New Data of the Climate and Health Impact of Black Carbon (Diesel Soot) and technical Abatements Possibilities

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Conference „How to keep clean air in Polish aglomeration?"
2nd of February, 2012,Warsaw, Poland

Climate

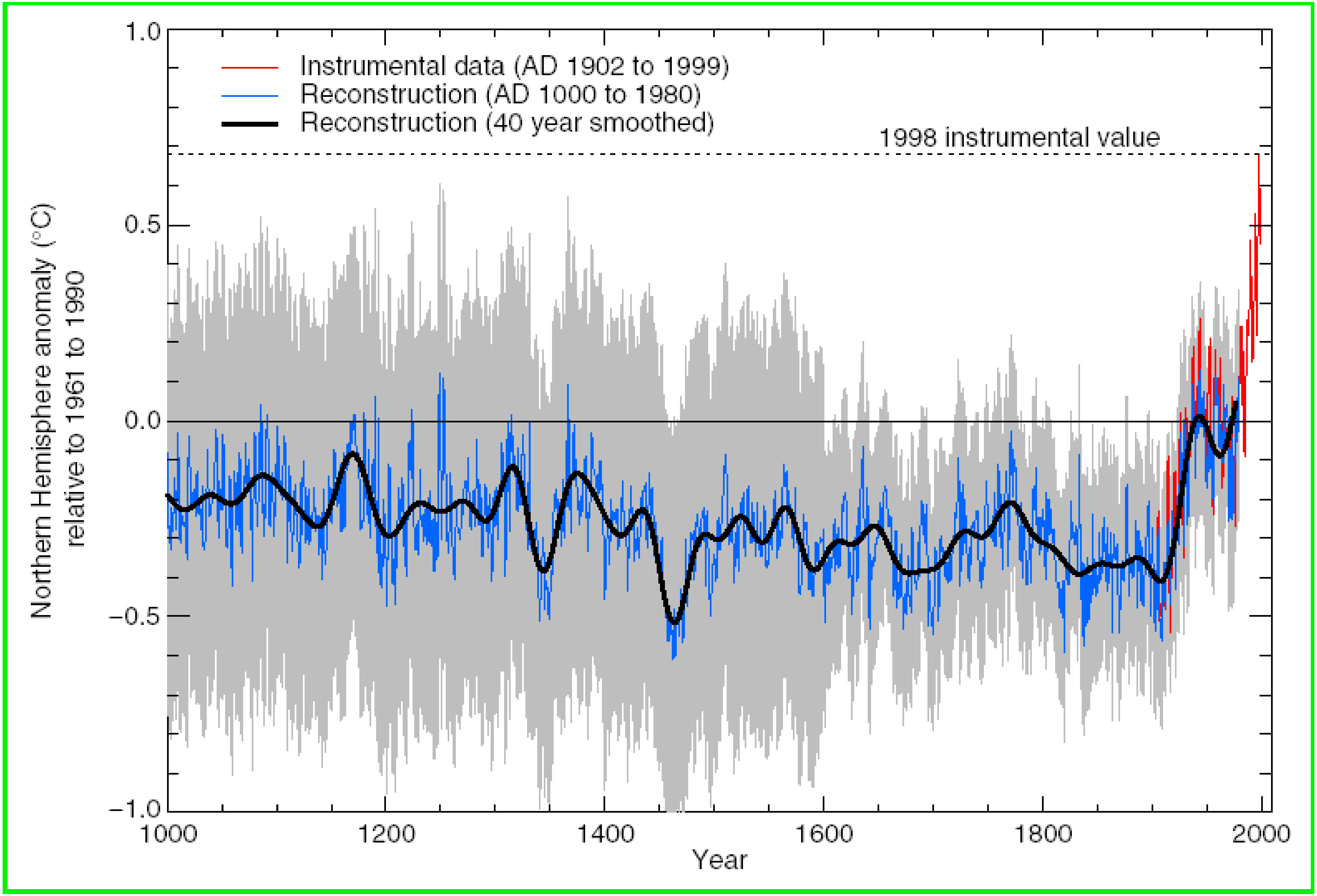
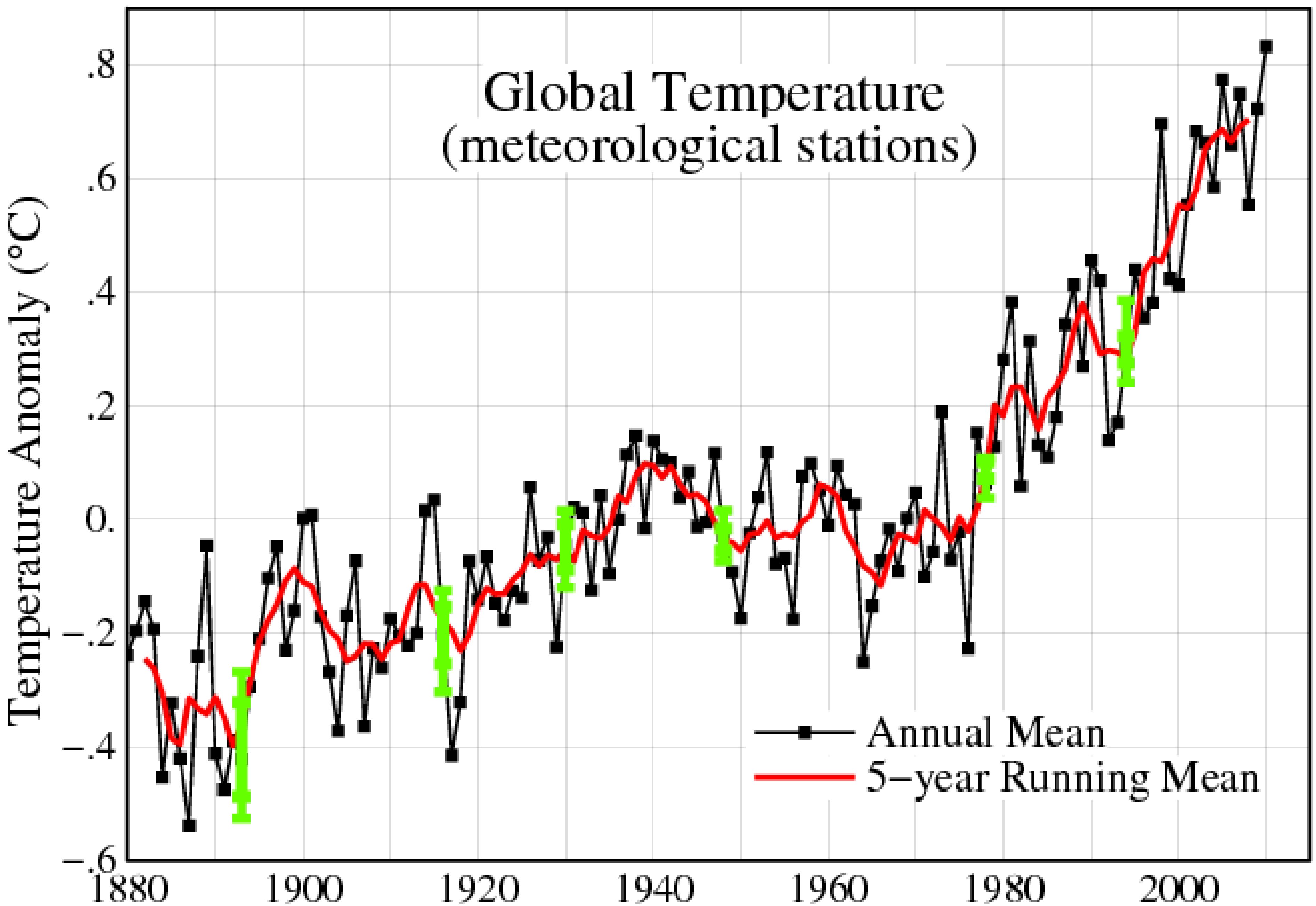
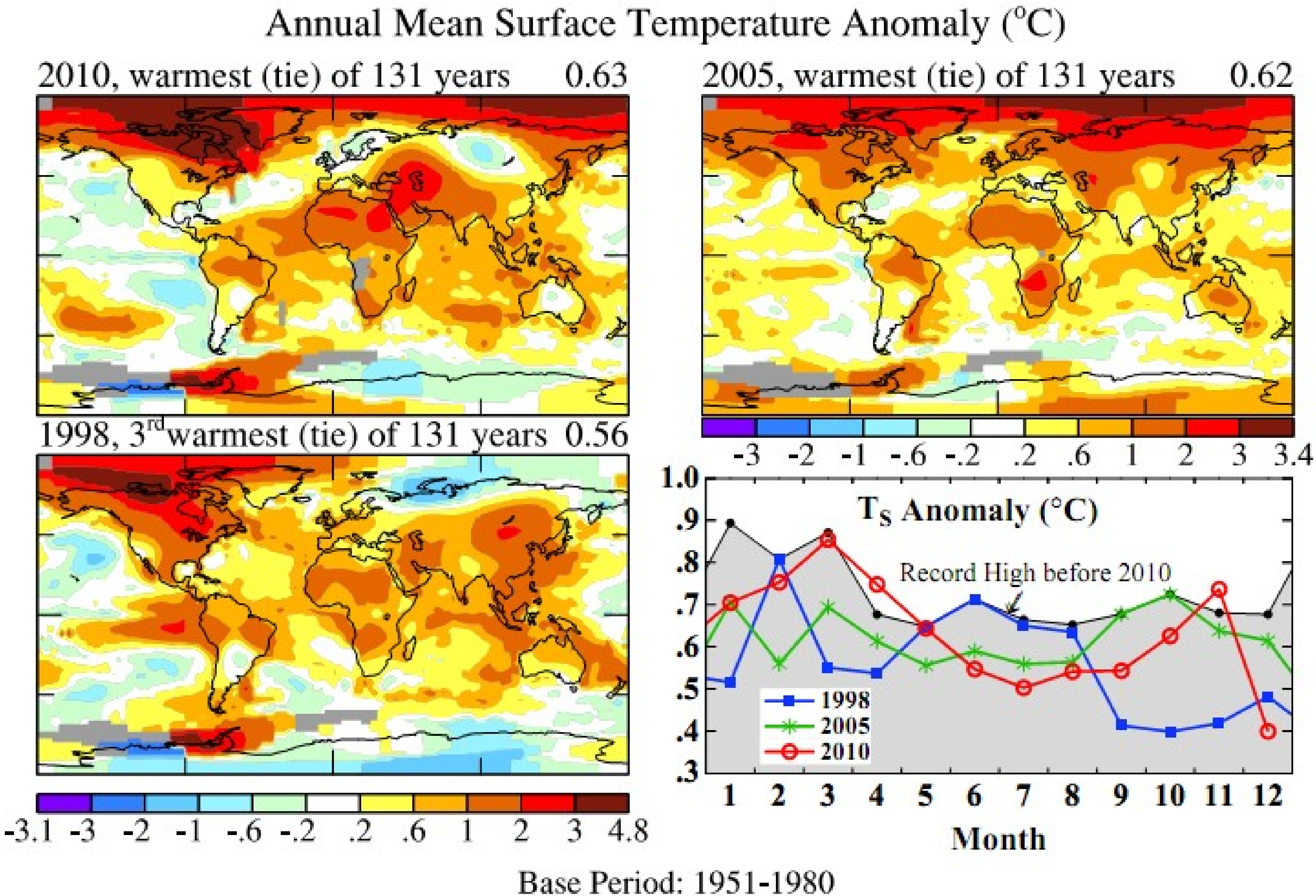


Figure 5: Millennial Northern Hemisphere (NH) temperature reconstruction (blue – tree rings, corals, ice cores, and historical records) and instrumental data (red) from AD 1000 to 1999. Smoother version of NH series (black), and two standard error limits (gray shaded) are shown. [Based on Figure 2.20]

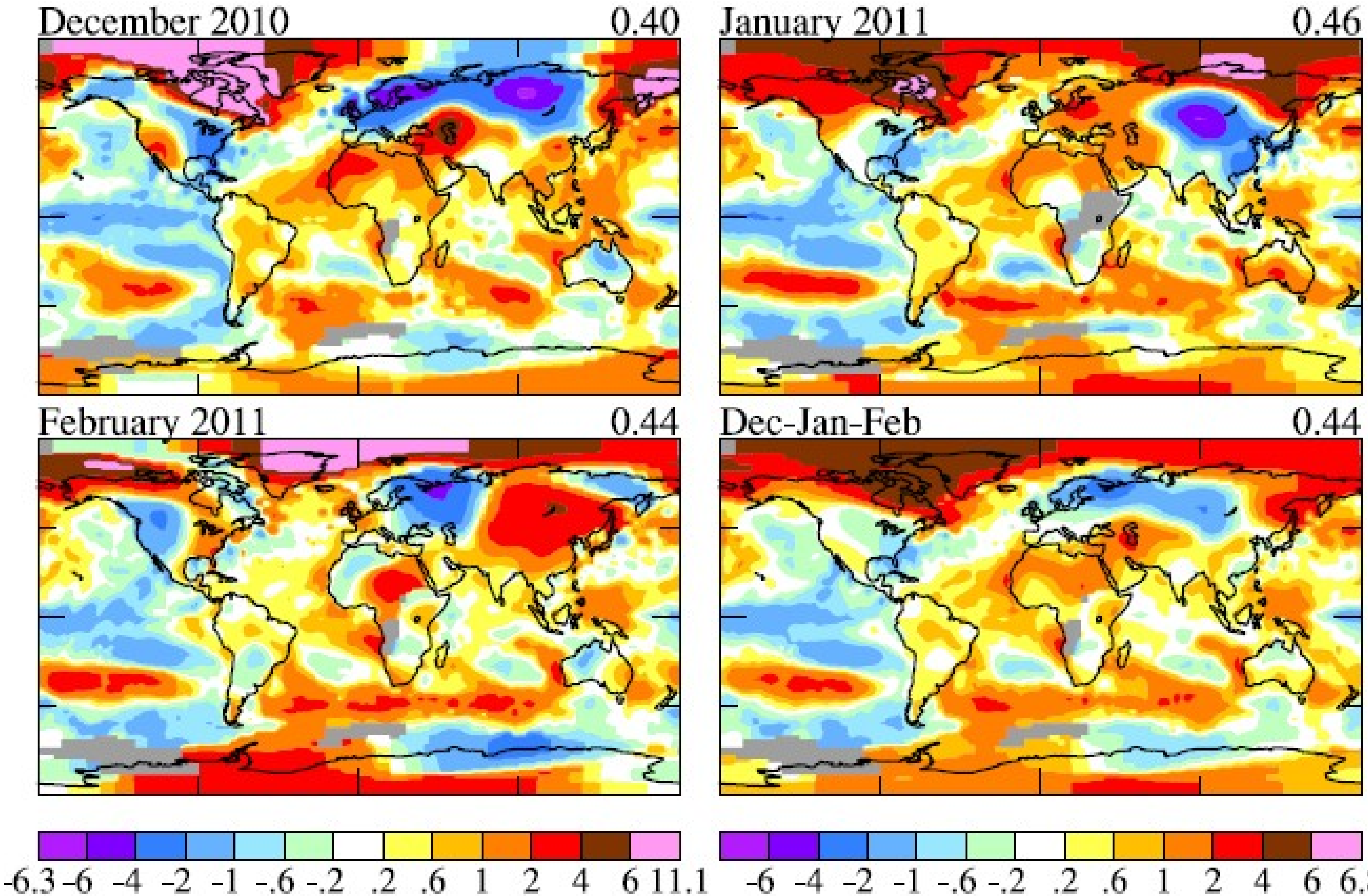


http://data.giss.nasa.gov/gistemp/graphs/Fig.A.lr
g.gif



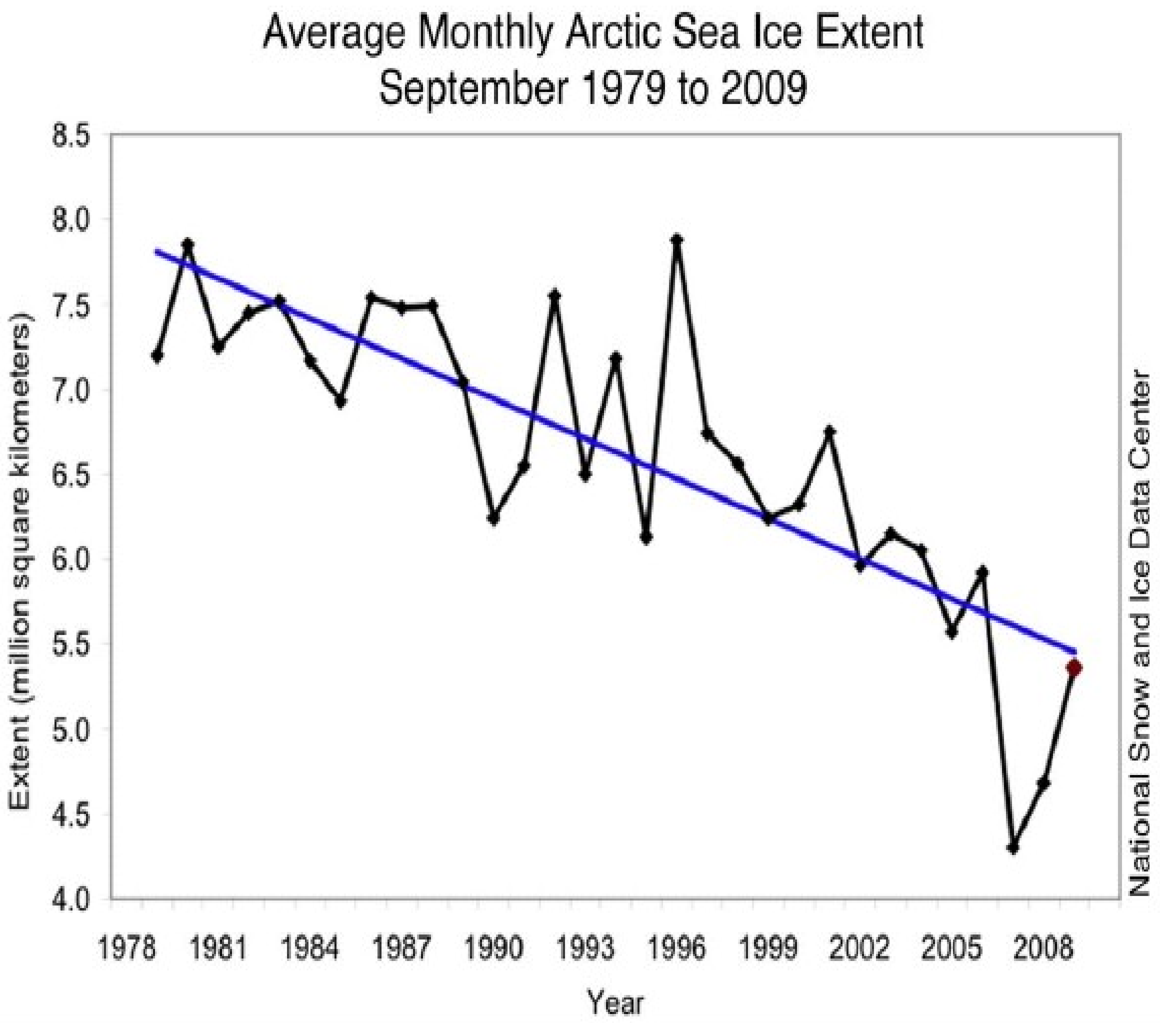
http://data.giss.nasa.gov/gistemp/graphs/2010vs2005+1998.pdf

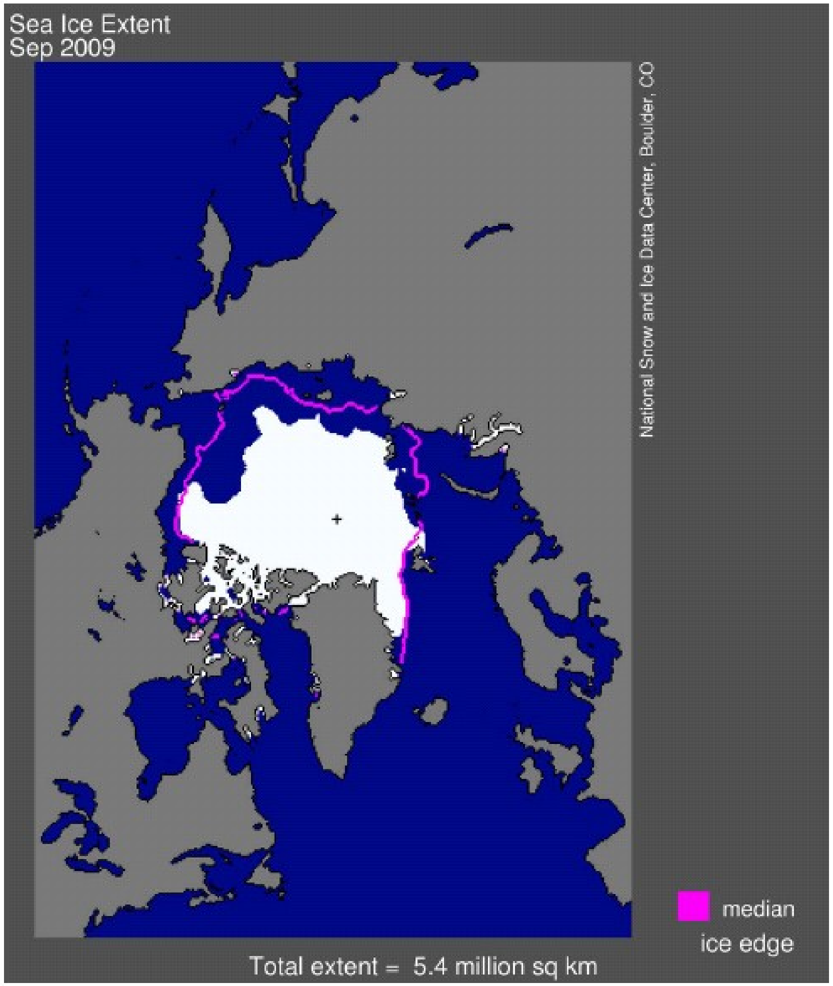
Surface temperature anomalies in Northern Hemisphere winter 2010-2011 relative to 1951-1980 mean.



Source: Hansen, J., R. Ruedy, M. Sato, K. Lo, 2010: Global surface temperature change, Rev. Geophys., 48, RG4004, 29 pp.

Arctic Sea Ice Summer Minimum



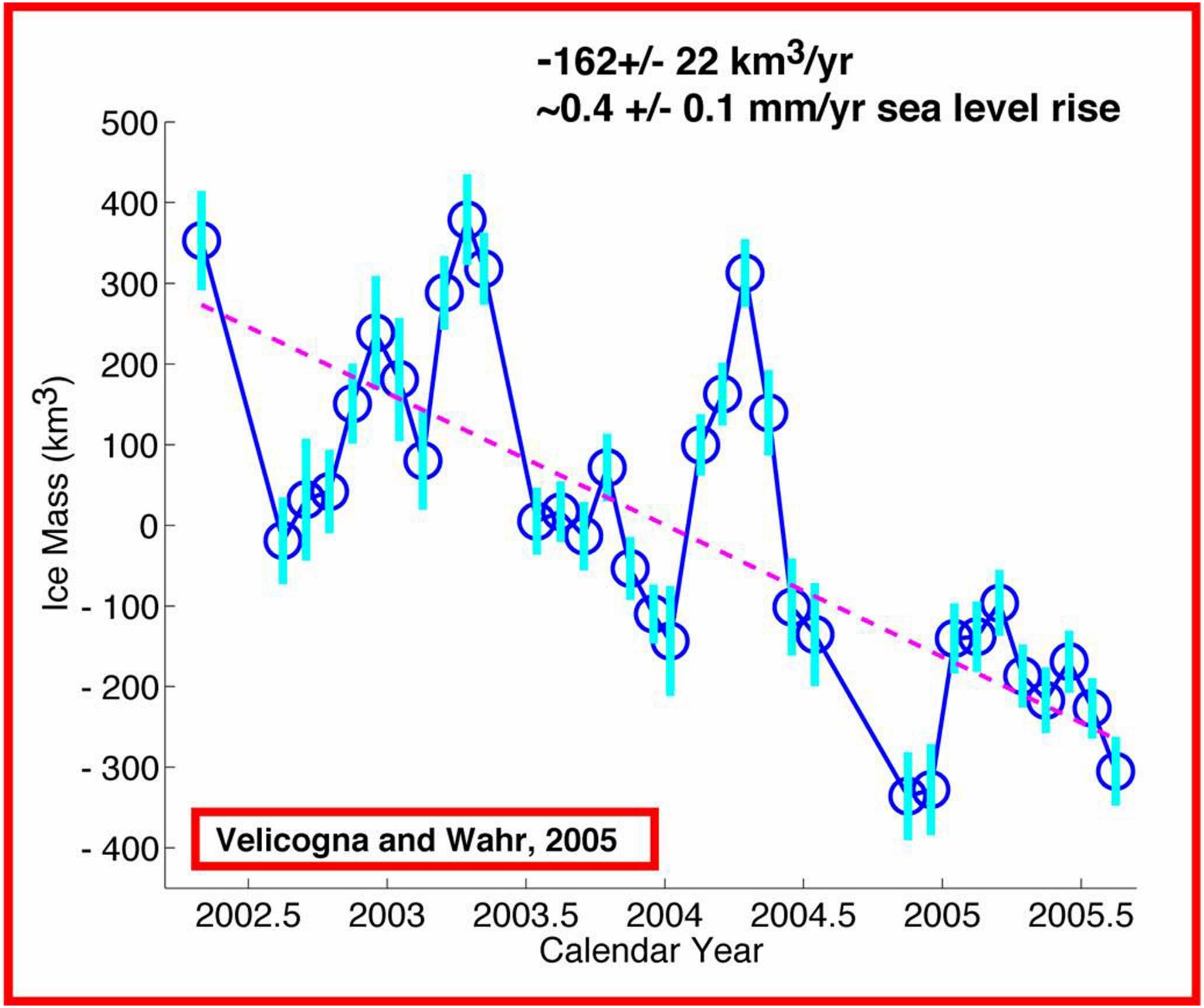


Source: National Snow and Ice Data Center, Boulder, Colorado.

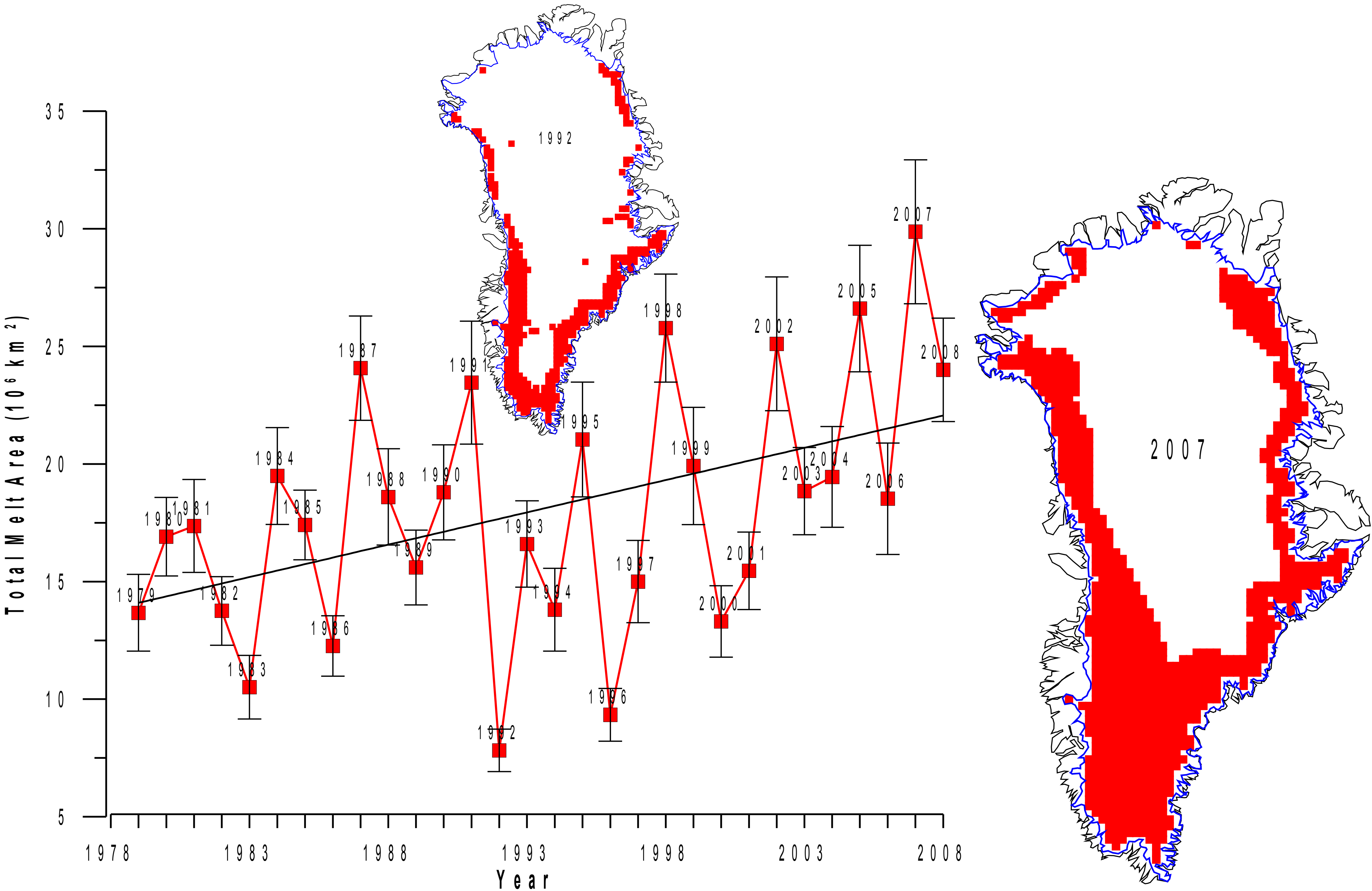
Evidence of Arctic Ice Melt

Arctic summer sea ice has decreased by 40% since 1979, accompanied by increasing discharge from the Greenland ice sheet. Natural variability may explain some of the changes, but the overall trend towards warming and melting has been attributed primarily to human induced climate change (Min et al., 2008; Holland et al., 2008). Summer sea ice melt creates a feedback loop that amplifies warming as reflective white ice/snow surfaces are replaced by darker ocean waters increased sunlight absorp tion. Recent work suggests a link between Arctic sea ice melt and increased glacier runoff in Greenland. (Rennermalm et al., 2009)

Greenland Mass Loss – From Gravity Satellite



Melting Areas in Greenland




1985

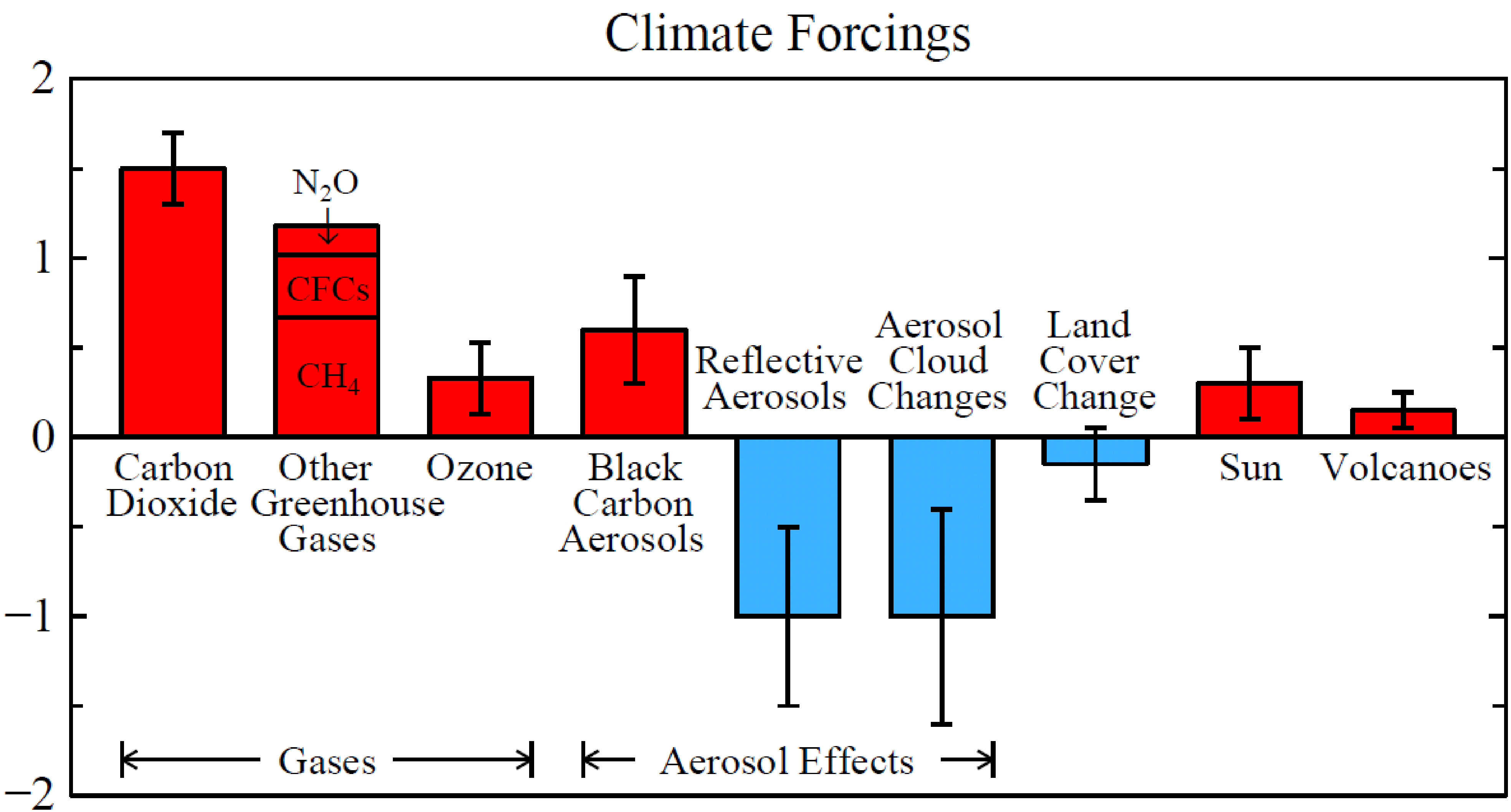
2000

Himalayan (Rongbuk) Gletscher

Rongbuk, the largest glacier on Mount Everest’s northern slopes, in 1968 (top) and 2007.

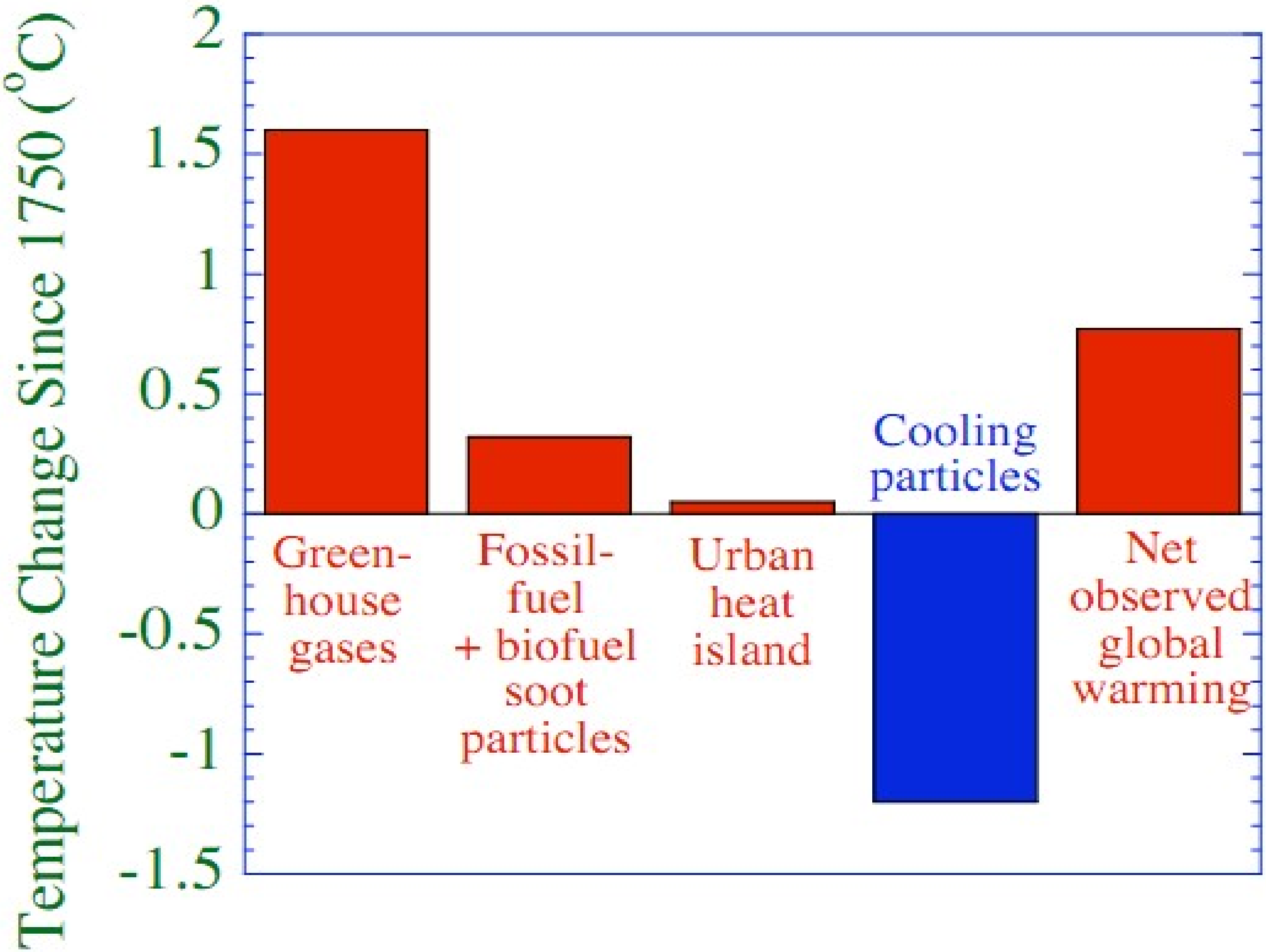
Glaciers are receding rapidly world-wide, including the Rockies, Andes, Alps, Himalayas.

Glaciers provide freshwater to rivers throughout the dry season and reduce spring flooding.



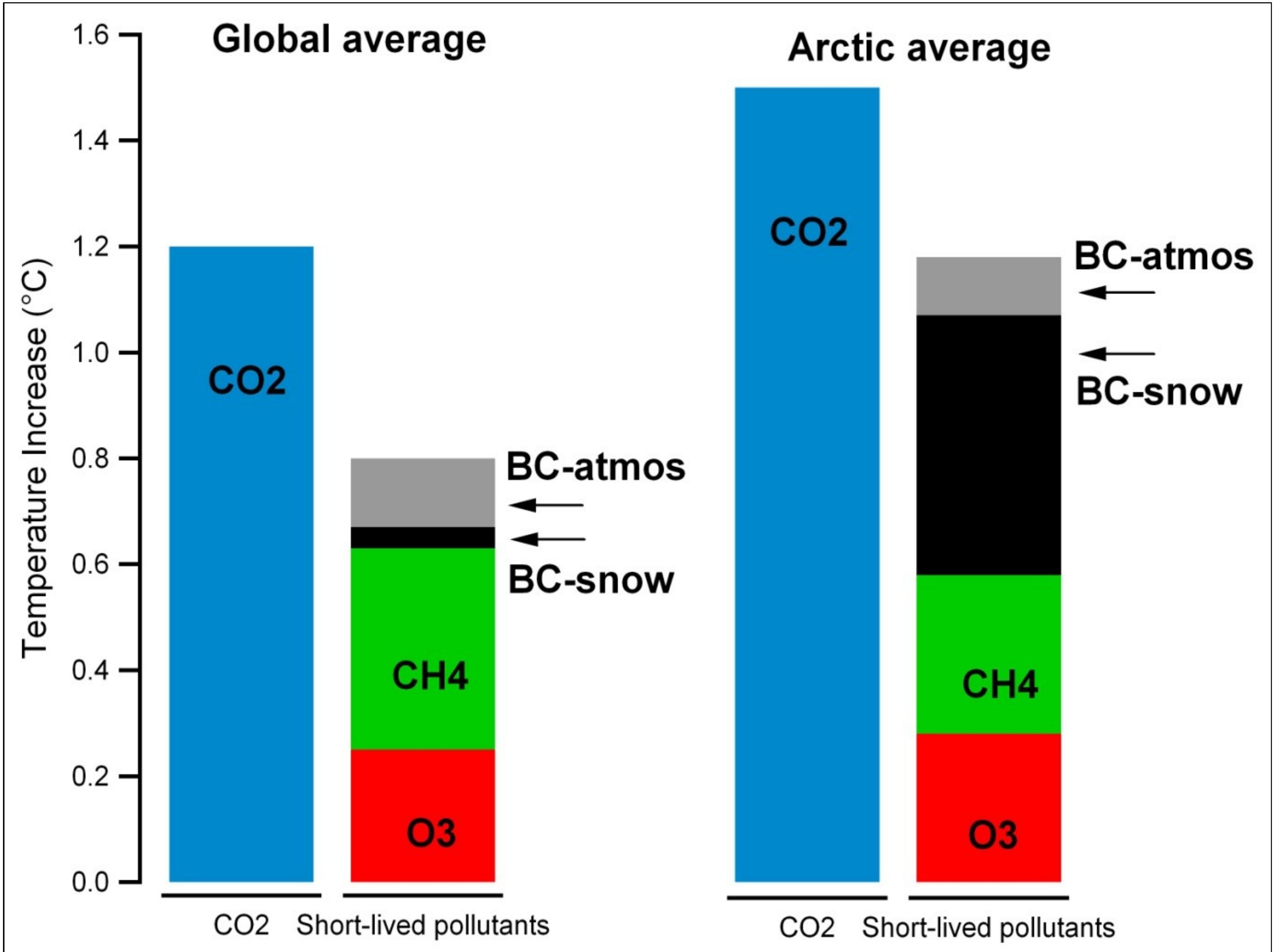
Change of climate forcings in W/m² between 1750 and 2000. [from Hansen et al. "Efficacy of Climate Forcings" (2005)

Primary contributions to observed global warming 1750 to today from global model calculations.
The fossil-fuel plus biofuel soot estimate is from Ref. 2. and accounts for the effect of soot on snow albedo.



Global vs. Arctic Warming

1830 to the Present



Source: Arctic Monitoring & Assessment Program (AMAP A working group of the eight nation Arctic Council

Shindell, Faluvegi - April 2009

Black Carbon responsible for 50% or nearly 1.0º C of the 1.9º C temperature increase in the Arctic from 1890 to 2007

Tankers successfully traverse the Arctic's Northeast Passage

30th September 2011 19:02 GMT

The Stena Poseidon successfully traversed the Northeast Passage
Two Neste Oil tankers have successfully traversed the Northeast Passage between Murmansk and the Pacific Ocean, Neste Oil has informed Sustainable Shipping.
"Only a few vessels including Neste Oil's ships have operated along the route this year. The first Neste Oil tanker to traverse the route was the MT Stena Poseidon, which carried a customer's cargo along the Northeast Passage and onwards to South Korea. She was followed by the MT Palva, which delivered a customer's cargo to a port in China," Neste Oil said.
Melting ice has opened a route from South Korea along Russia's Arctic coast to Siberia in the Northeast Passage. The sea lane has been previously avoided because of its heavy ice floes.

How Does Black Carbon Affect the Climate?

- Black carbon absorbs radiative heat from the sun and warms everything around it (direct effect)
- Black carbon interacts with clouds and affects rainfall patterns (indirect effect)
- Black carbon falls onto snow and ice and changes the overall reflectivity of those surfaces (albedo effect)

Sources of Black Carbon Emissions

1. Domestic combustion: Use of wood or coal, in heating stoves and boilers of different kinds.
2. Land transport: On-road and off-road diesel and machinery,

3. Shipping: Different vessel types espechiallly operating in Arctic waters.
4. Energy and industrial production and waste treatment: Use of fossil and biofuels for power generation and process emissions from industrial production and combustion of wastes.
5. Field burning: Anthropogenic burning of agricultural wastes (crop residues)
6. Forest and grass fires: Biomass burning that can be natural or
anthropogenic. In northern latitudes these are generally considered 'natural',

20- and 100-year global warming potentials (GWPs) for fossil-fuel soot and black carbon within fossil-fuel soot.

X	20-year GWP	100-year GWP
FF soot	2530	840-1280
BC in FF soot	4470	1500-2240

The global warming potential is defined here as the change in temperature per unit emissions of X relative to the change in temperature per unit emissions of CO_2. Multiply the GWPs in the table by 12/44 to obtain the GWP relative to CO_2-C. BC= black carbon. FF soot=56% black carbon + 43% primary organic carbon + 1% sulfate.

UNEP

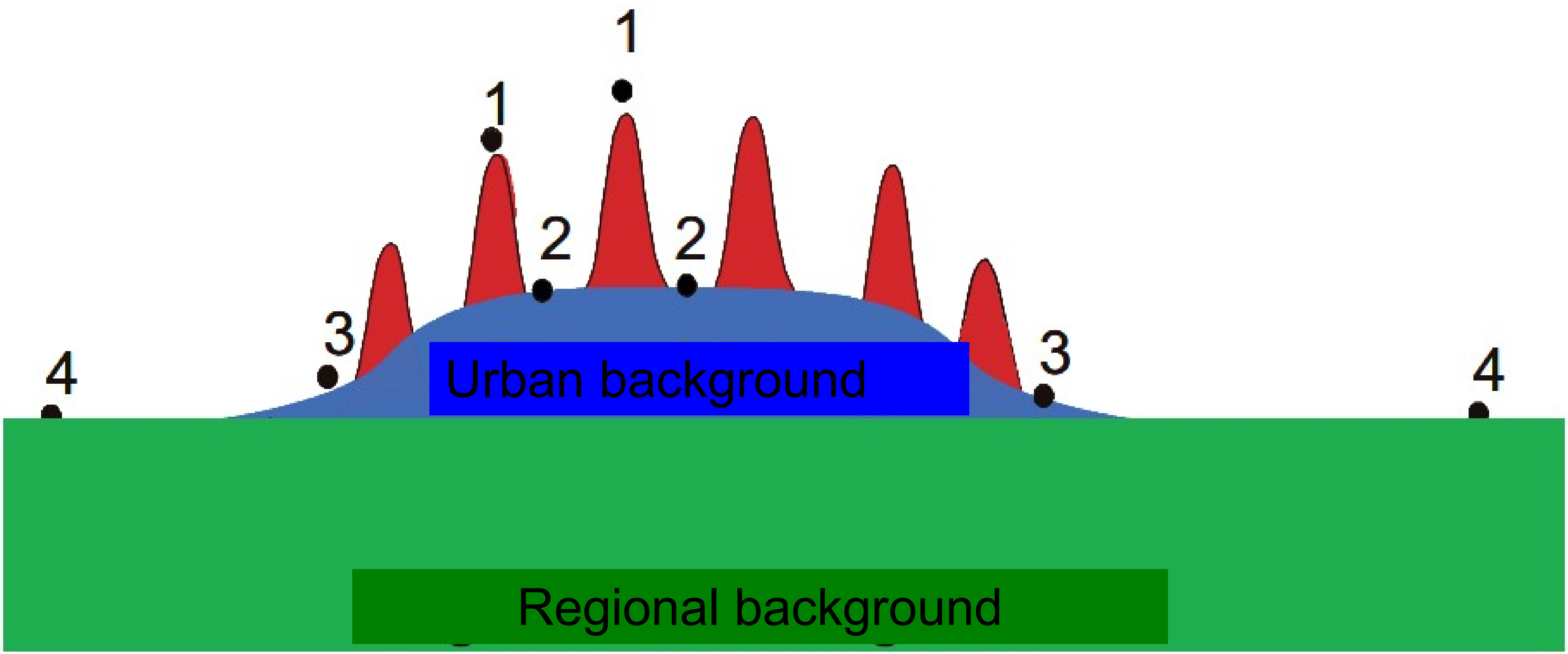
World Meteorological Organization

Integrated Assessment of Black Carbon and Tropospheric Ozone

Summary for Decision Makers

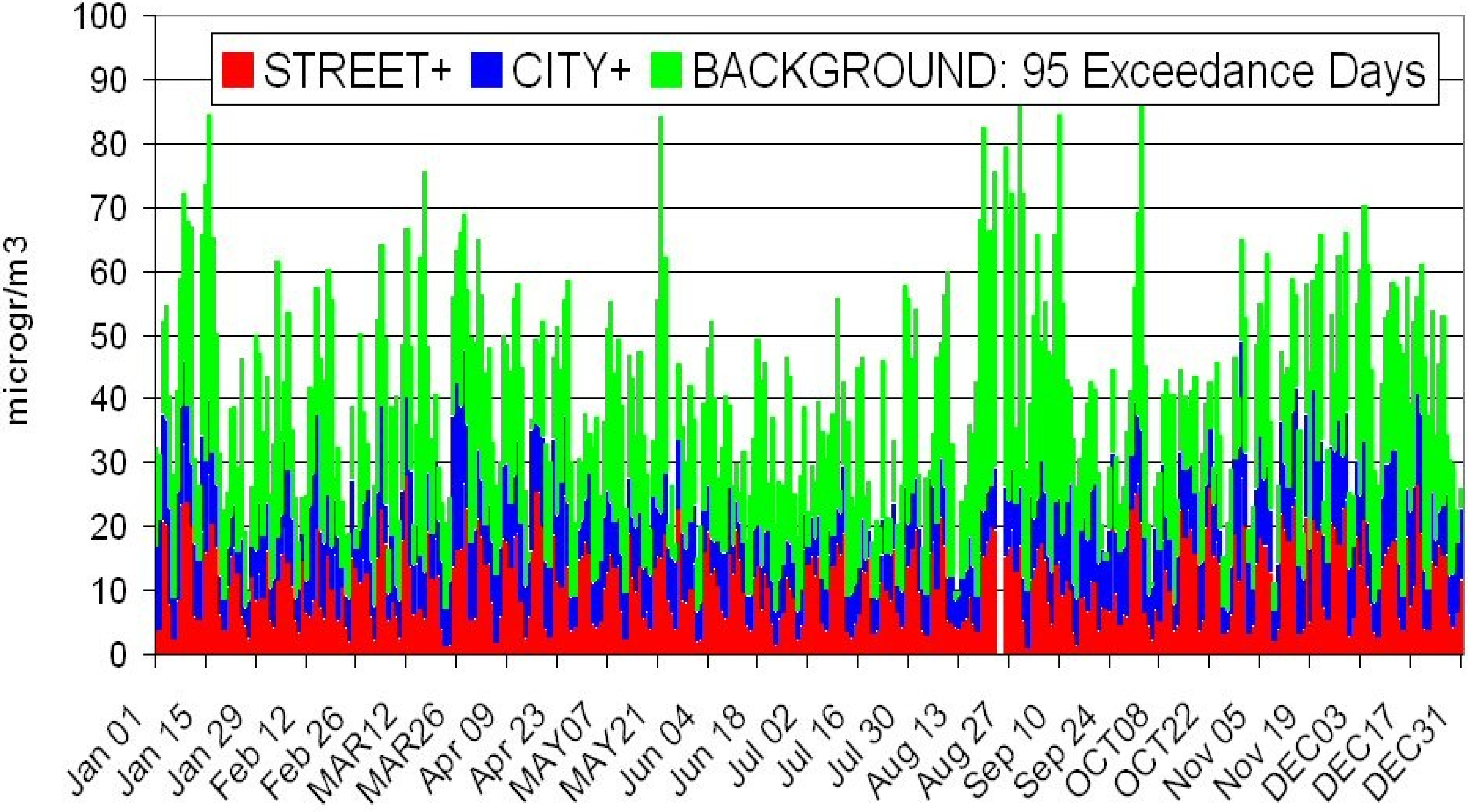
Sources

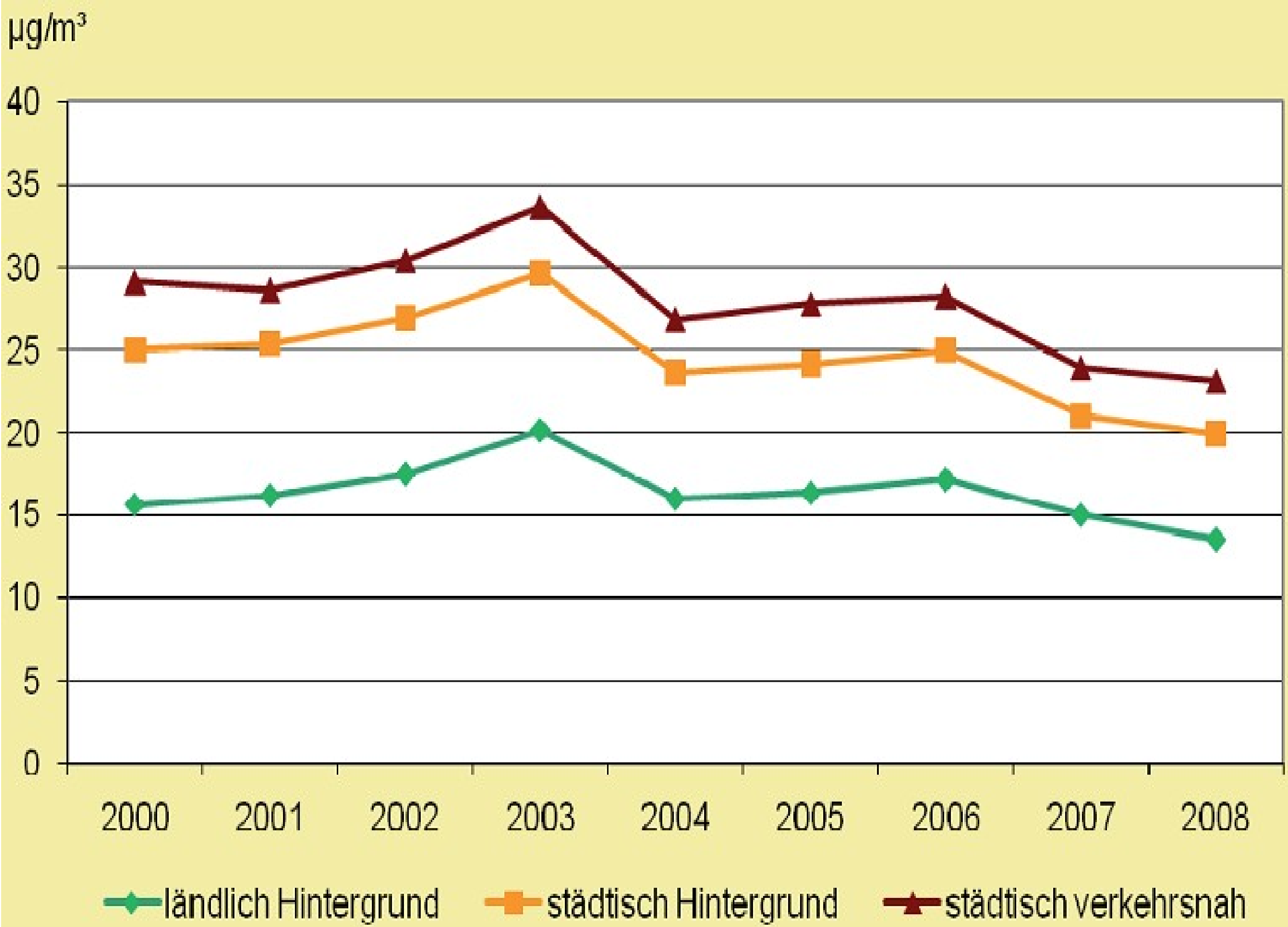
Schematic Share of PM10 Load in Urban Areas



Source: Berliner Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz

Contributions of all Emissions to Street Canyon PM10 Daily Mean concentrations: Berlin-Silbersteinstr.

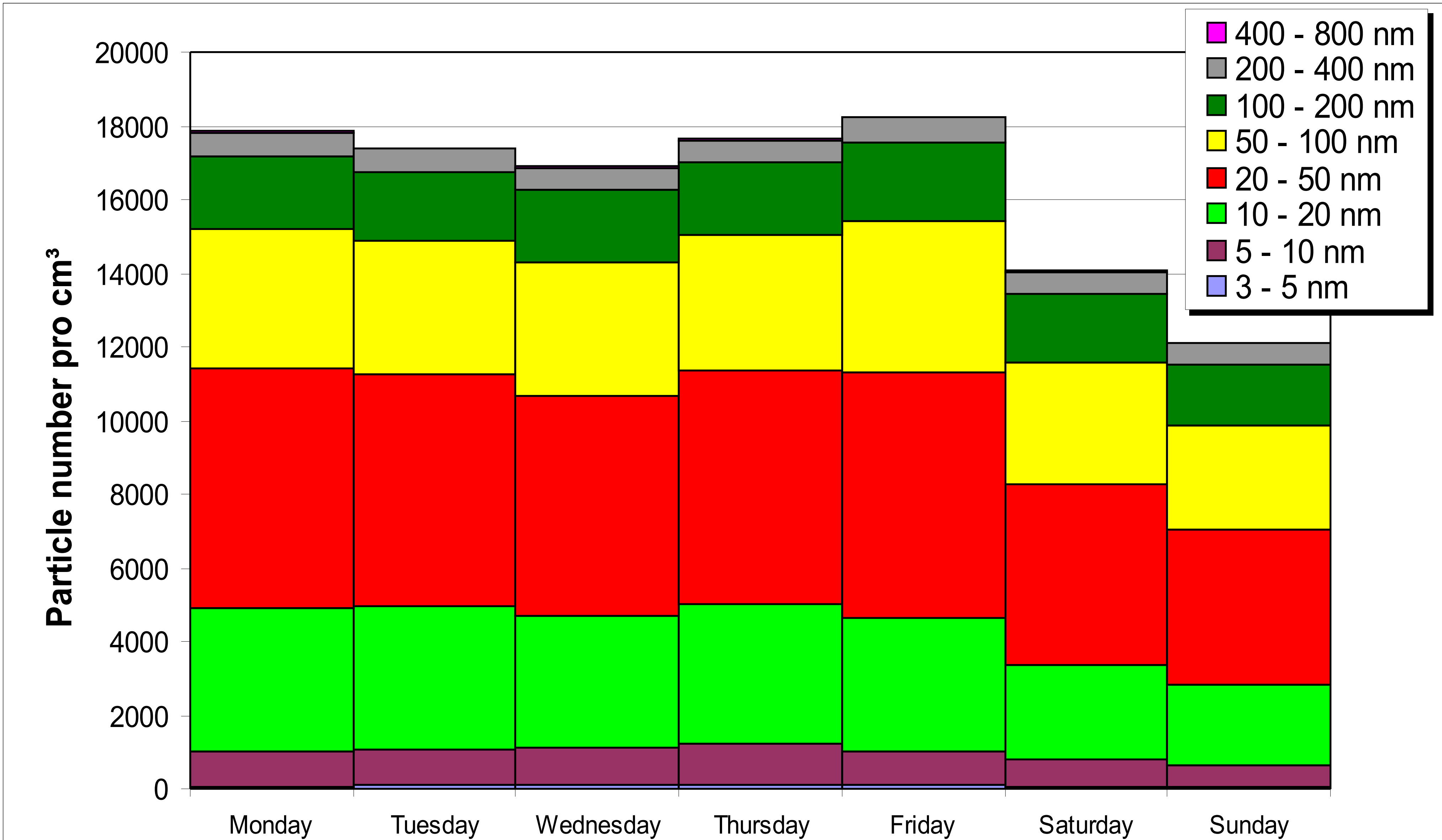




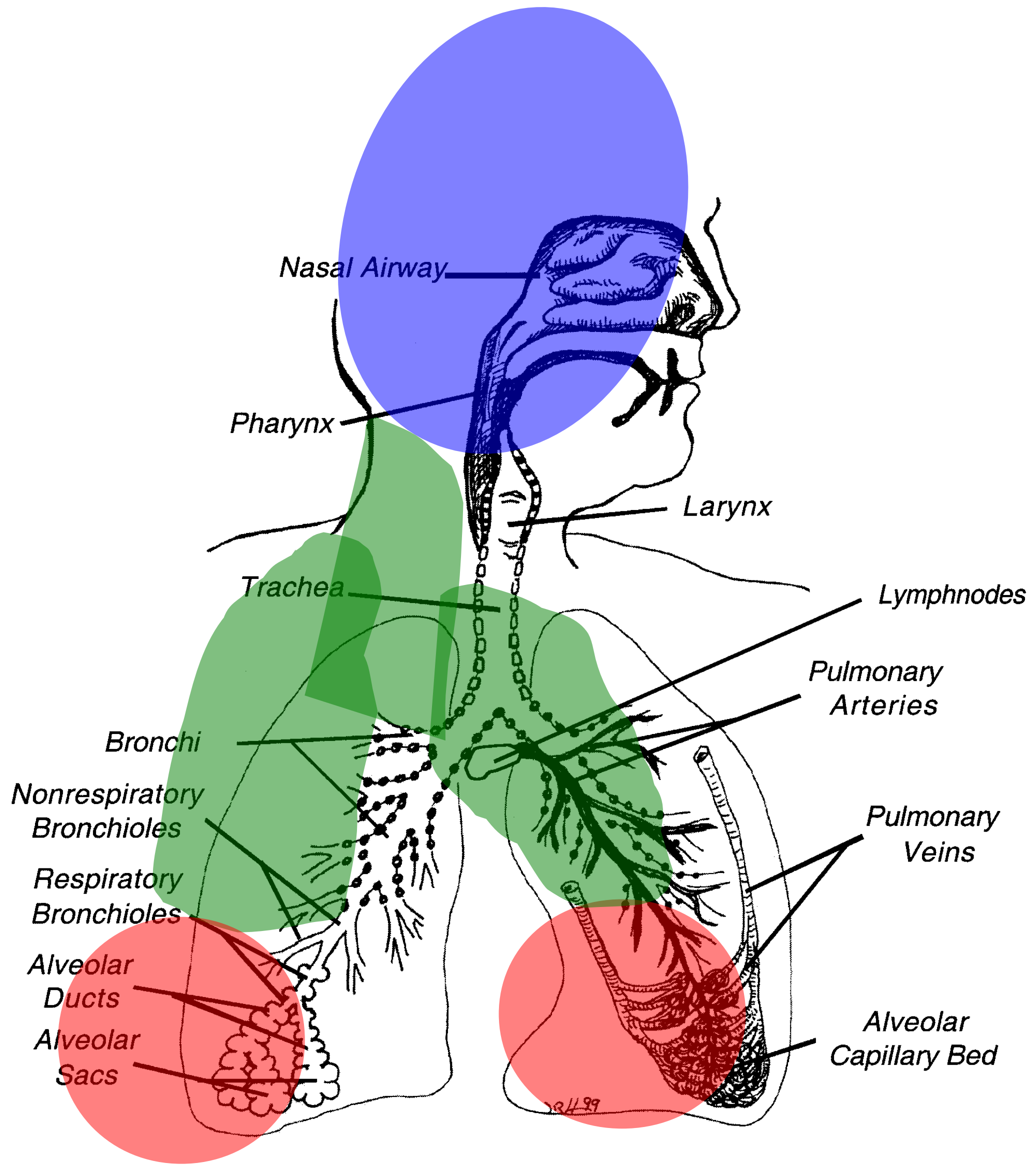
PM10-yearly average 2000 to 2008 for the measuring station categories „rural background“, „urban background“ and „urban near traffic“.

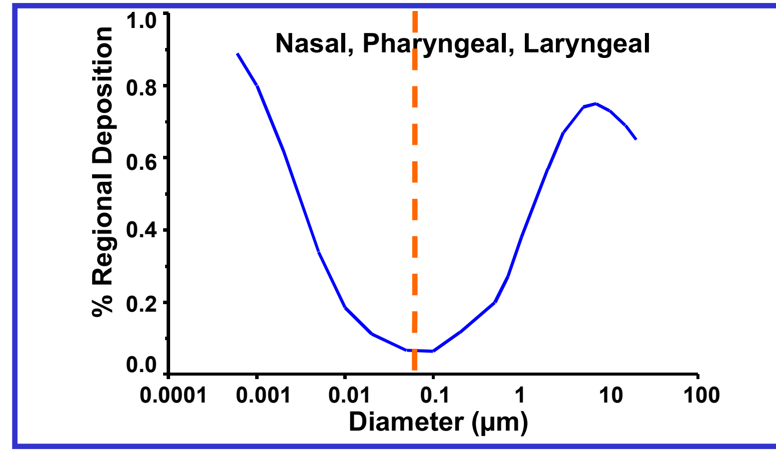
Source

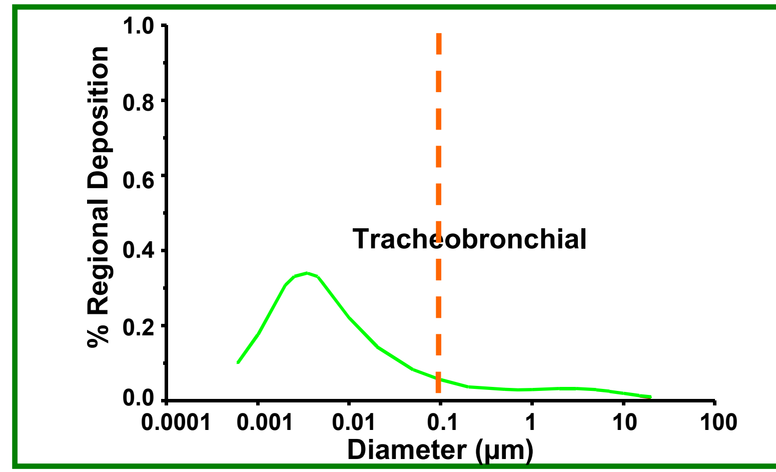
Av. Weekly Var. of the Particle Number Concentration over 12 Month



Fractional Deposition of Inhaled Particles (Oberdörster)







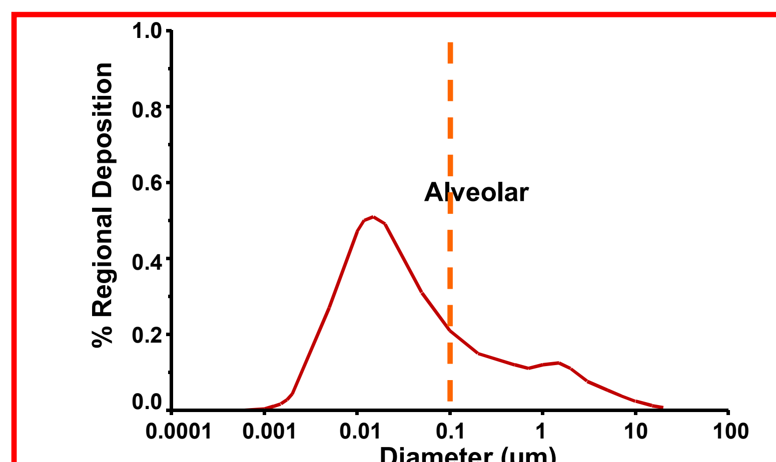


Figure courtesy of J.Harkema

Health
(Ultrafine Particles)

Ultrafine Particle Study Women in North- Rhine-Westfalia

Long term Health Effectsof Ultrafine Particles

LANUV-Fachbericht 31

(www.lanuv.nrw.de)

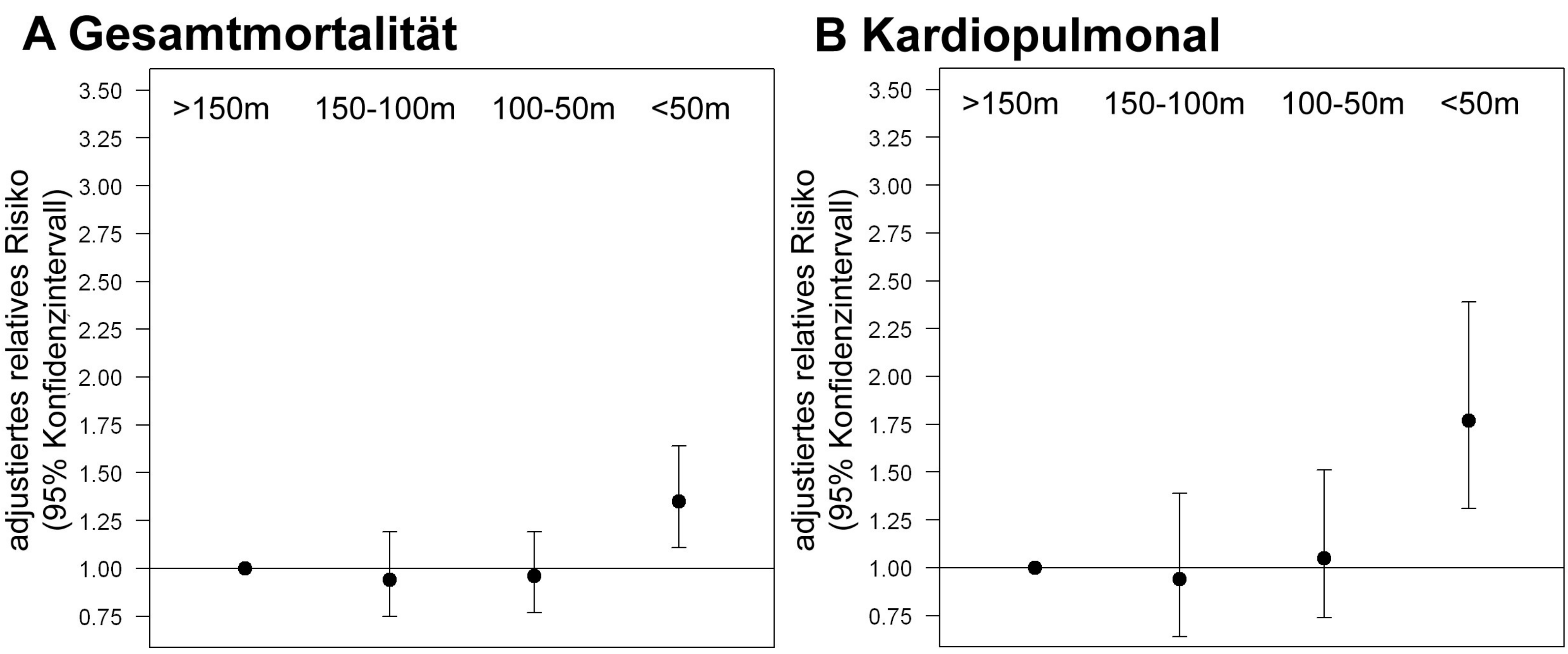
http://www.lanuv.nrw.de/veroeffentlichungen/fachberichte/fabe31/fabe31.pdf

Wichmann, Thiering, Heinrich 2011

Living near on traffic intensive roads

DIstance less than 50 m

Increase of total mortality by 38% and of cardiopulmonal death cases by 77%



Verkehrsreiche Straßen: 5000 Fahrzeuge pro Tag; aRR: adjustiert für Sozialstatus und Rauchen

Wichmann, Thiering, Heinrich 2011

The effect of particle size on cardiovascular disorders – The smaller the worse

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A R T I C L E I N F O

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Environmental medicine

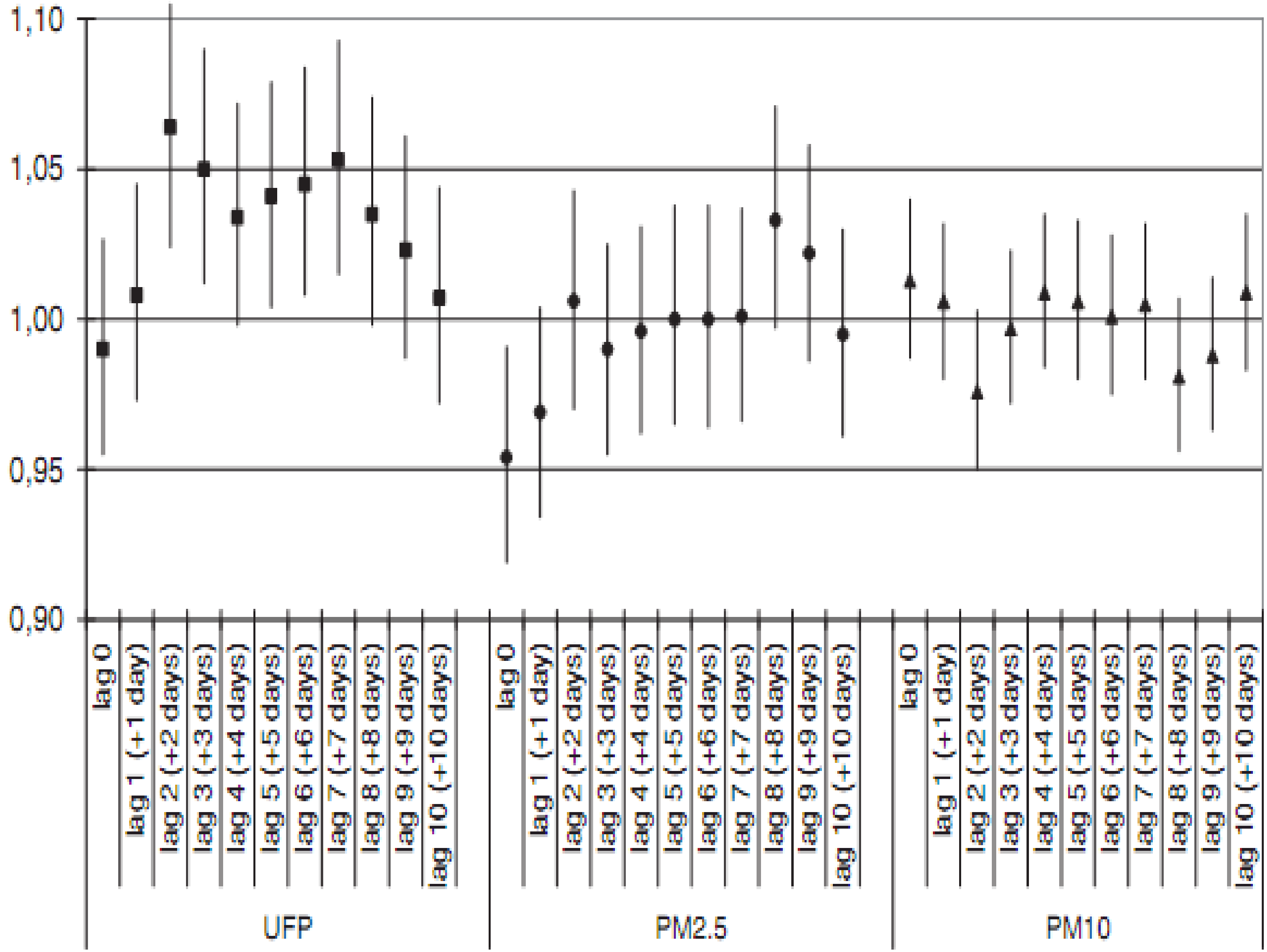
A B S T R A C T

Background: Previous studies observed associations between airborne particles and cardio-vascular disease. Questions, however, remain as to which size of the inhalable particles (coarse, fine, or ultrafine) exerts the most significant impact on health.

Methods: For this retrospective study, data of the total number of 23,741 emergency service calls, registered between February 2002 and January 2003 in the City of Leipzig, were analysed, identifying 5326 as being related to cardiovascular incidences. Simultaneous particle exposure was determined for the particle sizes classes <100 nm (UFP), <2.5 μm (PM2.5) and <10 μm (PM10). We used a time resolution of 1 day for both parameters, emergency calls and exposure.

Results: Within the group of cardiovascular diseases, the diagnostic category of hypertensive crisis showed a significant association with particle exposure. The significant effect on hypertensive crisis was found for particles with a size of <100 nm in diameter and starting with a lag of 2 days after exposure. No consistent influence could be observed for PM2.5 and PM10. The Odds Ratios on hypertensive crisis were significant for the particle size <100 nm in diameter from day 2 post exposure OR = 1.06 (95%CI: 1.02–1.10, p = 0.002) up to day 7 OR = 1.05 (95%CI 1.02–1.09, p = 0.005).

Conclusion: Ultrafine particles affect cardiovascular disease adversely, particularly hypertensive crises. Their effect is significant compared with PM2.5 and PM10. It appears necessary, from a public health point of view, to consider regulating this type of particles using appropriate measurands as particle number.



OR and 95% confidence interval in emergency calls related to hypertensive crises depending on time of exposure to airborne particles and size of particles (ultrafine[UFP]–fine [PM2.5]–coarse [PM10])

Source: U. Franck et al. / Science of the Total Environment 409 (2011) 4217–4221

The results demonstrated very clearly the significant association number concentration of ultrafine particles (b100 nm diameter) on hypertensive crisis. These particle effects were more significantly impairing than that of the PM2.5 or PM10 particlemass concentration. e strongest impact was observed for ultrafine particles on hyperten-
The crises starting to be observed shortly after exposure on (lag day 2). The number concentration was significantly correlated.

The maximal change was found to be 5% in the emergency call rate per 1000 particles/cm³ (ultrafine particles). This has to be seen in comparison to an annual mean of ~12,000 particles/cm³. No consistent effect was detected for PM 2.5 (annual mean 20.6 µg/m³) and PM10 (annual mean of 32.5 µg/m³)

Source: U. Franck et al. / Science of the Total Environment 409 (2011) 4217–4221

Berlin LEZ – impact analysis health benefit

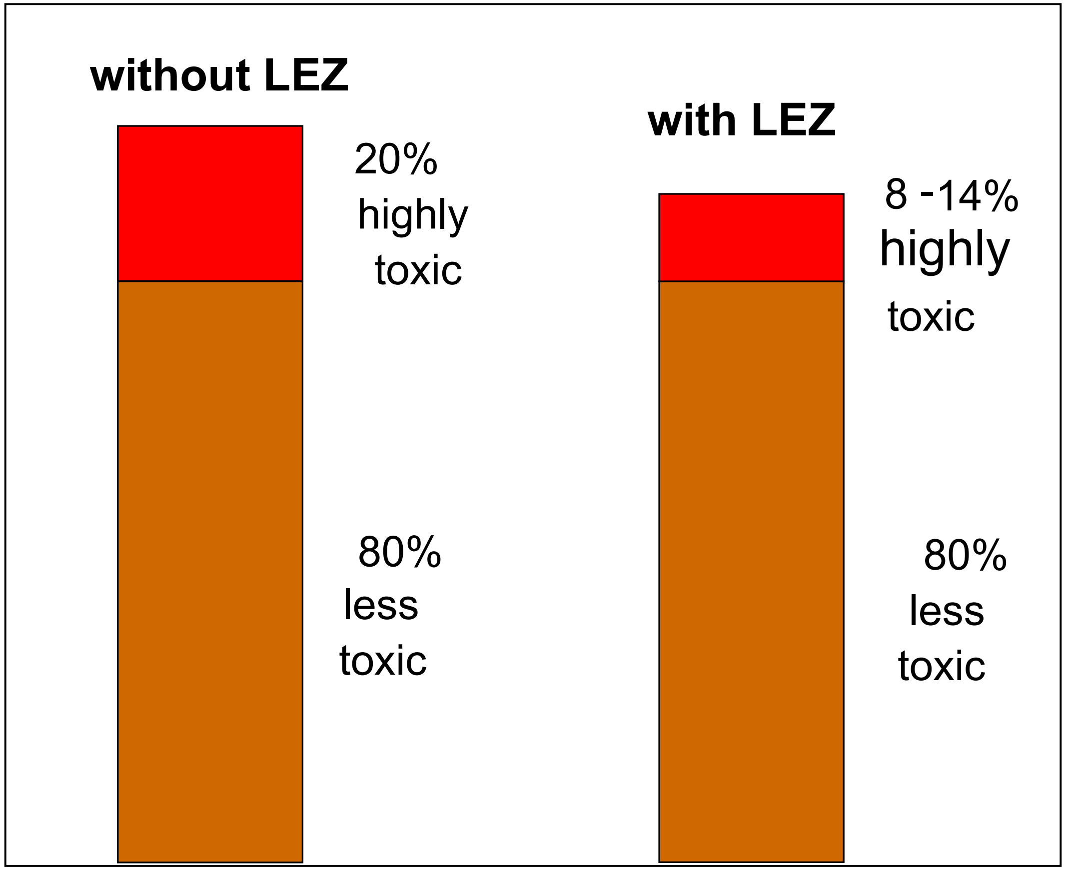
LEZ benefit for public health

some essentials:

about 20% of total PM10 consists of highly toxic diesel soot

30- 60 % reduction of Diesel soot emissions also mitigates health risk by 30-60%,

even though total PM10 levels fall by only about 7 % (in Berlin)

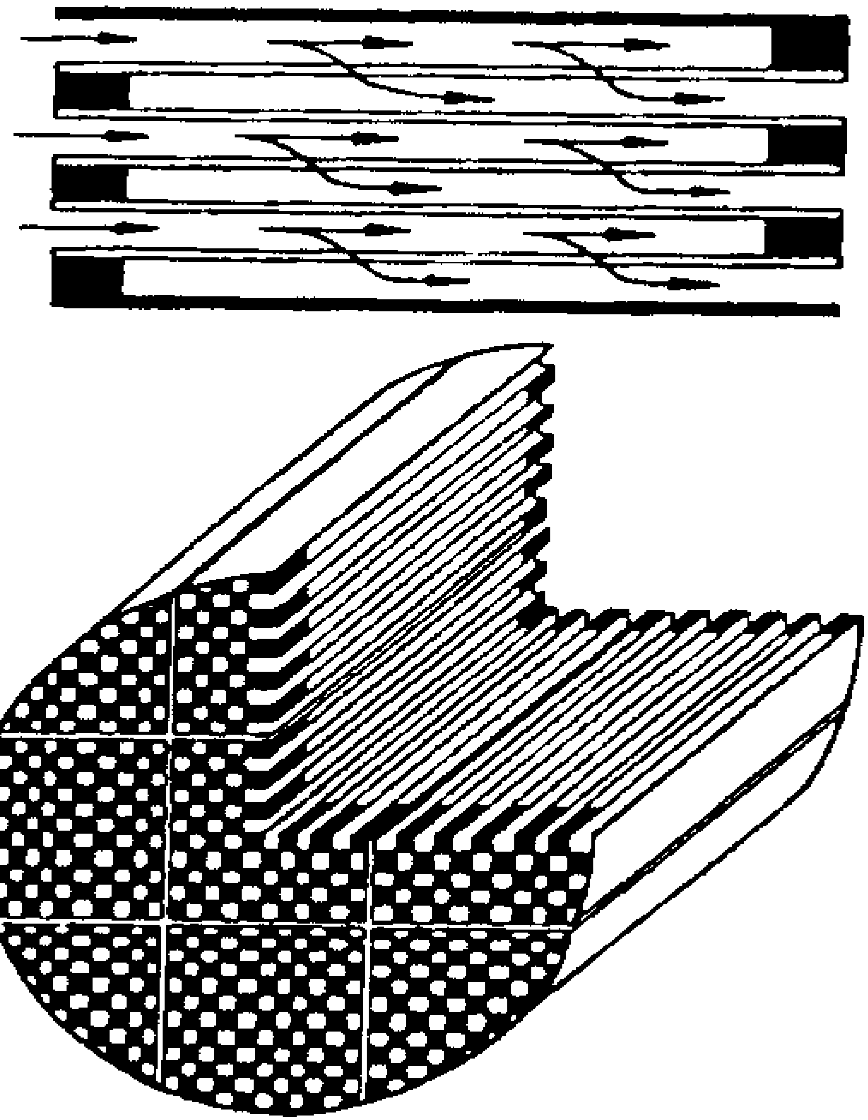


source:: **LEZ and public health protection** by Prof. Dr. med. Dr. rer. nat. Erich Wichmann,
Helmholtz Zentrum München Institut für Epidemiologie I (press conference Deutsche Umwelthilfe 7.4.2011 Berlin)

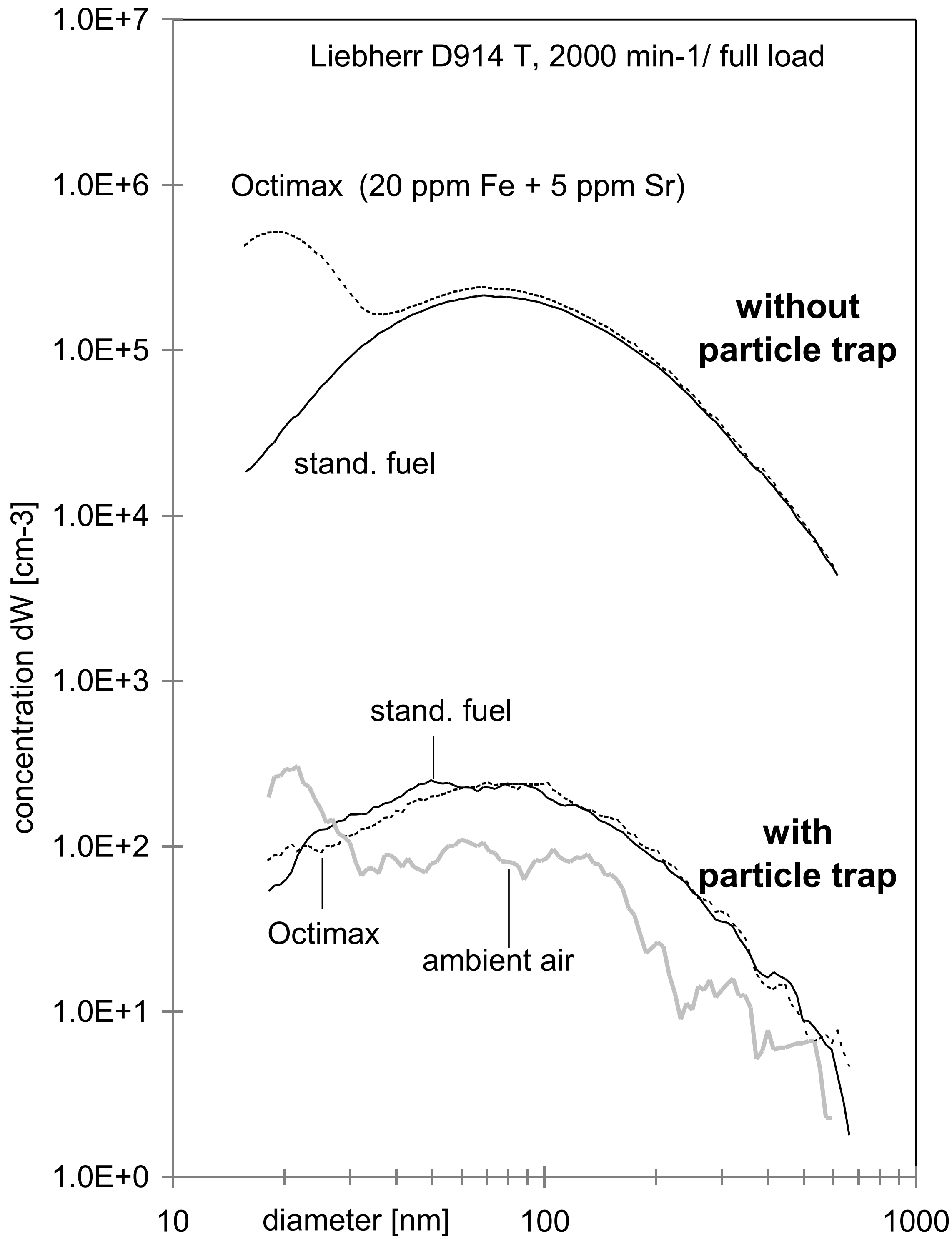
Abatement

he classic CORNING wall flow ceramic Substrate

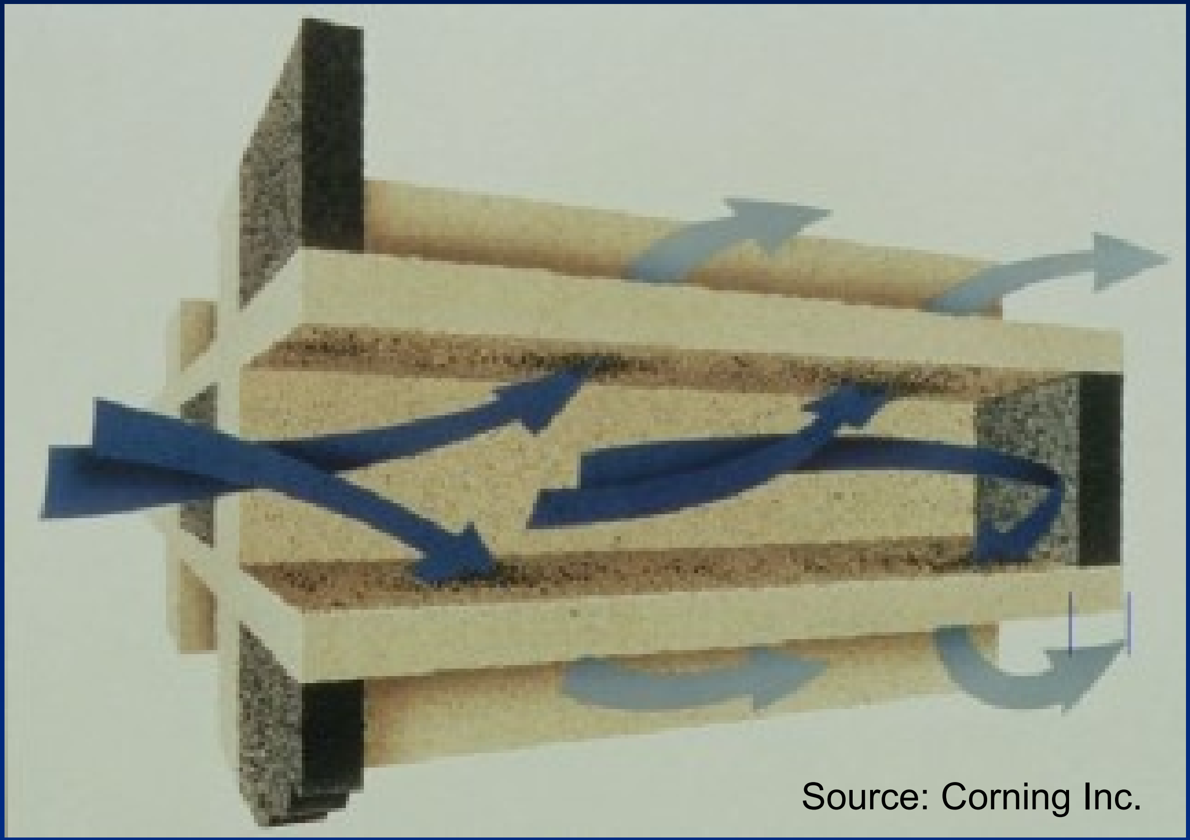
Source CORNING 1982



Particle Elimination
with Particle-Filter



Enabling Near Zero Emission Levels



Diesel Particulate Filters (CDPFs) eliminate more 99% of solid particles (soot & metals)

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