**Particles and Health- Lessons from the SAPALDIA study**

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**The human body had not enough time to adapt to the emissions of the automobile since the first cars drove on Swiss streets, about 100 years ago. Particles in the air are not only reducing the visibility and causing global warming. They are responsible for increased morbidity and mortality, especially among those living near busy roads.**

SAPALDIA (Swiss Study on Air Pollution and Lung in Adults)- the Swiss "Framingham"-study- is a multi-center cohort study in eight geographic areas representing the wide range of environmental, meteorological and socio-demographic conditions of Switzerland. It was initiated in 1991, with follow-up assessments in 2002 and actually in 2010/11.

In 1991 a random sample of 9'651 subjects, aged 18 to 60 years, were recruited for a detailed computer-based interview, lung function and allergy testing. In the 2002 follow-up, 8'047provided health information and blood samples to establish an extensive blood, plasma, serum and DNA bank. In addition, 1'813 subjects aged 50 or older participated in 24h-ECG- monitoring to provide detailed data on parameters of heart rate variability. With the inclusion of cardiovascular endpoints, SAPALDIA is one of the first studies examining effects of long-term exposure to air pollution on cardiovascular health parameters as well. Ongoing studies are focusing on gene-environment interactions, a crucial question to understand why some persons suffer more from the effect of air pollution than others.

The WHO and the European Research authorities have acknowledged the importance of SAPALDIA as one of the very few population-based adult cohort studies in Europe. It is well positioned to address crucial questions of air pollution epidemiology and important environmental health policy-related questions in the coming years.

Due to SAPALDIA, air quality is now a major issue: Poor air quality is affecting 40% of the Swiss population (living in areas with PM10-levels above 20 mcg/m3, the mean annual standard in Switzerland). It is responsible for lower lung function (3% lower vital capacity per 10 mcg/m3 increase of PM10), more respiratory symptoms (30% more cough etc per 10mcg/m3 of PM10), higher blood pressure and pulse and more irregular heartbeats; causing health costs of more than 2 billion SFR and an estimated 3000 premature deaths every year in Switzerland. Thanks to these data, new air quality regulations have been implemented and have led to an attenuated lung function decline and reduced respiratory symptoms since 1991.

The significant association of measured particle mass and vicinity of home and work place to busy roads with the observed health effects in humans as well as experimental data let us strongly advise to measure particle number counts (of fine and ultrafine particles) as well and to do everything possible to filter the air from noxious particles.

**Respiratory health effects of traffic related air pollution:**

**Short-term effects**

**More premature deaths (0.6 % more per 10 mcg/m3 increase in PM10)**

**More emergency room visits and hospital admissions for asthma (+1.1 %) and COPD**

**Long-term effects**

**More cardiopulmonary and lung cancer deaths (6 % or more per 10 mcg/m3 increase in PM2.5, thus resulting in >3000 premature deaths every year in Switzerland!)**

**Lower lung function in children and adults**

**More allergies**

**More asthma in children living near busy roads**

**More chronic bronchitis and COPD in adults living near busy roads**

**More lung cancer (diesel particles are loaded with carcinogens!)**

**Higher mortality after lung transplantation**

Recently published studies have shown that arteriosclerosis, the thickening of the wall of blood vessels, is also more prevalent near busy roads. And symptoms like cough or wheezing are even more pronounced if you live close to a major highway in a mountain valley, the Gotthard highway. **Living near busy roads is obviously dangerous: keep a distance of more than 50 up to 200 meters!**

If you do research, please apply for the **Swiss Aerosol Award**: You have to submit your application before August 31, 2011 (see www.swisslung.ch) to my address above.

Finally, Behavior Change is the most difficult part, please support the following suggestions:

1) Clean the air with diesel particle filters for the exhaust and Nanofilters in the vehicle cabin

2) Think first, then drive; walk or bike short distances; use public transportation

3) Use (and produce) the most advanced, non-polluting and fuel-efficient vehicles

If you need more info, you can download from **www.ersnet.org/airquality** for free a 60 page publication in German, English, French, Italian or Catalan covering this topic, air pollution and health.

Literature (extract)

Künzli N, Bridevaux PO, Liu LJ et al: Traffic-related air pollution correlates with adult-onset asthma among never-smokers. Thorax 2009; 64: 664-70.

Laura Perez, Regula Rapp, Nino Künzli: Outdoor air pollution and lung health. Swiss Med Wkly 2010; 140:w13129.

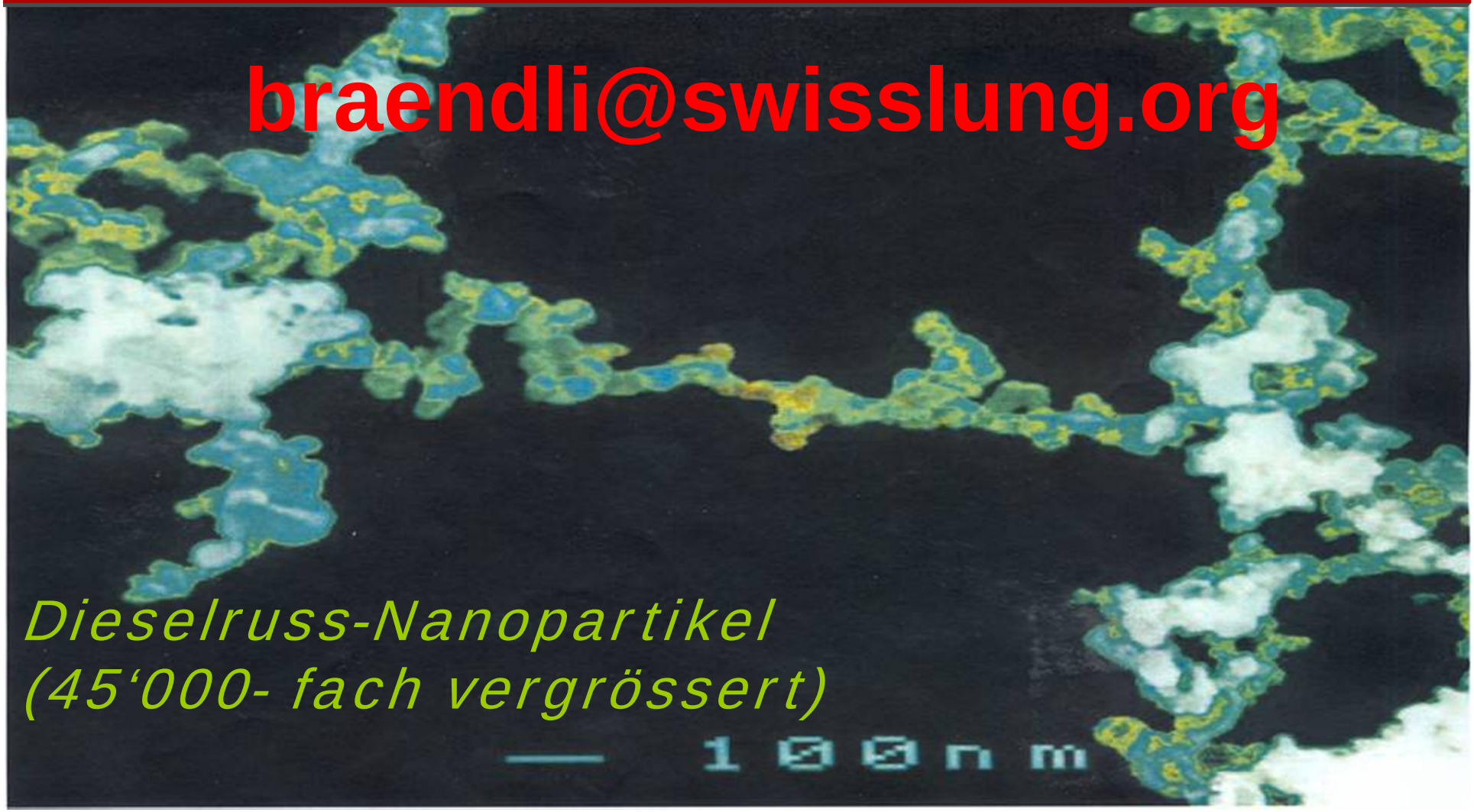
Downs SH, Schindler C, Liu LJ, Keidel D, Bayer-Oglesby L, Brutsche M, Gerbase Margaret, Keller R, Künzli N, Leuenberger P, Probst-Hensch N.M., Tschopp Jean-Marie, Zellweger Jean-Pierre, Rochat Thierry, Schwartz J, Ackermann-Liebrich U and the SAPALDIA Team. Reduction in PM10 attenuates age-related Lung function decline in Adults. New Engl J Med 2007; 357:2338-47.

Hazenkamp-von Ax ME, Schindler C, Ragettli MS et al: Impacts of highway traffic exhaust in alpine valleys on the respiratory health in adults. Environ Health 2011;10:13.

Künzli N et al: “Air quality and health”, more information on air pollution in Europe, the nature of its effects and the measures that are being (and should be) taken to combat it. Created in conjunction with the Swiss Tropical and Public Health Institute (Basel, Switzerland) and the Centre for Research in Environmental Epidemiology (Barcelona, Spain), the booklet is available in English, Italian, Catalan, French, German and Turkish, available by http://www.ersnet.org/index.php/publications/air-quality-and-health.html

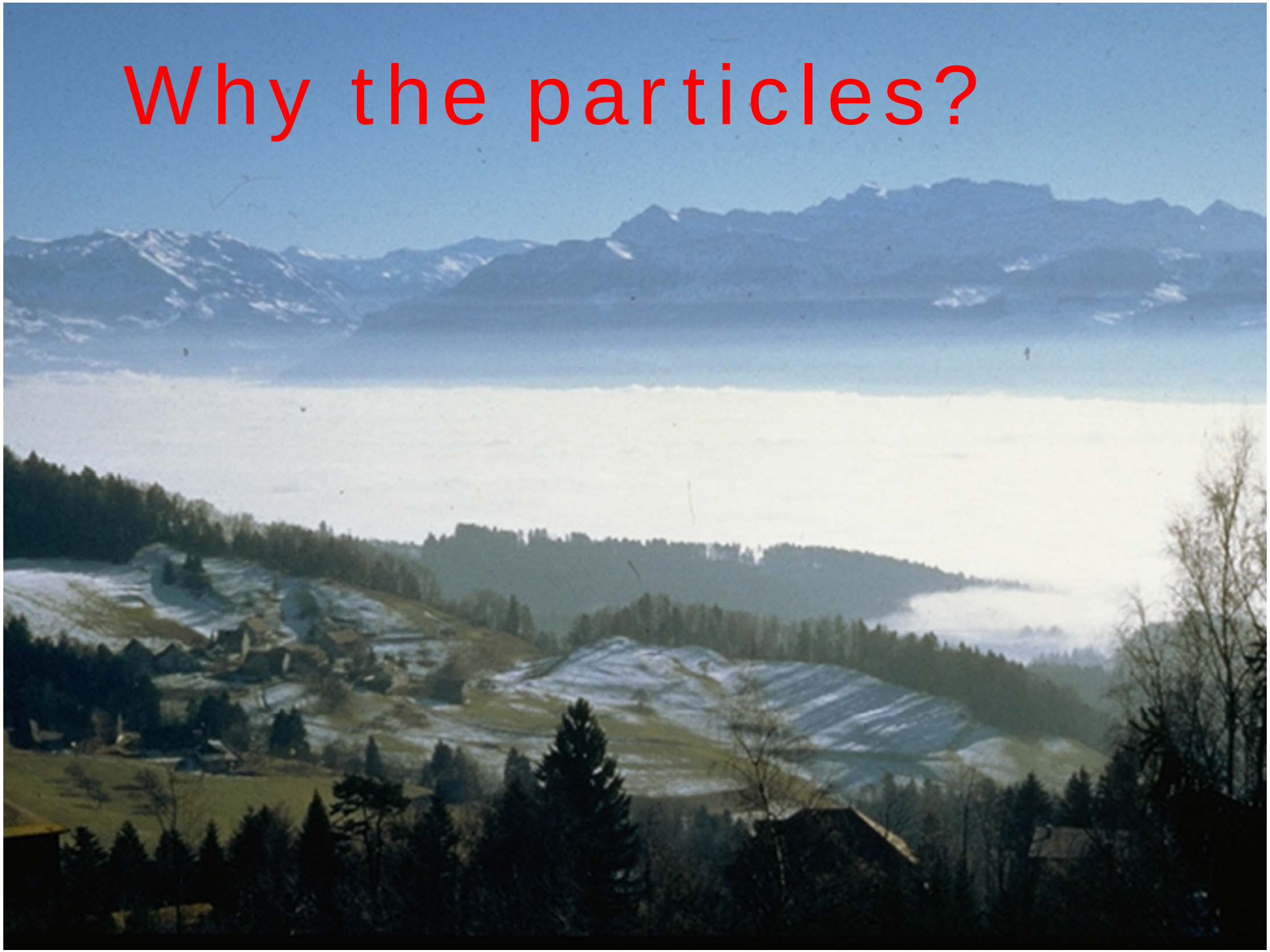
# Particles and Health: Lessons from the SAPALDIA-study

**braendli@swisslung.org**



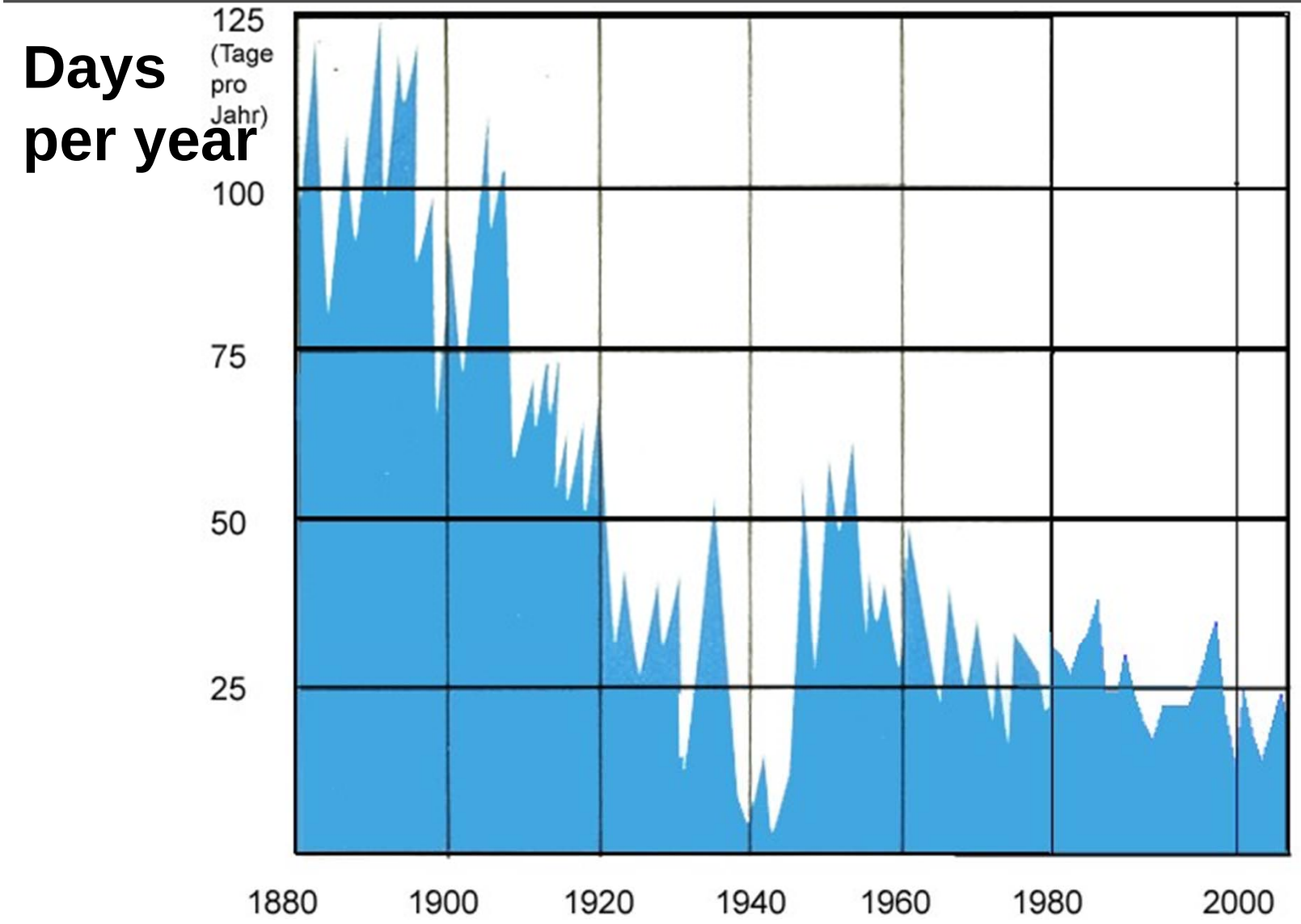

*Dieselruss-Nanopartikel*
*(45‘000- fach vergrössert)*

# Why the particles?



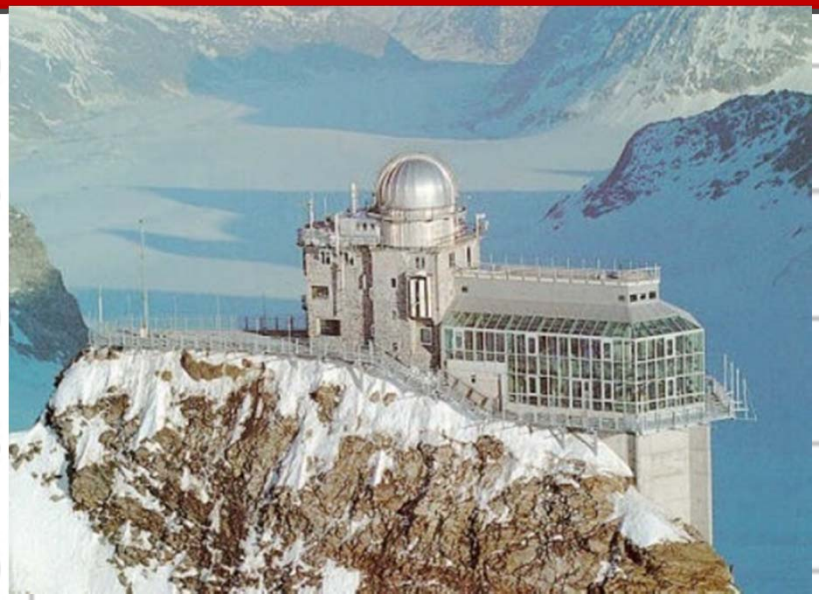

*Smog* = *smo*ke (particles)
and f*og* (water droplets)
Zürich from the Uetliberg, 23.2.2003

# Visibility of Urirotstock (distance 57 km)from Swiss Meteo, Zürich)

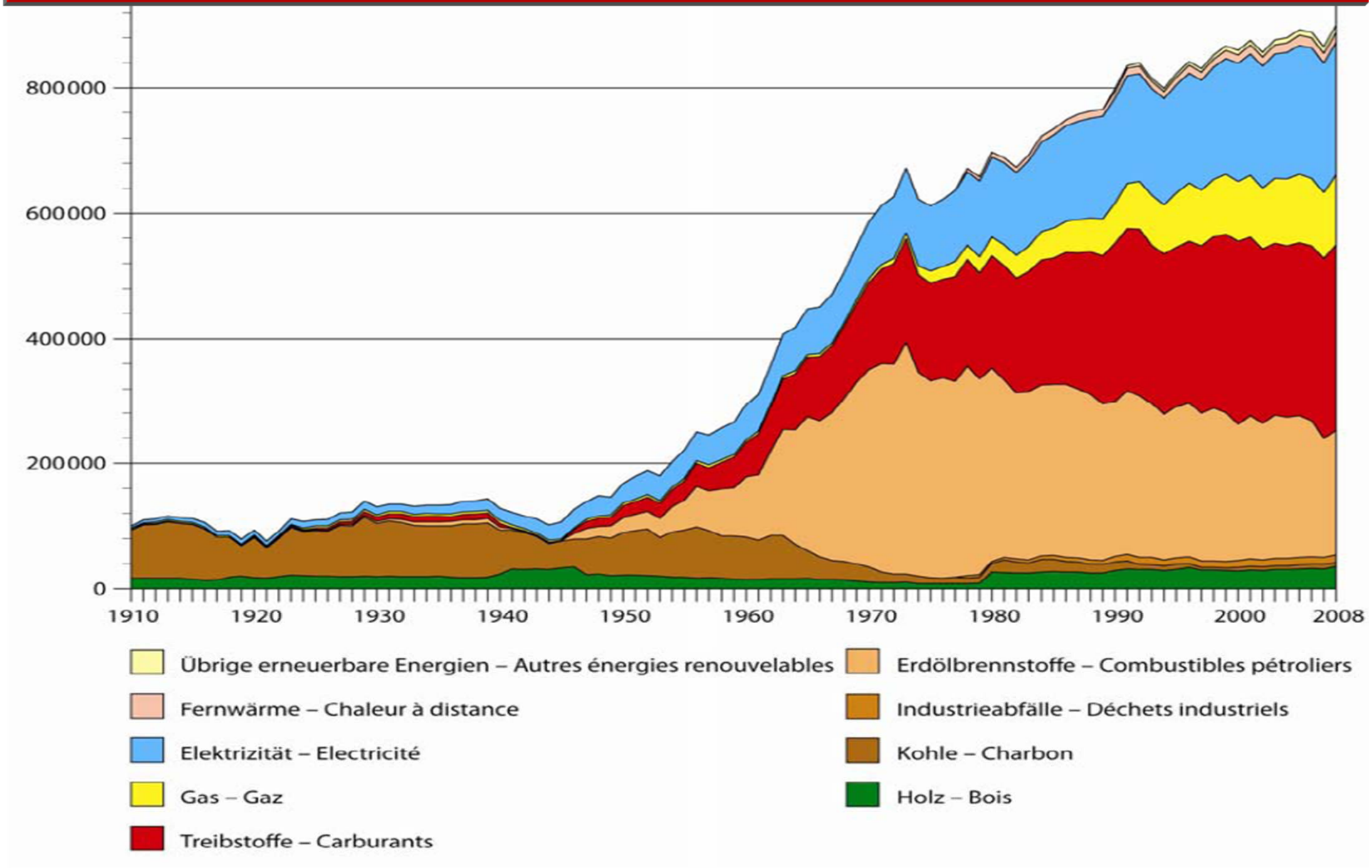


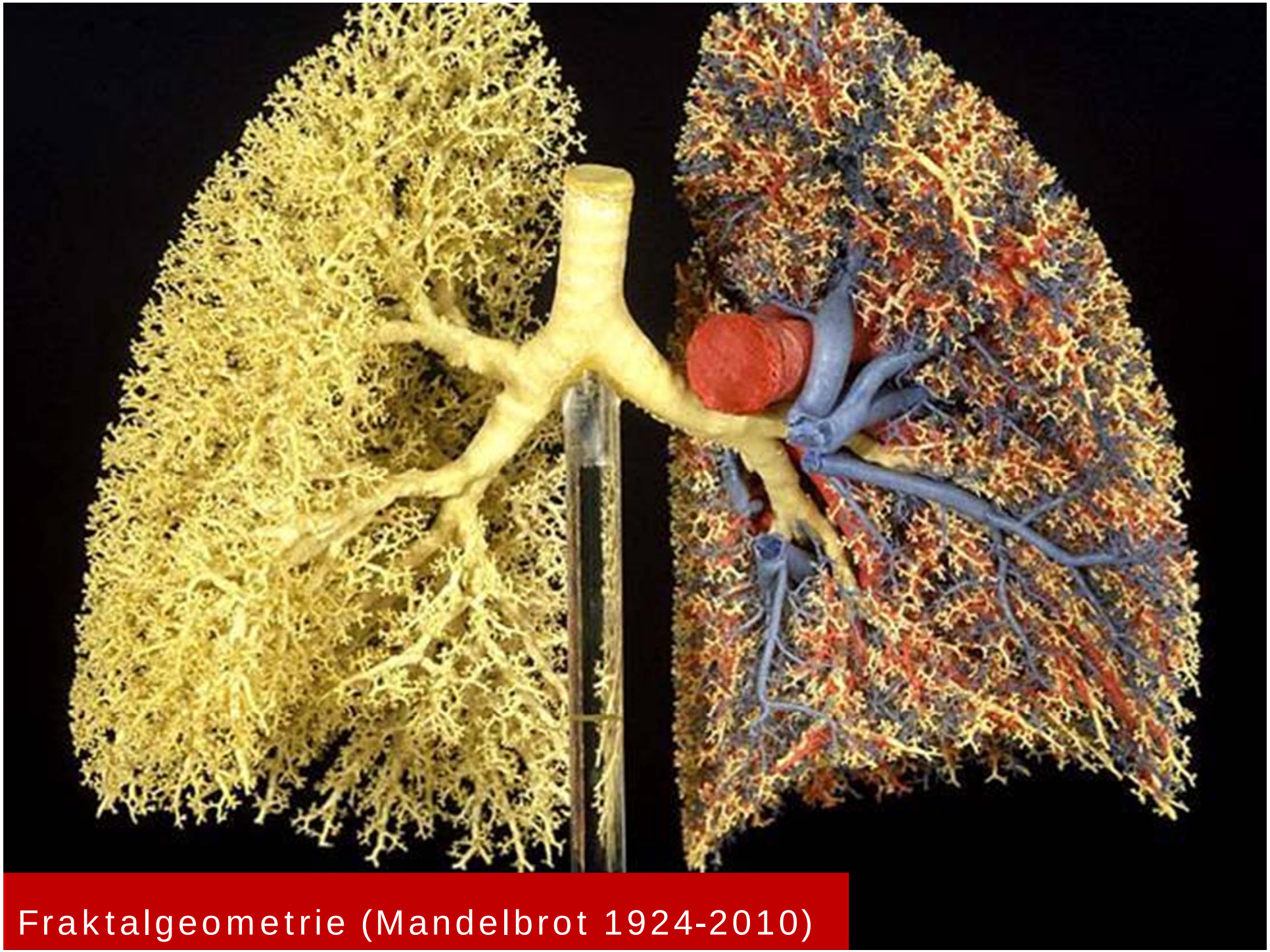
# Tambora, Simbawa, Indonesia, 1815

# Volcanic ash from Eyjafjallajökull, Island (Jungfraujoch, 19.4.2010 )



# Swiss energy consumption 1910-2008 (TJ)

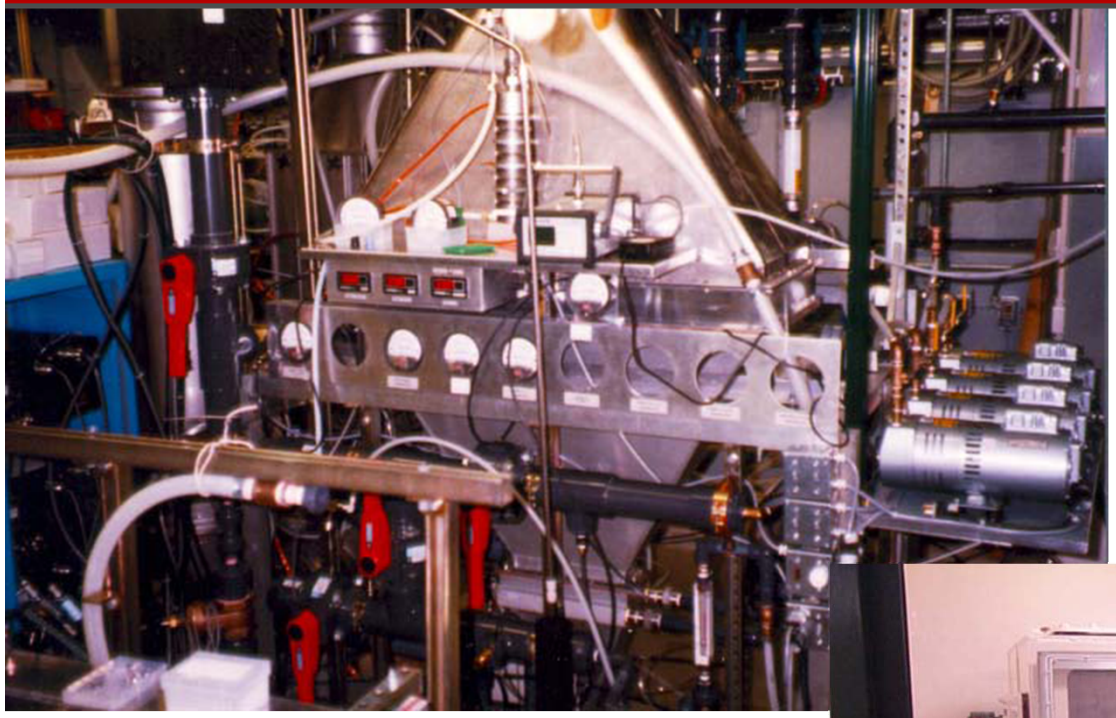




Fraktalgeometrie (Mandelbrot 1924-2010)

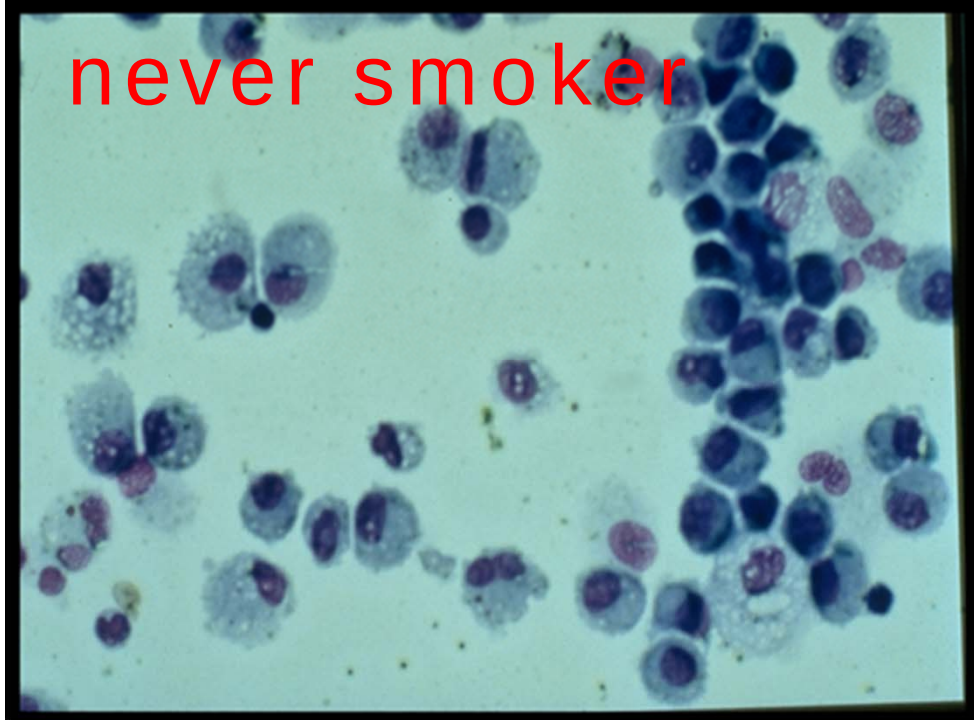
# More than 1000 particles enter each of our 500 million alveoli every day!

# Experimental data: Climate chambre

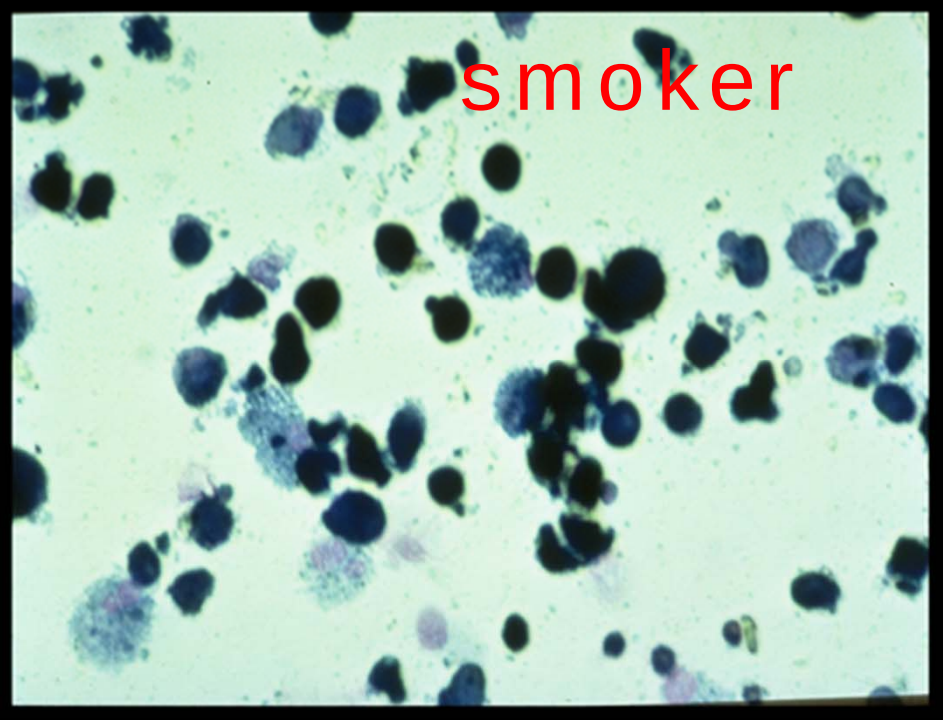


human studies division, EPA, Research Triangle Park NC

3 month old child
living near busy road



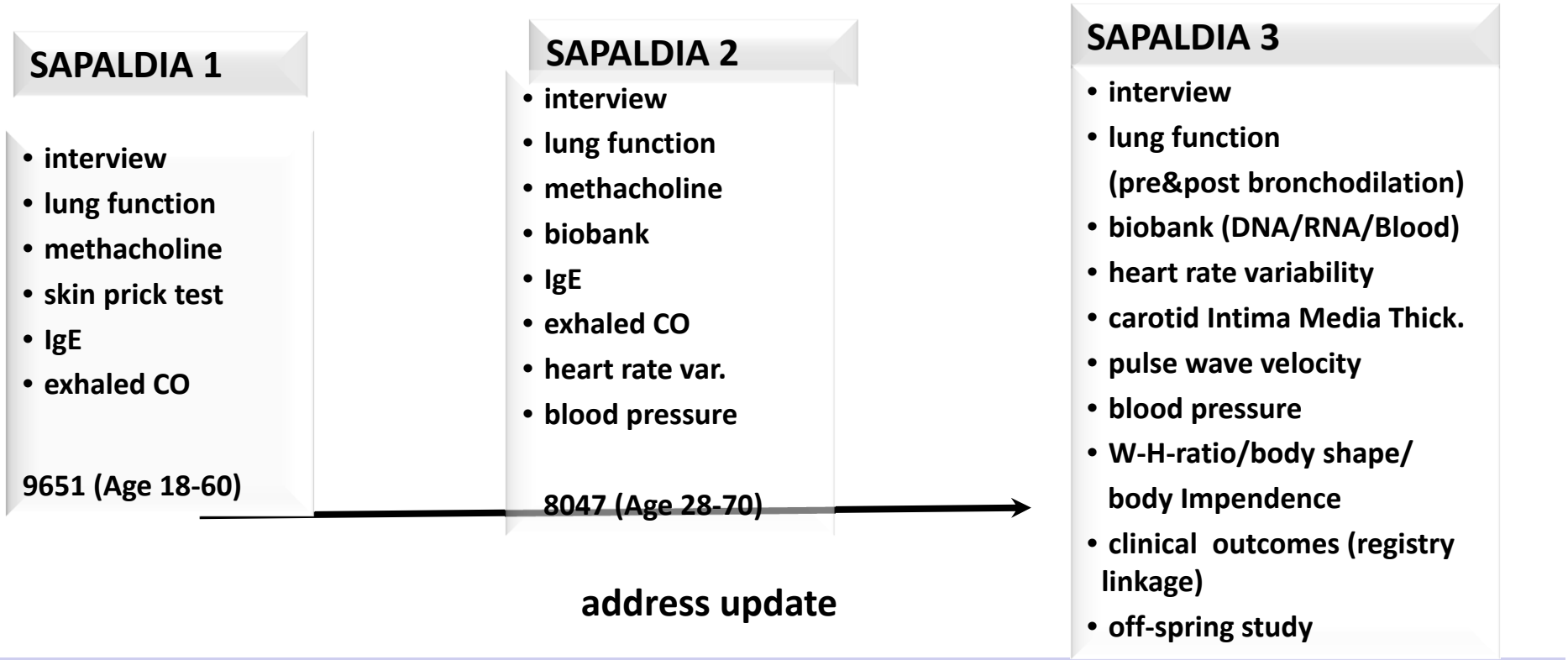
never smoker



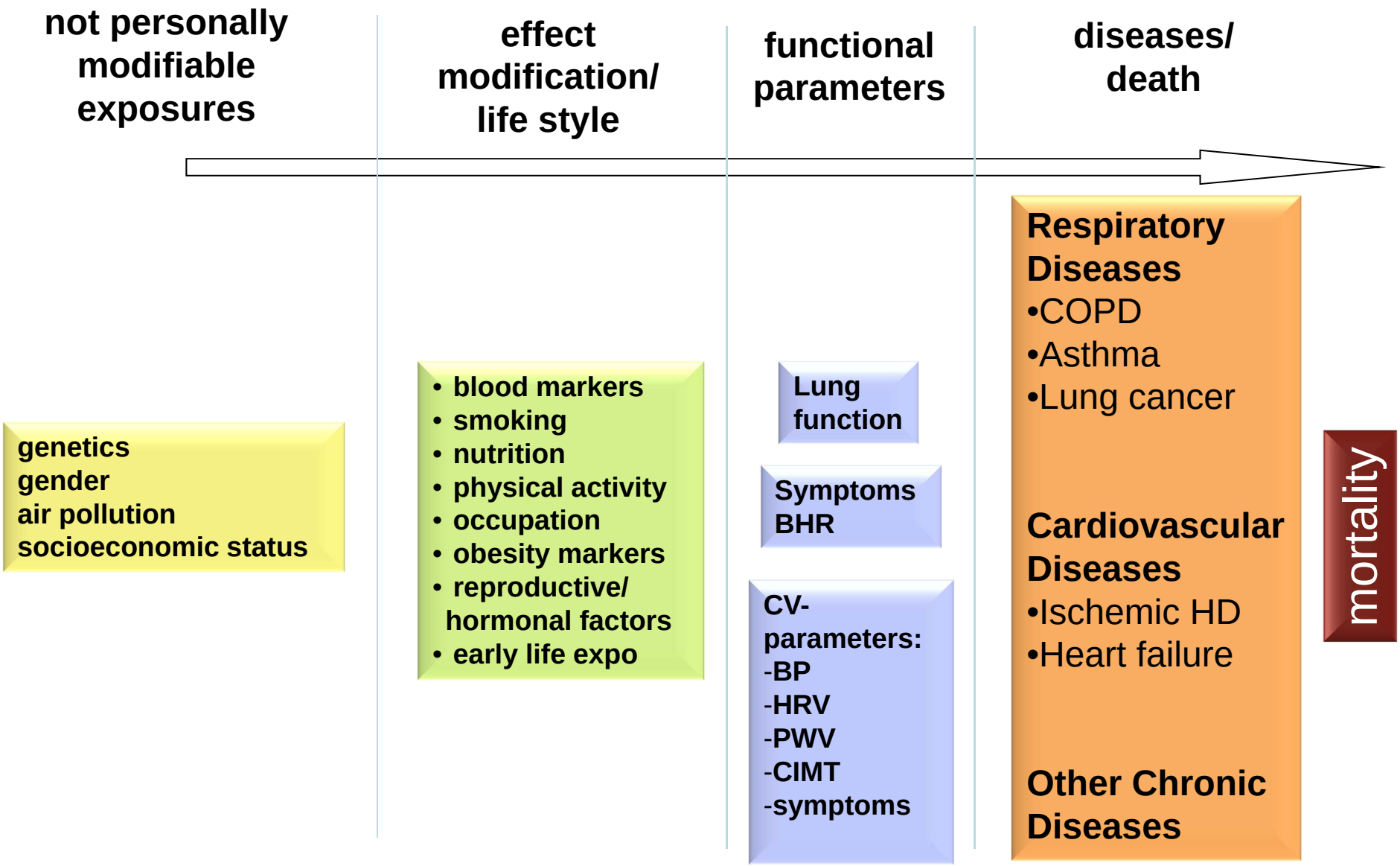
smoker

# Experimental data: SAPALDIA (Swiss cohort study on Air Pollution and Lung Disease in Adults)

# SAPALDIA 1991- 2011: methods

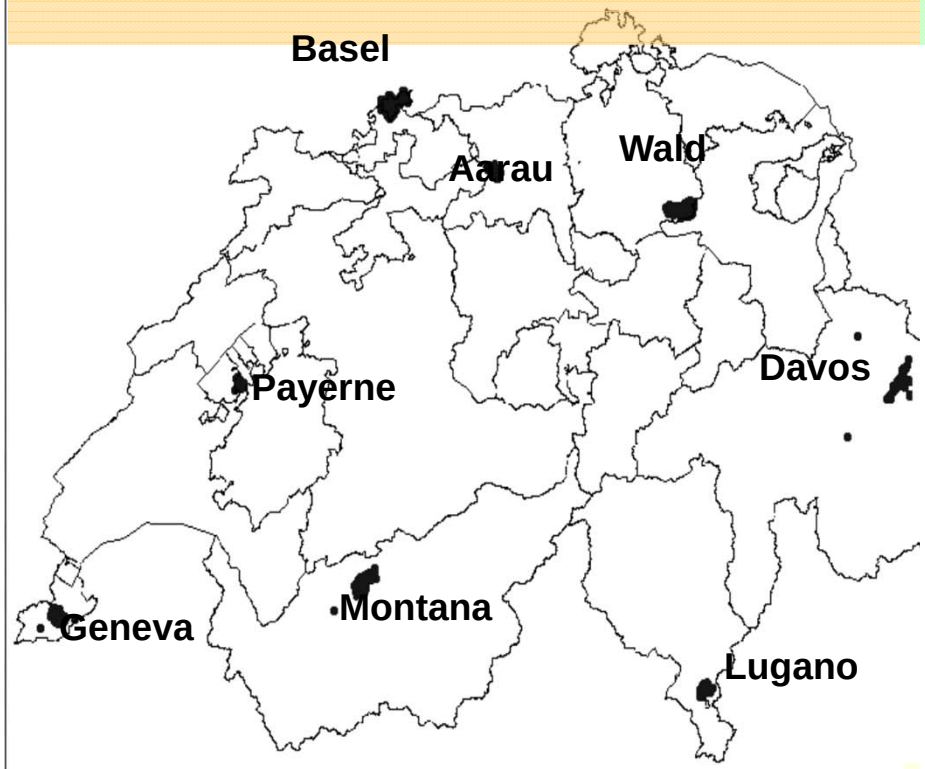


# SAPALDIA Research Potential



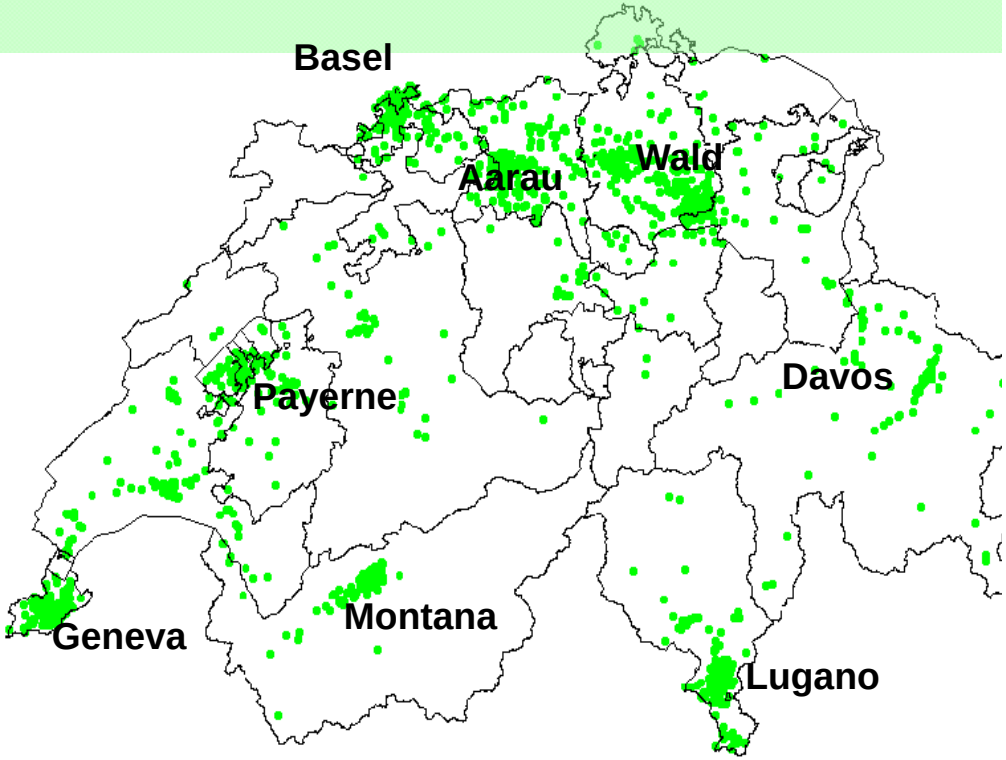
# SAPALDIA: participants

## SAPALDIA 1 - 1991




9‘651 participants, age 18-60

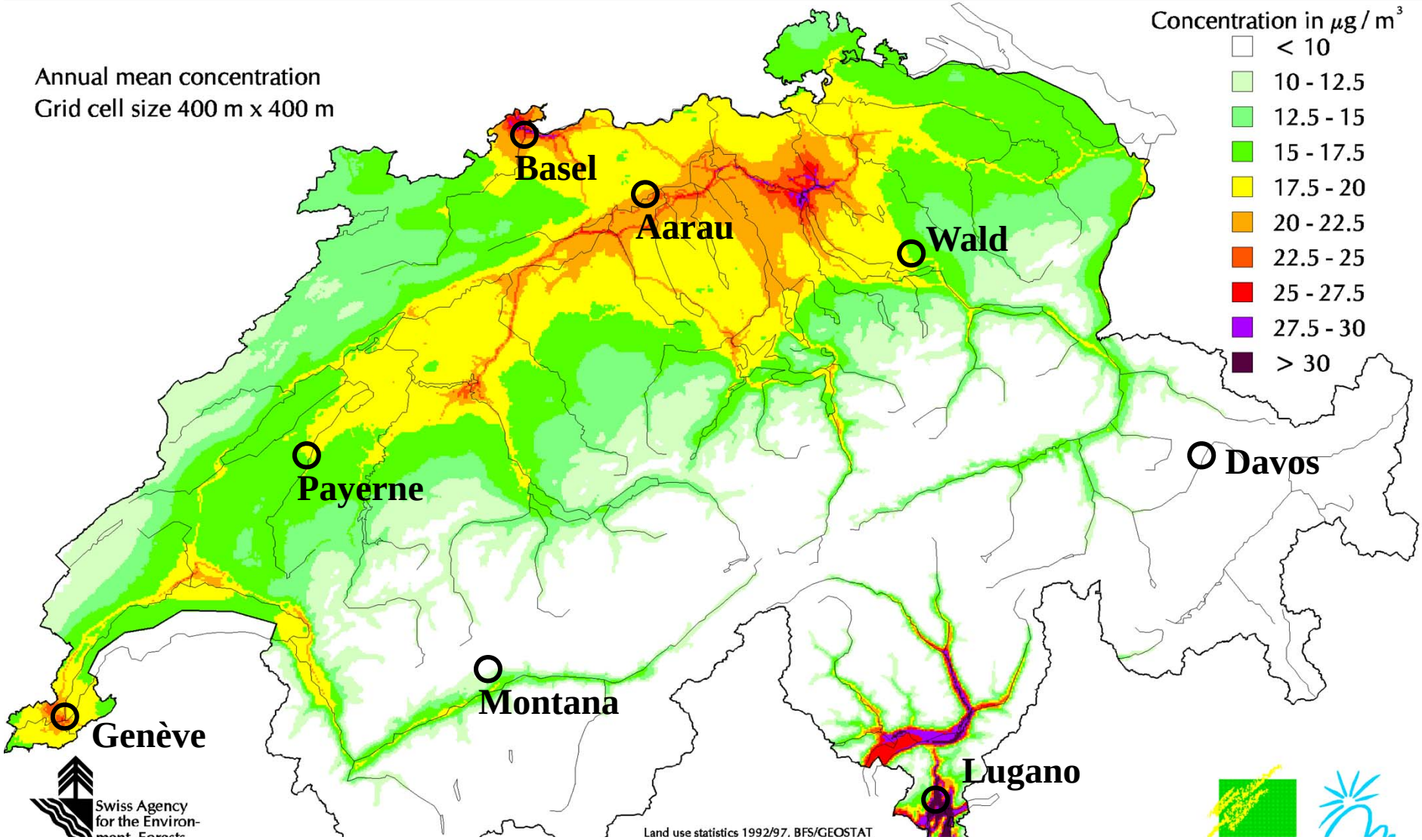
## SAPALDIA 2 - 2002




8‘047 participants, age 29-71

Geo-coding of home addresses at time of S1 and S2 examination

# 40% of the Swiss population breath air with PM10 higher than 20 mcg/m3, the Swiss annual mean standard!



# SAPALDIA: results (1)

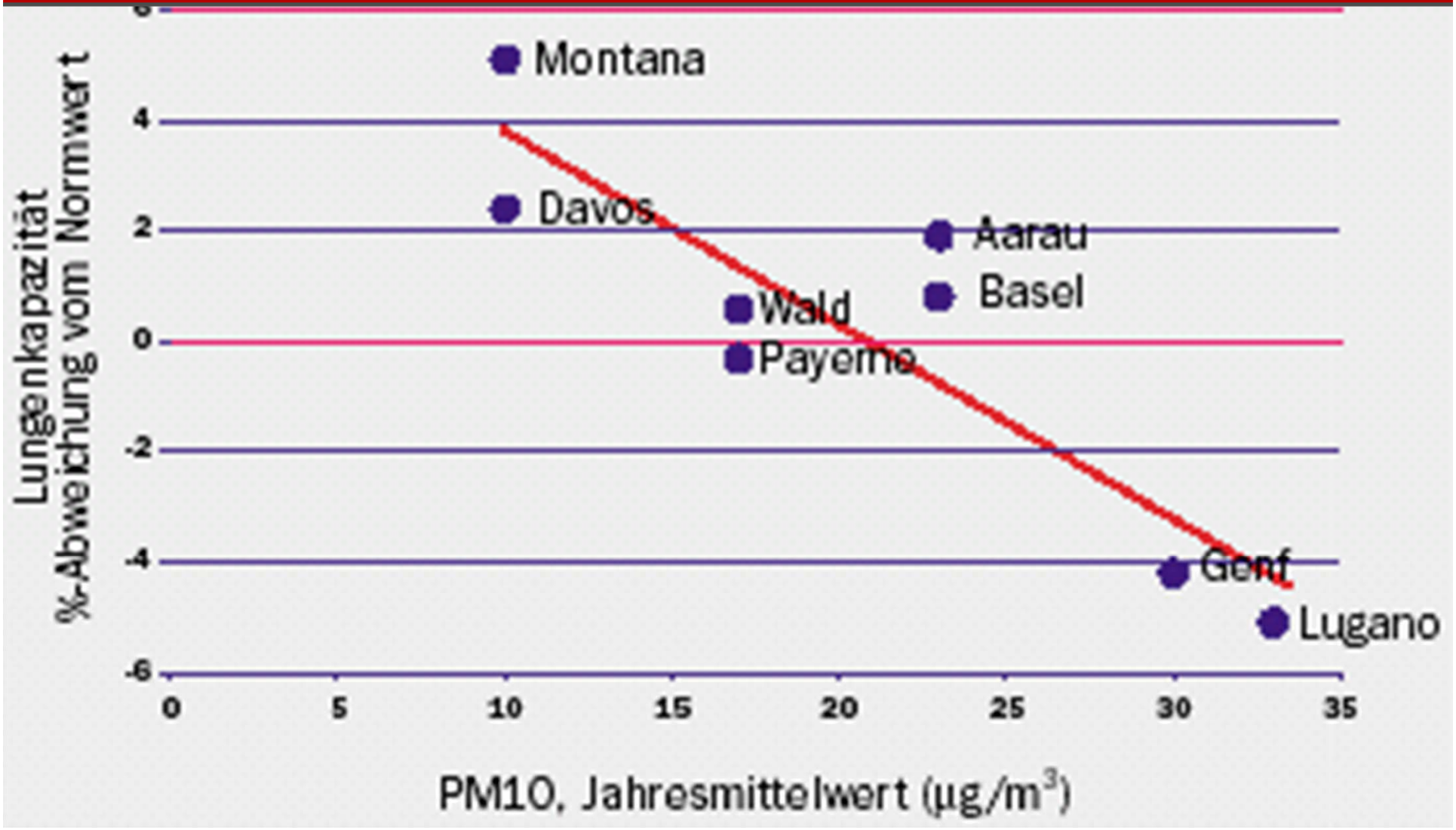
Air quality is now a major issue in Switzerland, leading to:

- Lower lung function

  (-3% per 10 mcg/m3 increased PM10)
- More respiratory symptoms

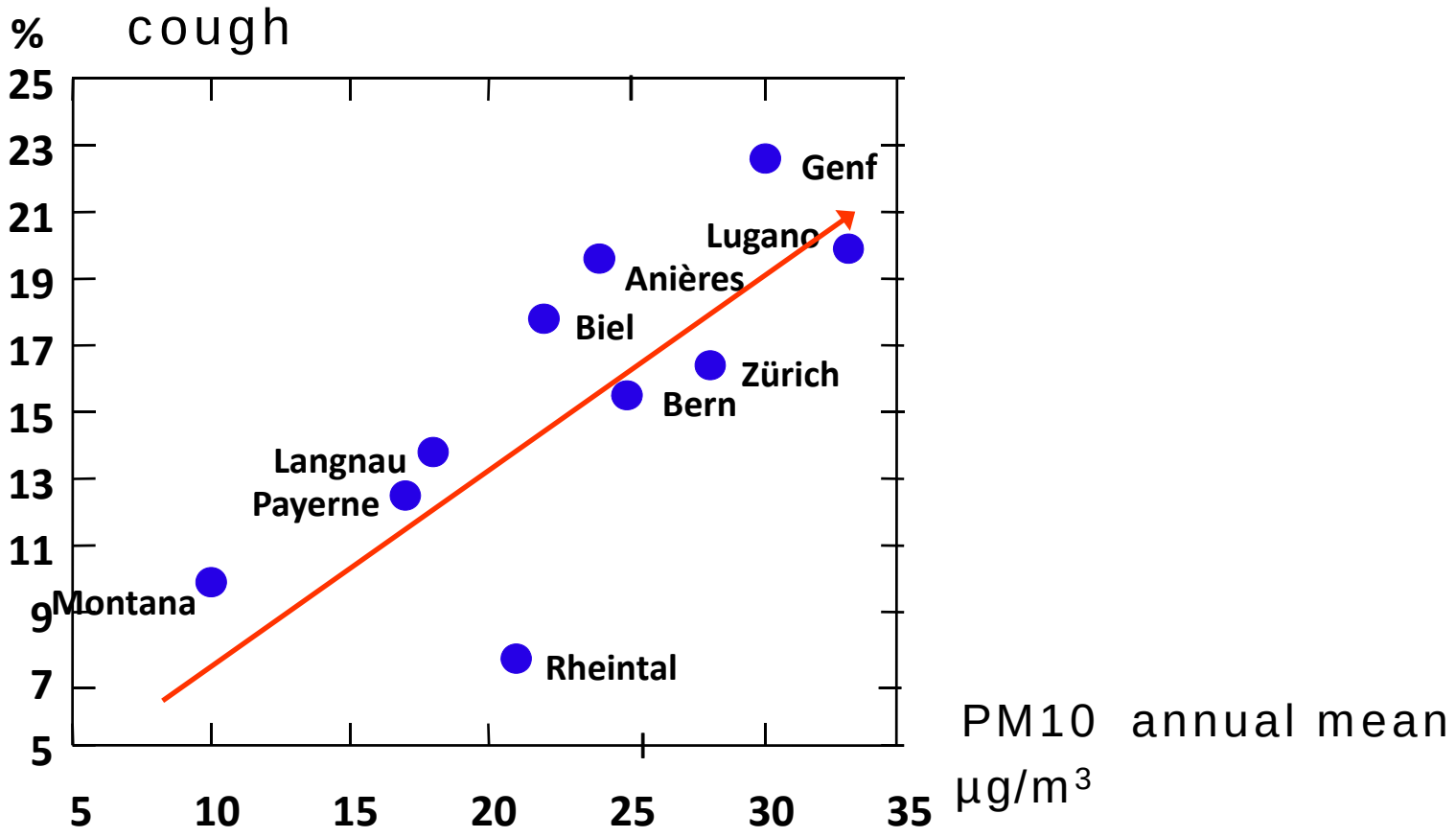
  (+30% per 10mcg/m3 of PM10)
- Higher blood pressure and pulse, more irregular heart beats

# Lower lung capacity (FVC) with increasing PM10-concentrations



# ...and more children coughing!
## (SCARPOL; schoolchildren studied 1992/93)

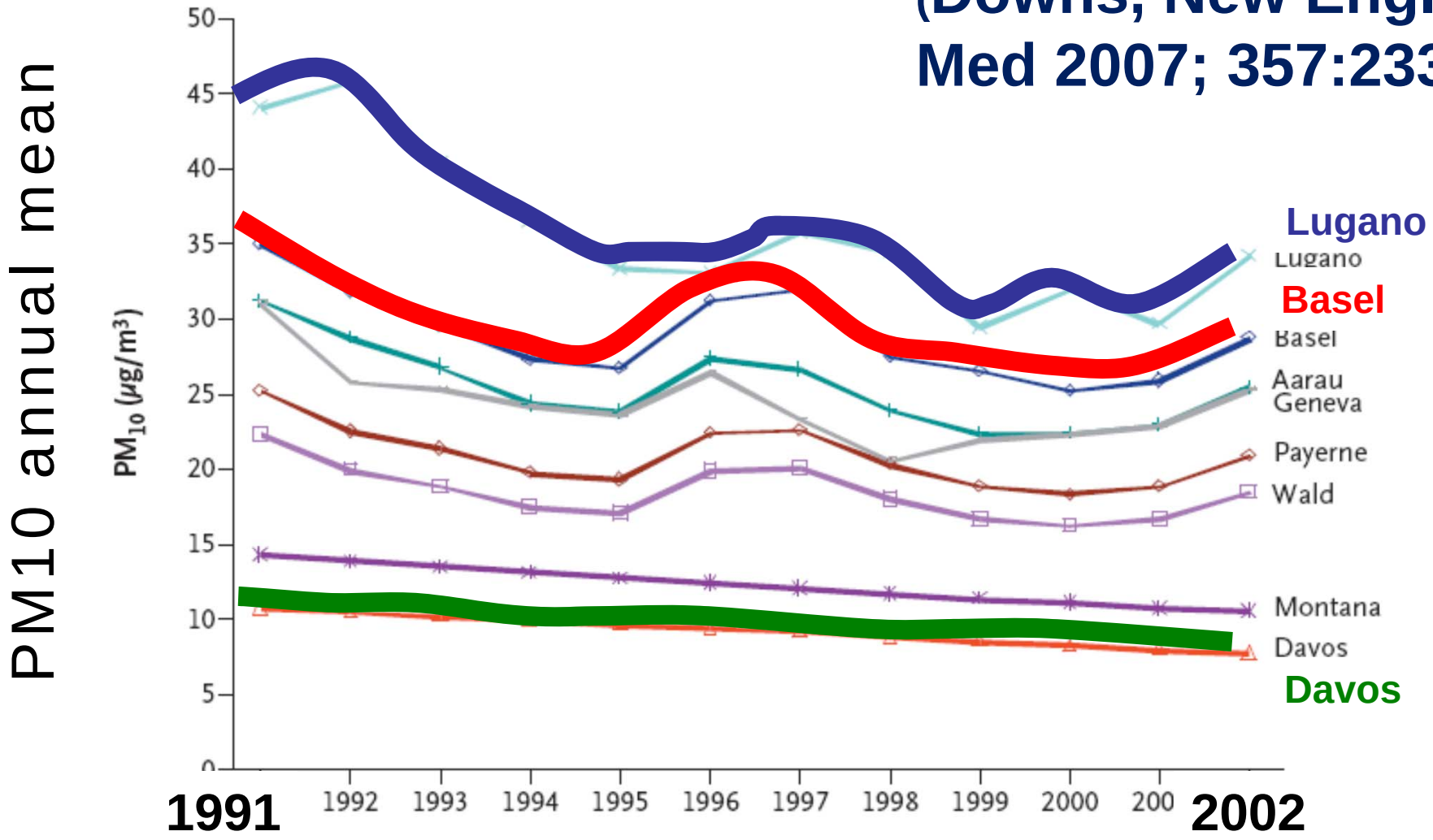
4500 schoolchildren, 1., 4. und 8. class



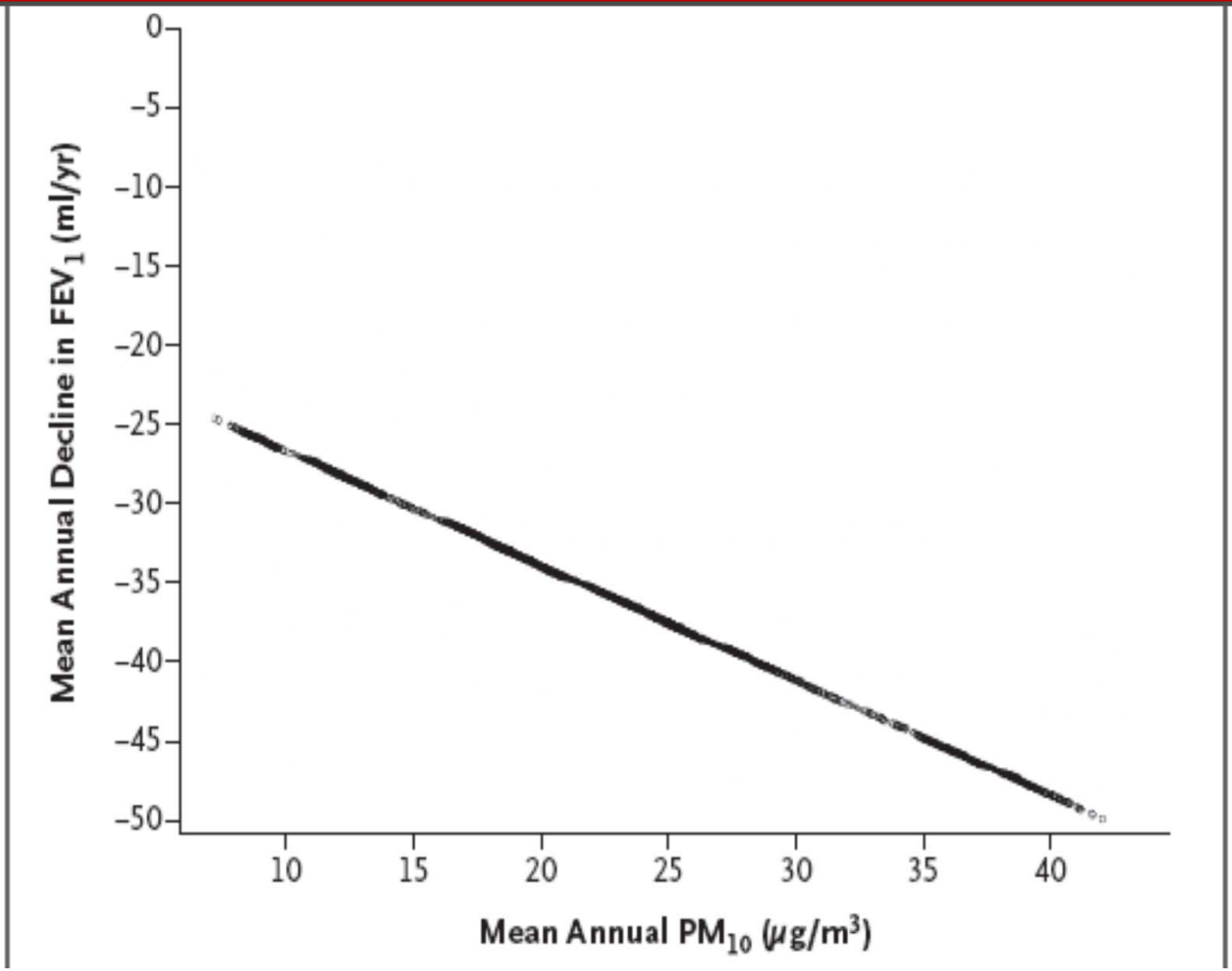

Braun-Fahrländer 1997

# Swiss Clean Air Regulations result in lower PM10

(Downs, New Engl J Med 2007; 357:2338-)

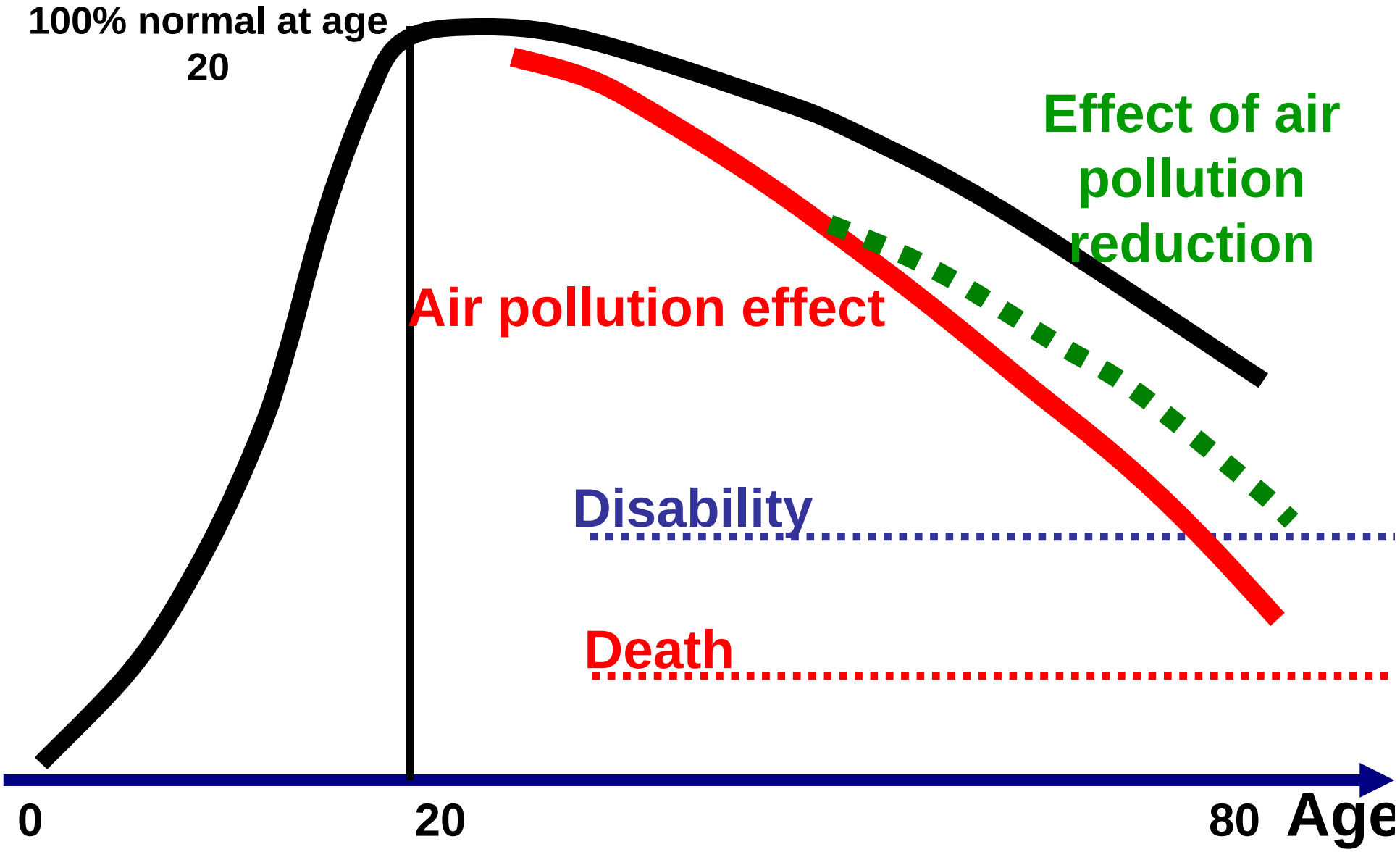


# and less mean annual decline of lung function (FEV1)



# Life-time course of lung function

## (e.g. forced expiratory capacities such as FEV1 and FVC)



# SAPALDIA: results (2)

Better air quality thanks to clean air regulations:

- attenuates the lung function decline,
- reduces respiratory symptomes
- and correlates with the onset of asthma in never-smokers

Some population segments are more vulnerable

by genetic traits, workplace or societal influences

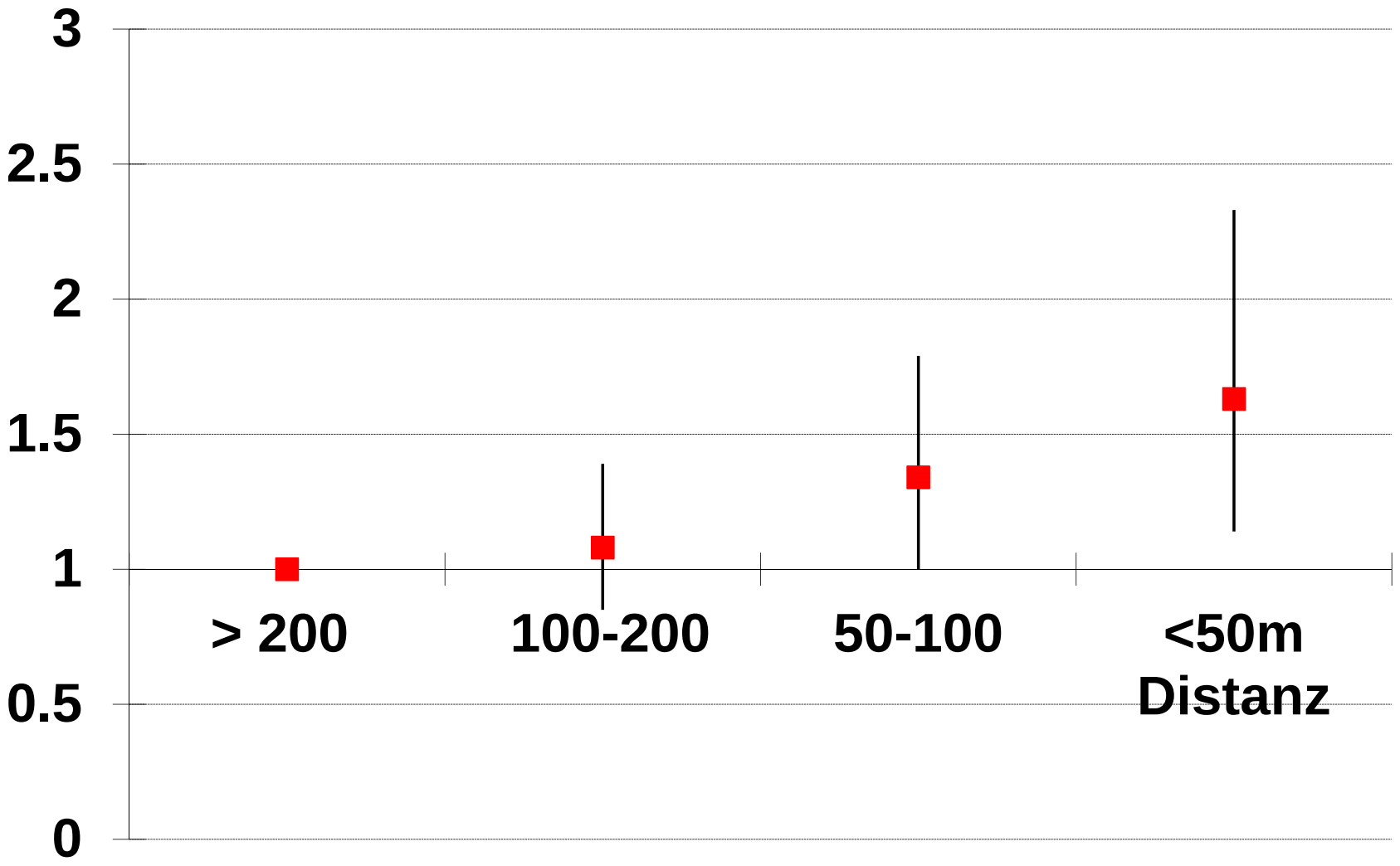
(for example children, smokers, obese, asthmatics)

# Summary: respiratory health effects of traffic related air pollution

- *Short-term*
- More deaths (0,6% per 10 mcg/m3 increase in PM10)
- More emergency room visits and hospitalisations for asthma

- *Long-term*
- More cardiopulmonary and lung cancer deaths (6% per 10 mcg/m3 increase in PM2.5, amounts to >3000 premature deaths every year in Switzerland!)
- Lower lung function in children and adults
- More allergies
- More asthma in children living near busy roads
- More chronic bronchitis and COPD in adults living near busy roads
- More lung cancer (diesel particles are carcinogens!)
- Higher mortality after lung transplantation .....

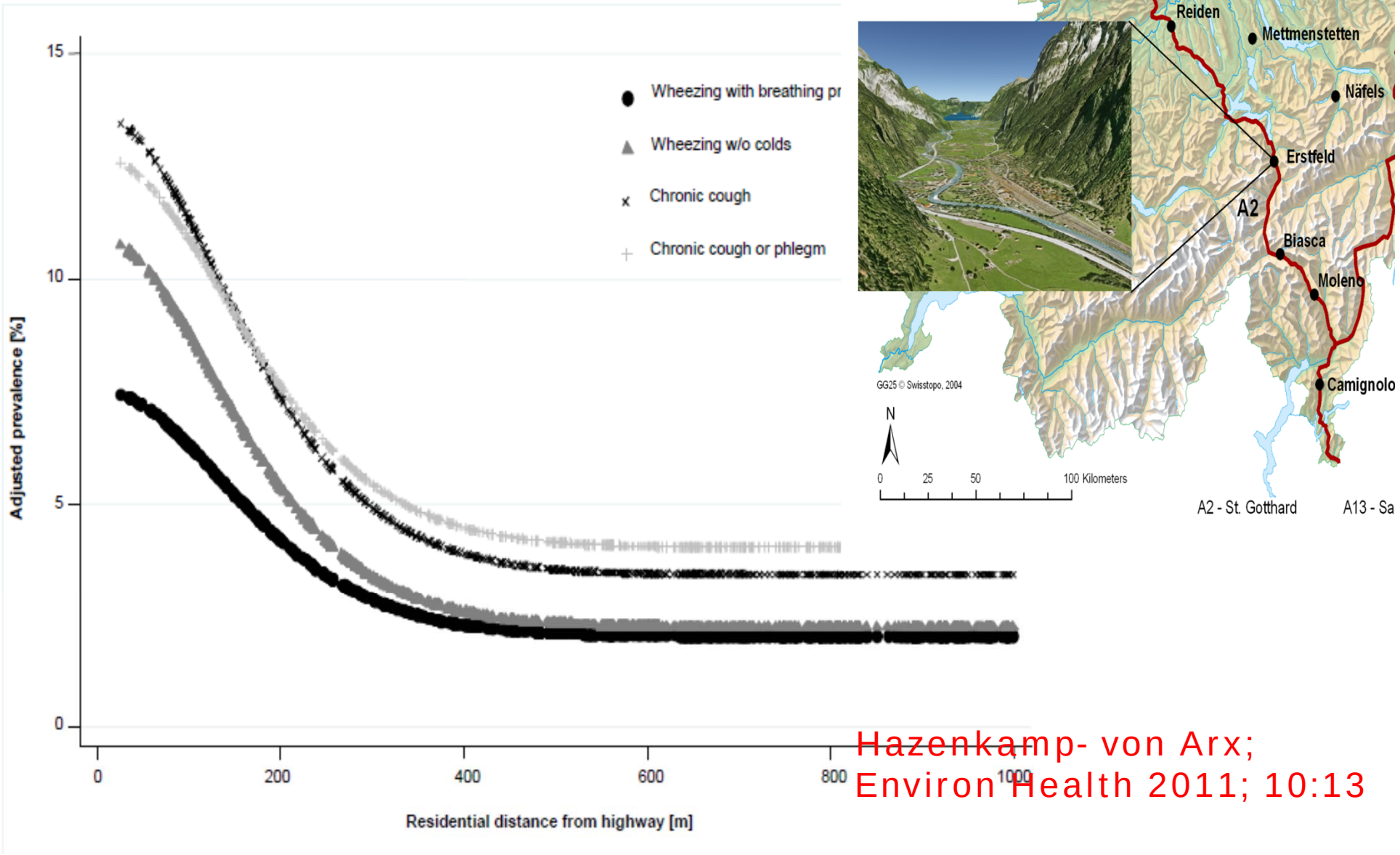
# More coronary artery disease living near busy roads (calcifications)




**Daten von 4494 Personen von 45-75 Jahren Ruhrgebiet, Deutschland**

Hoffmann Circulation 2007

# More cough and wheezing near Gotthard highway




Hazenkamp- von Arx; Environ Health 2011; 10:13

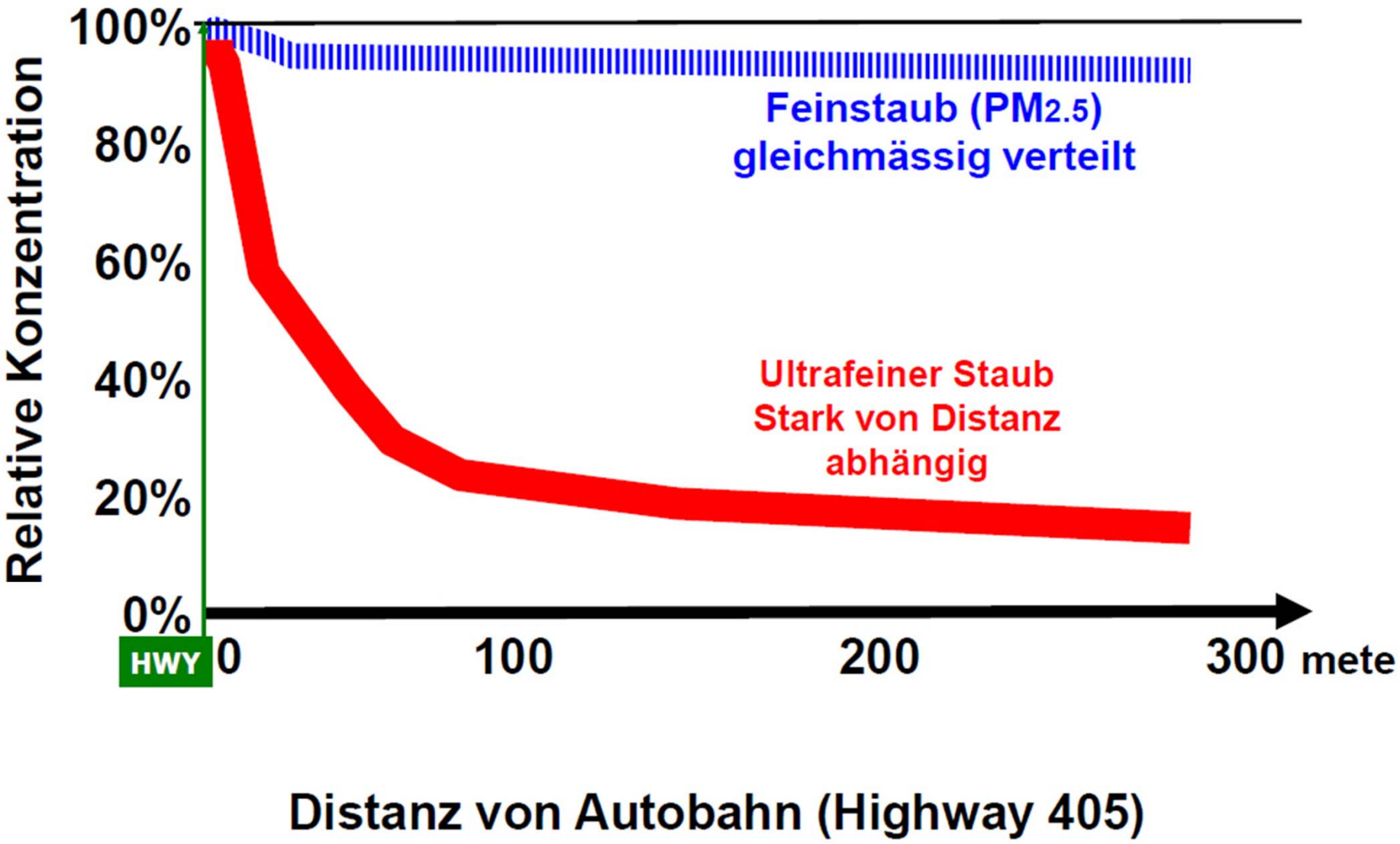
| particle size limits deposition | ultrafine «nano» particles PM 0.1 | «fine» PM 2.5 | „coarse“ particles PM 10 | visible dust |
|---|---|---|---|---|
| diameter (µm) | -0,1 (-100 nm) | 0,1-2,5 | 2,5-10 | >10 |
| deposition | alveoli (heart, brain) | alveoli bronchi | bronchi | nose, throat |
| clearance by | macro-phages | macro-phages, cilia | muco-ciliary escalator | cough, neeze, swallow |
| for example | viruses, diesel-particles | soot | bacteria, mucus droplets | pollen |
| health problems caused | pneumonia, cardiac disease, death | alveolitis COPD | bronchitis | rhinitis |

# Measure particle number concentration not particle mass: 10 mcg PM 2.5 =

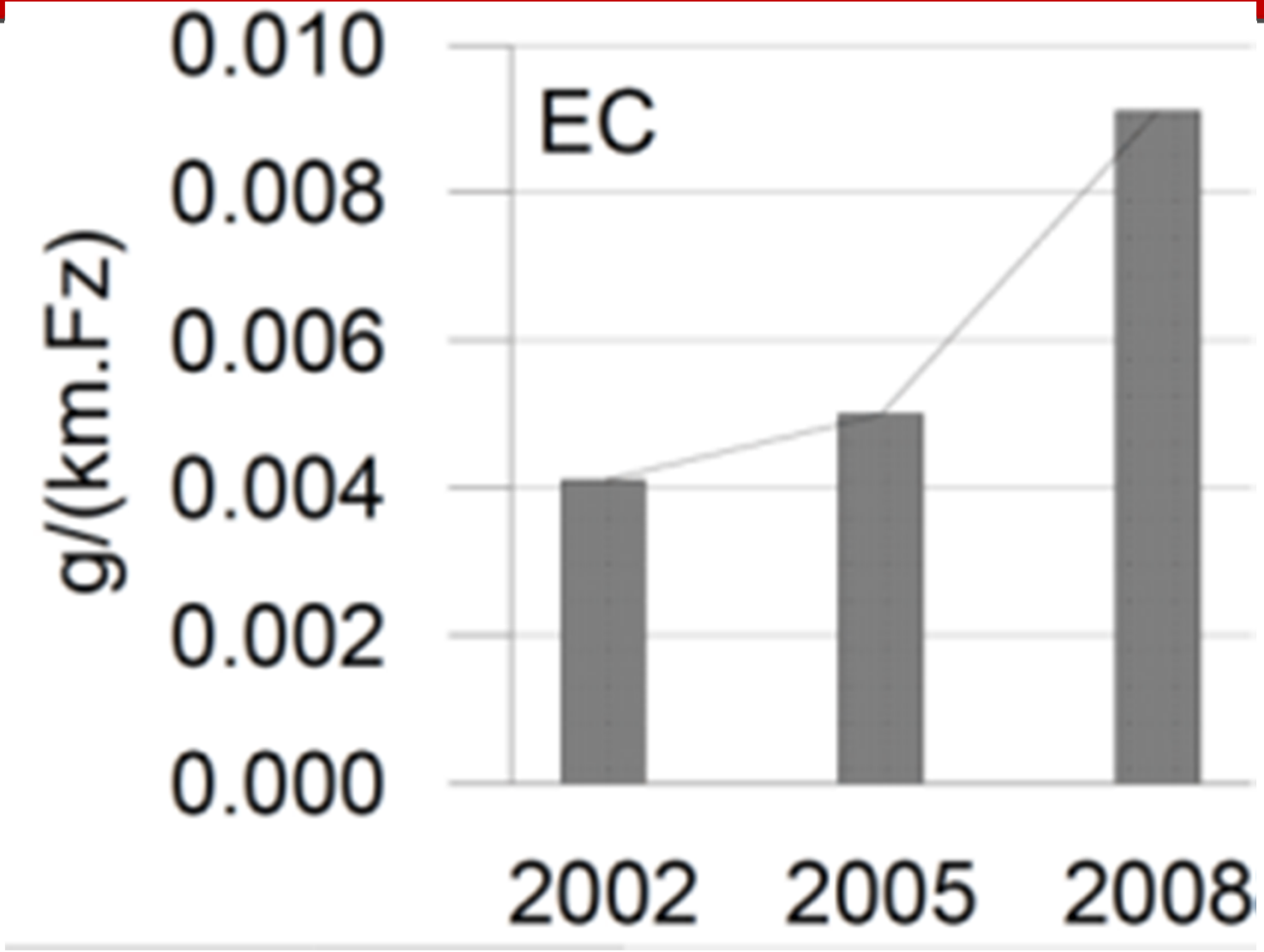
(Oberdörster 1994)

| diameter nanometer | number /cm3 | surface area microm2/cm3 |
|---|---|---|
| 20 | 2‘400‘000 | 3016 |
| 500 | 153 | 120 |
| 2500 | 1 | 24 |

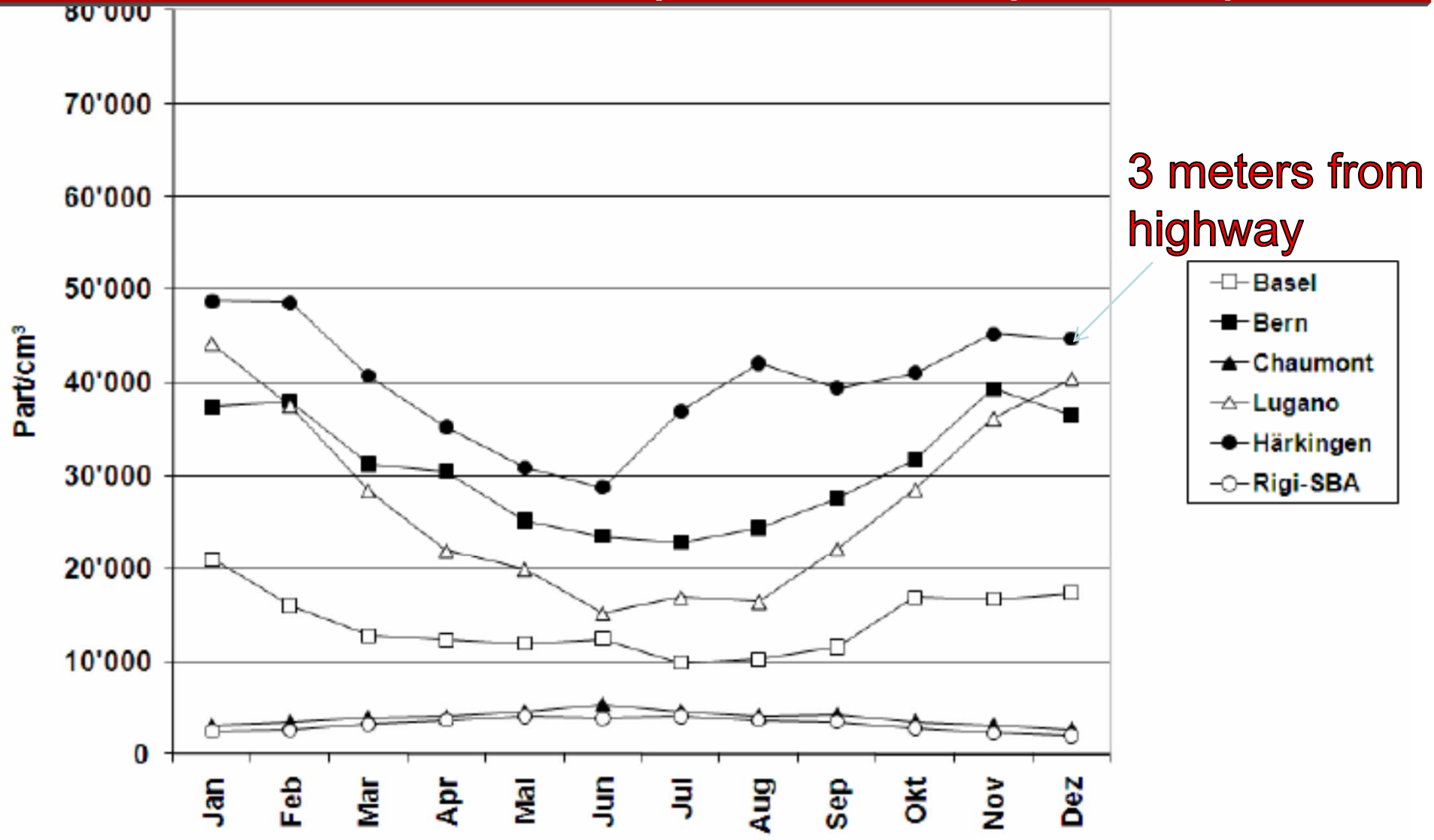
# Living near busy roads is dangerous!



# Elemental carbon in a highway-tunnel (Gubrist)



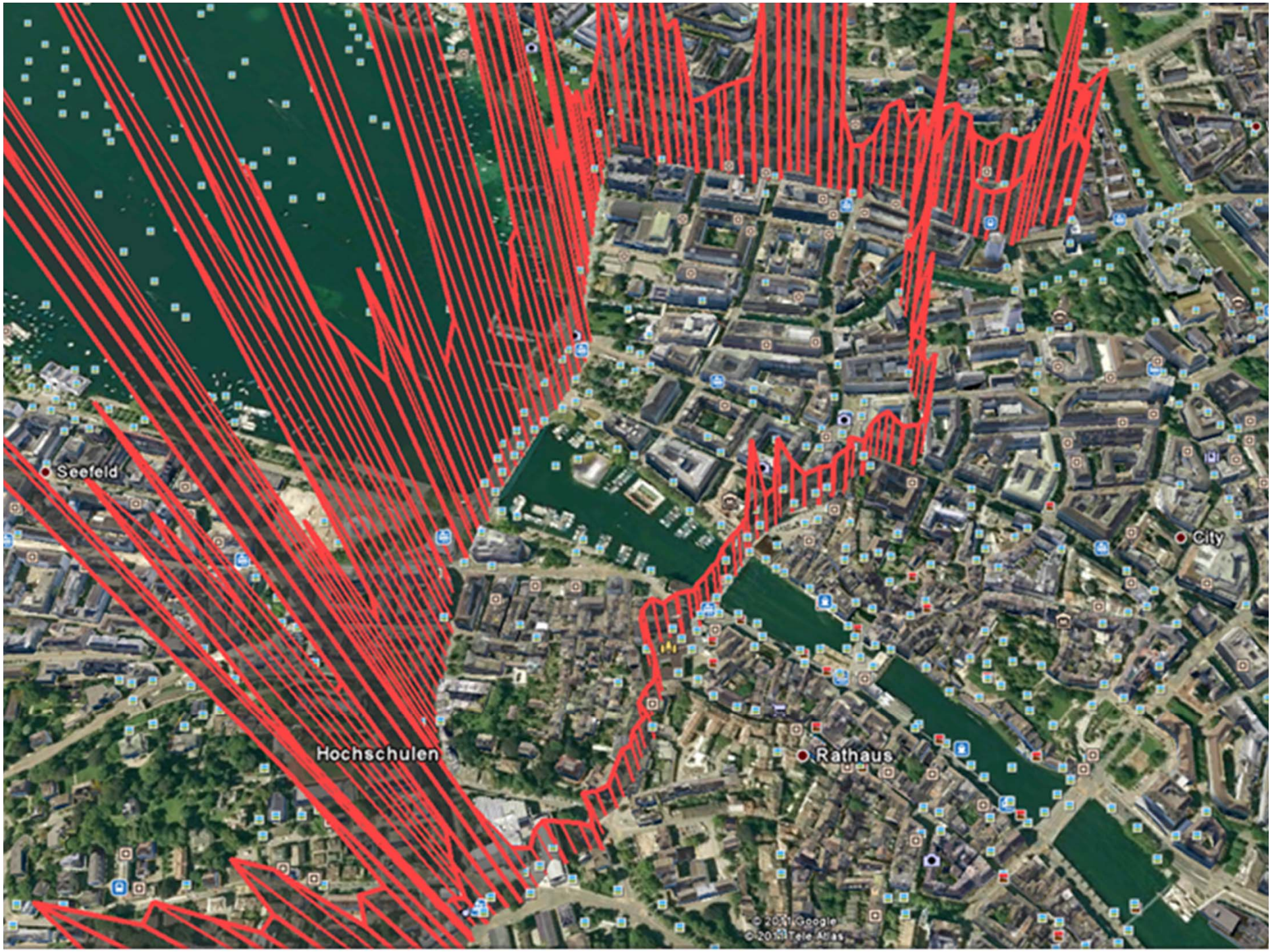
# Particle number/cm3 (annual mean, NABEL 2010, preliminary data)



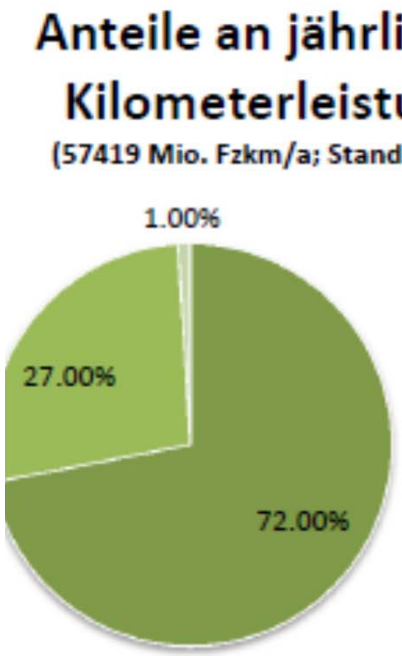
# www.DISCmini.ch

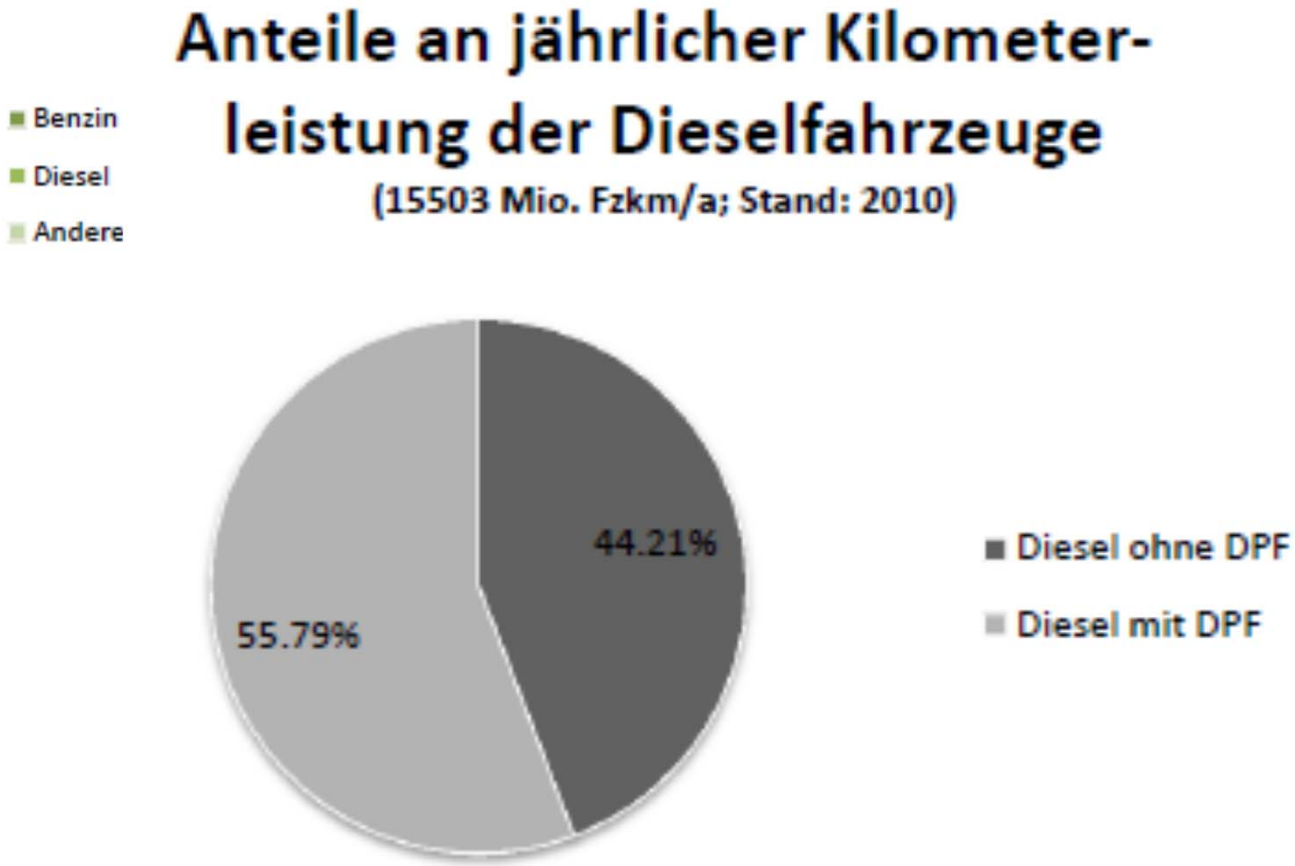

mkasper@matter-aerosol.ch

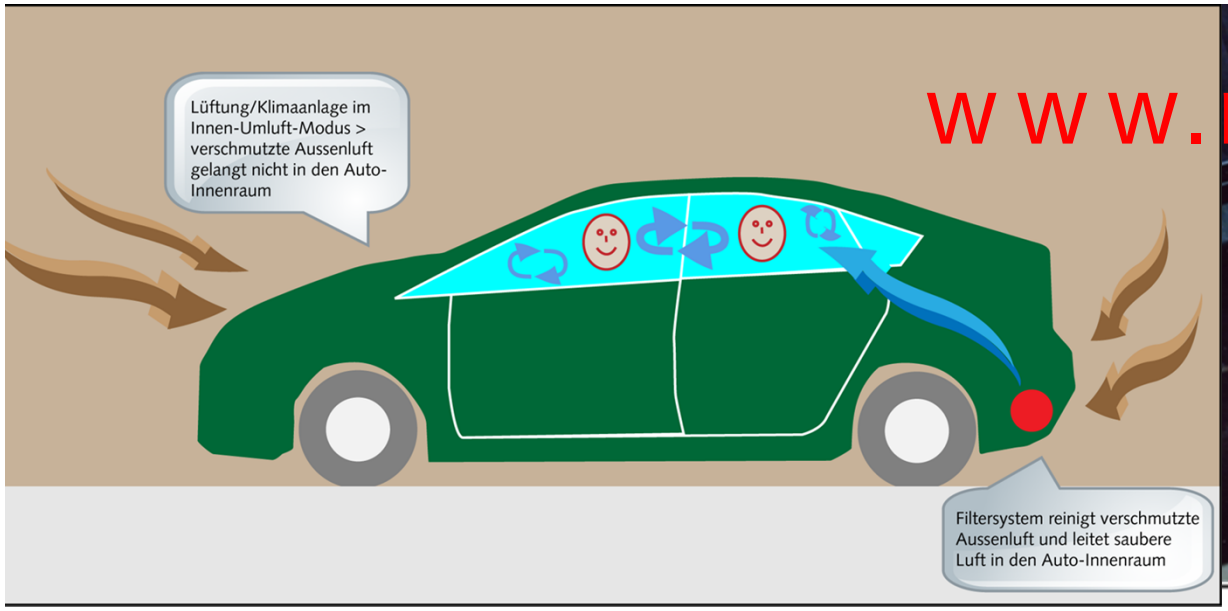
heinz.burtscher@fhnw.ch


Seefeld
Hochschulen
Rathaus
City

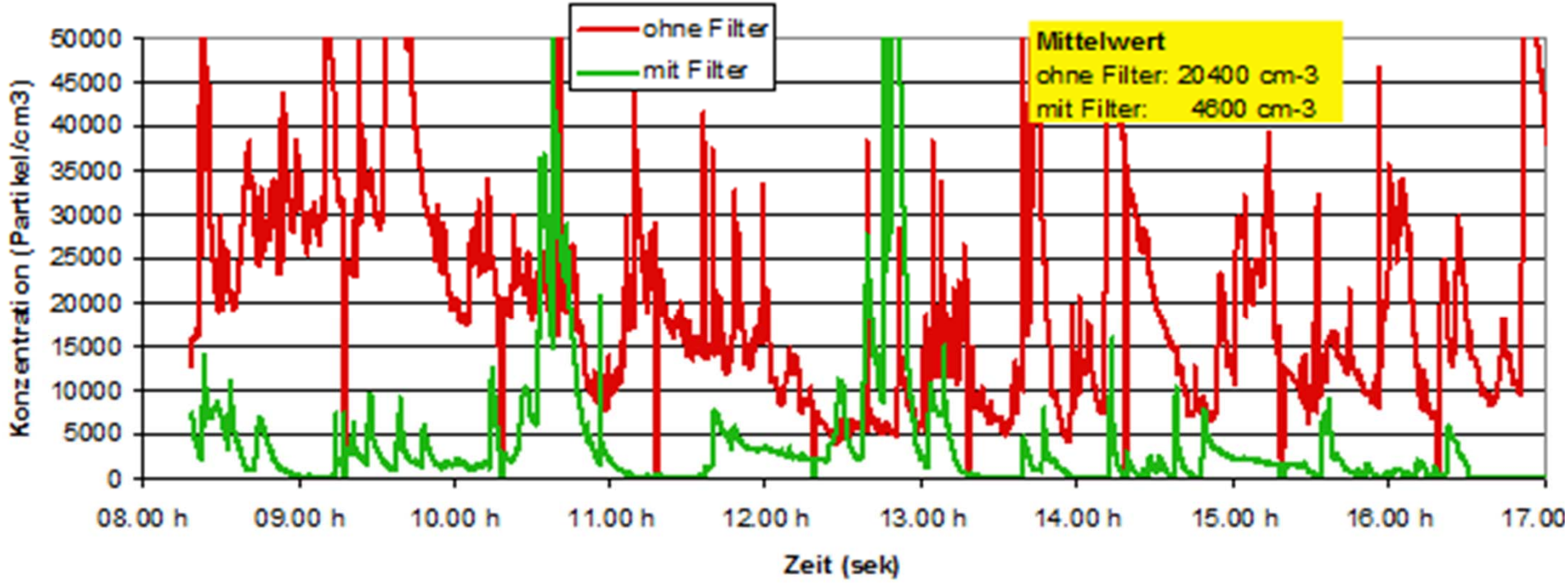
# Swiss fleet 2010: 27% diesel, 44 % without DP-filter!







# Swiss Aerosol Award 2011

The Swiss Lung Foundation has established an

annual award of 10’000 CHF

for the best scientific publication in the field of international Aerosol research

- the work should come from a Swiss university, clinic or research institute.
- The manuscript can be written in German, French or English and must either be accepted for publication or published in a peer-reviewed journal since Jan 1st 2011

The documents should be submitted by August 31

to Dr. med. Otto Brändli

Hömelstrasse 15, 8636 Wald

braendli@swisslung.org


Behavior Change is the most difficult!
1) think first, then drive
2) walk or bike short distances
3) use public transportation
4) or use (and produce) the most advanced, non-polluting and fuel-efficient vehicles