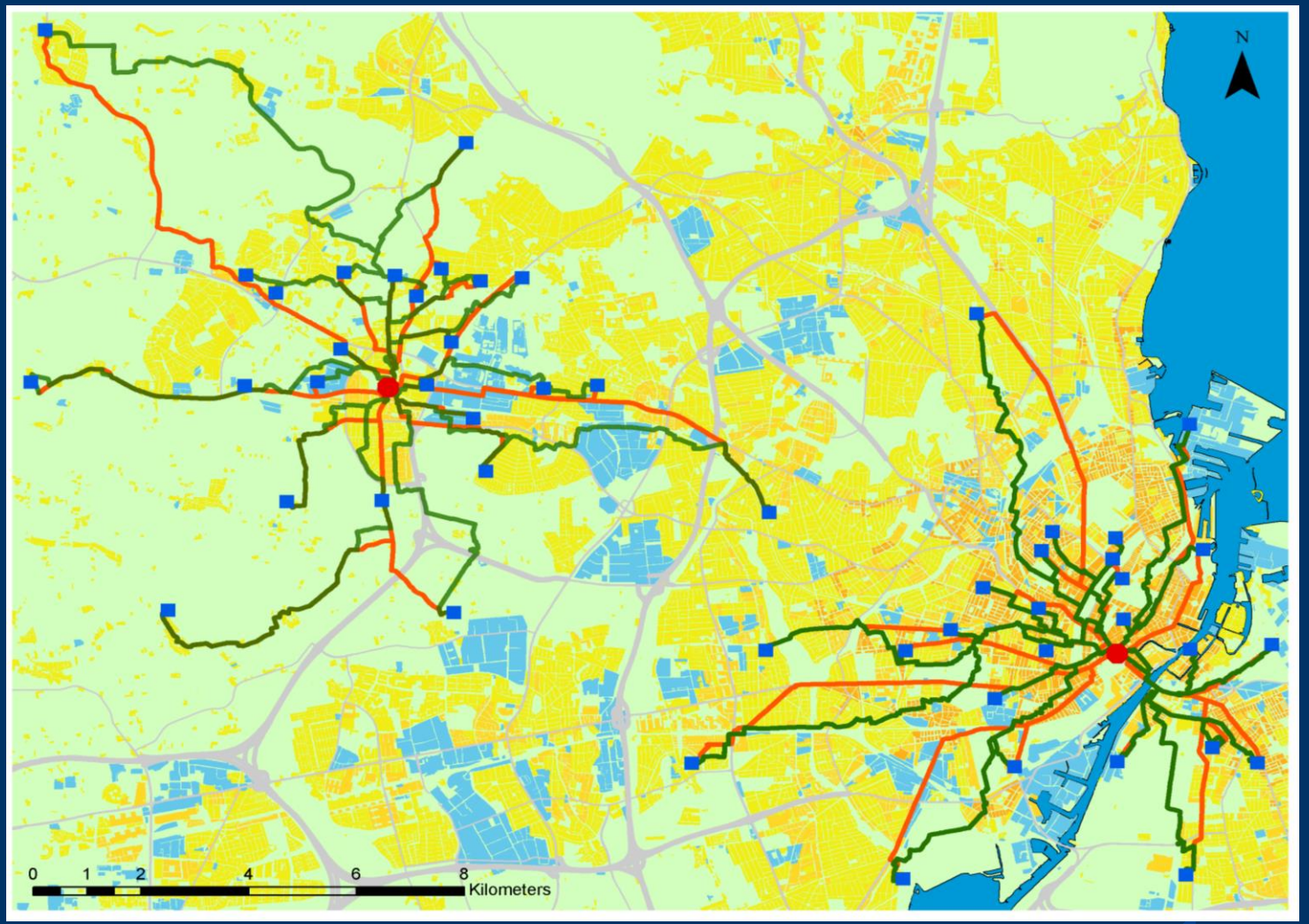
Mapping address level exposure in Danish city



Application of AirGIS/OSPM for exposure study

Exposure bicycling home & work

shortest & cleanest



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Short-term effects Danish studies

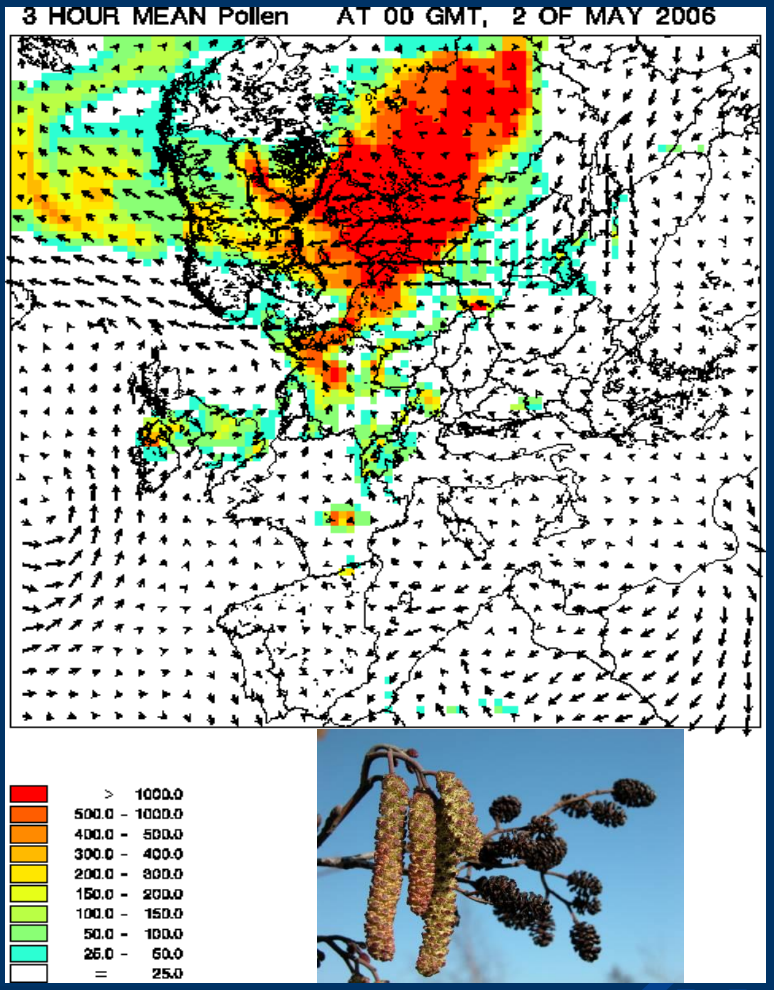
Health endpoint	PM_{10}	$PM_{2.5}$	Particle #	NO_2 / NO_x	CO
Interquartile range, IQR	(7)# 13-14 µg/m^3	5 µg/m^3	3800-3900	6-7/9 pbb	120 ppb
Cardiovascular death, lag 0-5 days	3%			0 to 1%	0 til 1%
Deaths of stroke	0%			0 to 2%	-2 til 2%
Deaths of respiratory disease all ages, summer & winter, 0-5 d lag	-3 to 1%			-2%	-5%
Cardiovascular hospital admission >65 years old lag 0-3 d, or all ages summer & winter 0-5 d lag	3%* 2%	3%*	0%	0 to 2% 2 % & 3%	1 to 2% 1%
Myocardial infarction summer & winter, 0-5 d lag	0 & 4%			2 % & 4%	2 & 7%
Cardiac arrest outside hospital, 3-4 d lag	5%* (IQR 7)	4%*	3%	2 to 3%	2 to 4%
Mild ischemic (clot) stroke, 0-4 d lag	8%		21%*	11%	10%
Respiratory admission >65 years old, 0-4 d lag, and for all ages summer & winter 0-5 d lag	4 to 6%* 4%	0%	4%	4 to 6% 0% & 4%	2 to 4% 1 & 3%
Asthma hospital admission 0-18 years old, 0-4/5 d lag	2 to 8% *	9 to 15%*	6-7%	4 to 13%*	0 to 10%
Wheezing among susceptible 0-1 year old & 0-3 year old, lag 2-4 d	21% & 4%		92% & -15%	45%/30% 19%/14%	33% & 7%

Long term effects Danish studies

	NO_2 per 10 µg/m^3	NO_x
Mortality		
Total	8 % (CI: 1 - 14 %)	
Cardiovascular illness	16 % (CI: 3 - 31 %)	
Ischemic	8 % (CI: -11 - 30 %)	
Stroke	9 % (CI: -17 - 42 %)	
Incidents/hospital admission		
Cardiovascular illness		
Stroke, all	5 % (CI: -1 - 11 %) per 43 % increase in NO_2	
Stroke, fatal	22 % (CI: 0 - 50 %) per 43 % increase in NO_2	
Airways disease		
COPD	8 % (CI: 2 - 14 %) per 6 µg/m^3	5 % (CI: 1 - 10 %) per 12 µg/m^3
Asthma (elderly)	12 % (CI: 4 - 22 %) per 6 µg/m^3	
Lung cancer		9 % (CI: -21-51 %) & 37% (CI: 6-76 %) per 100 µg/m^3

Pollen

- >20% of the population suffer from hay fever
- Current monitoring based on two stations
- Techniques from 1950's
- Pollen exposed to AP more allergenic



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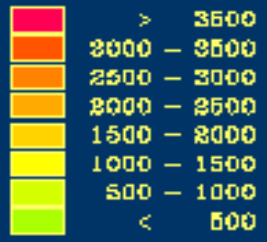
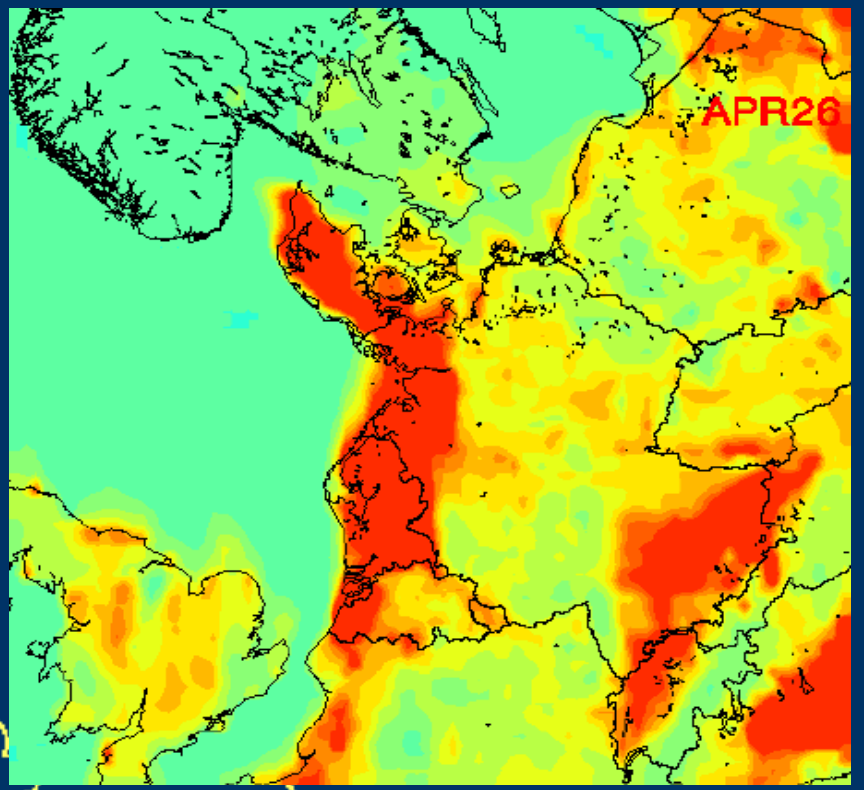
Danish NH_3 emissions on single farm level





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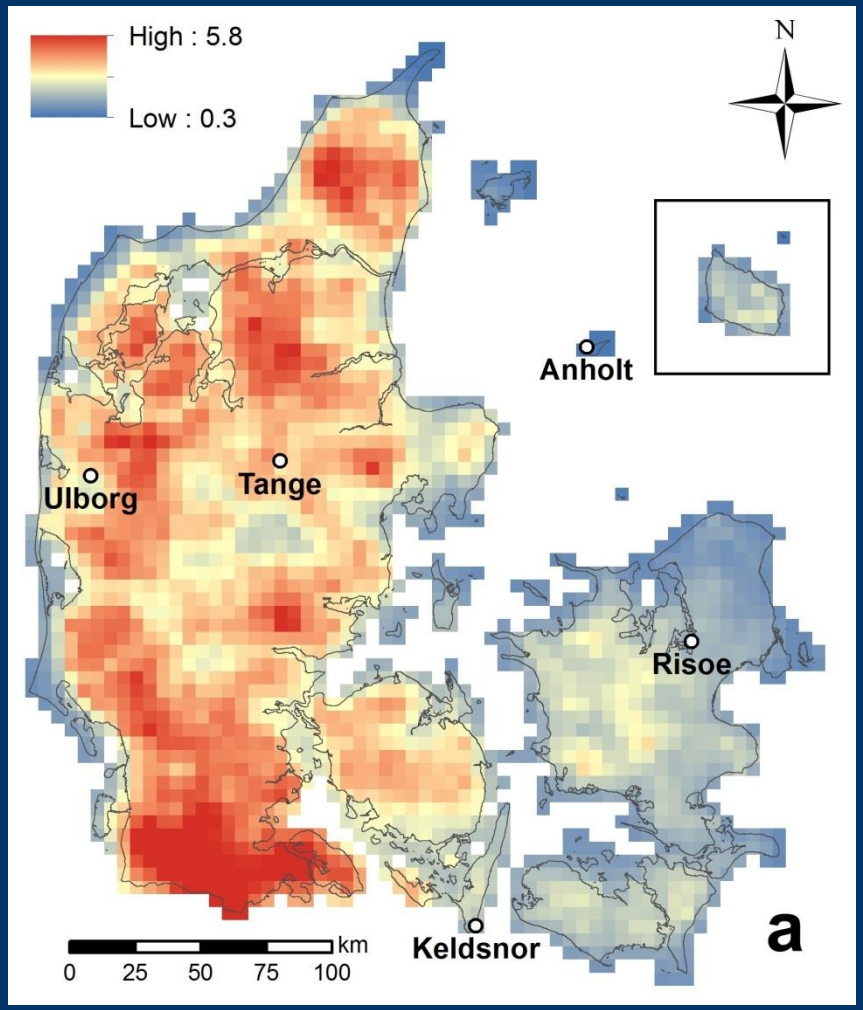
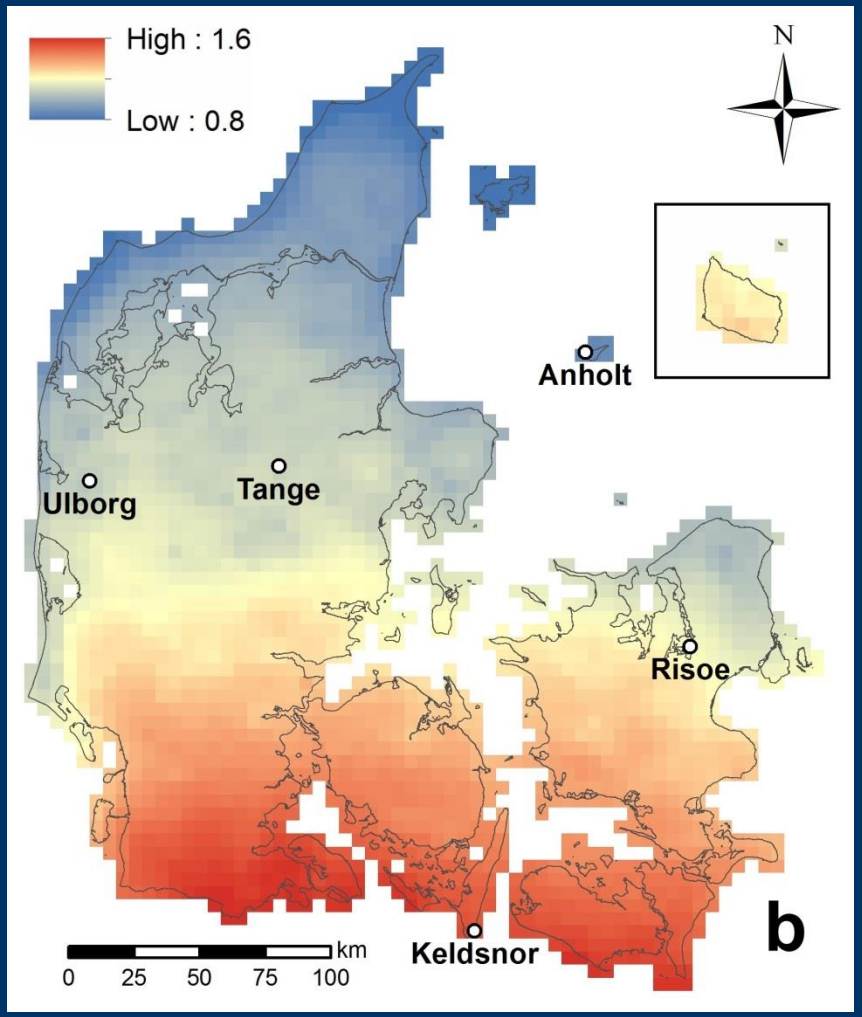
NH3 concentration NH4+ concentration





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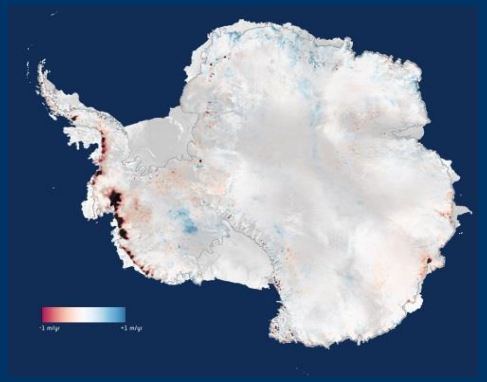
Reducing AP reduces emis CO_2 & SLCP e.g. soot & CH_4 contributing to short & long-term mitigation of climate change

Things that melts



Things you care about melting

Priorities and roadmap

- What do we want to provide on the long term – in relation to routine monitoring and public information?
- Micro-sensors should not substitute but supplement routine monitoring devices
- Future routine networks may look very different from todays and include low cost sensors!?
- The green route through the city or access to information about pollutant load at address might be future goals

Priorities and roadmap

- Still many unknowns in respect to health effects – e.g. what in PM is causing negative health effects – constituents, ultrafine?
- Airborne allergens may also be an issue of interest – >20% suffer from hay fever but monitoring still based on 1950/1960 technology
- Assessment of health effects of emissions from agricultural sources (fungal spore, animal material, ammonia)
- Assessment of health effects from wood stoves – 600.000 wood stove devices in DK (biggest single source of PM in DK)