Challenges and Opportunities in Research of Atmospheric Black Carbon

Alfred Wiedensohler

Leibniz Institute for Tropospheric Research

World Calibration Center for Aerosol Physics

Member of Leibniz Association

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Leibniz Institute for Tropospheric Research

What is Soot?

- Soot is carbon particles resulting from the incomplete combustion of hydrocarbons.
- Its color is black, therefore its also called “Black Carbon”
- Soot contains polycyclic aromatic hydrocarbons (PAHs) and heavy metals.
- Fresh soot particles might be surface-reactive

Black Carbon and Human Health

- The size of black carbon (BC) particles is approximately 0.1 µm
- BC is not water soluble and thus remain as particles in the lung
- BC itself is neither a toxic nor a carcinogen
- PAHs and heavy metal might be toxic and thus cause diseases
- Fresh soot particles are however surface-reactive
- BC particle are small enough to cross cell walls

Black Carbon and Human Health Examples of Research

- BC is used as a marker for air pollution in general
- Soot is part of multicomponent models (e.g. BC, PM10, PM2.5, UFP, NO2) in epidemiology (e.g. elderly people and children)
- High BC exposures were associated with impaired lung & cognitive function in cohort studies

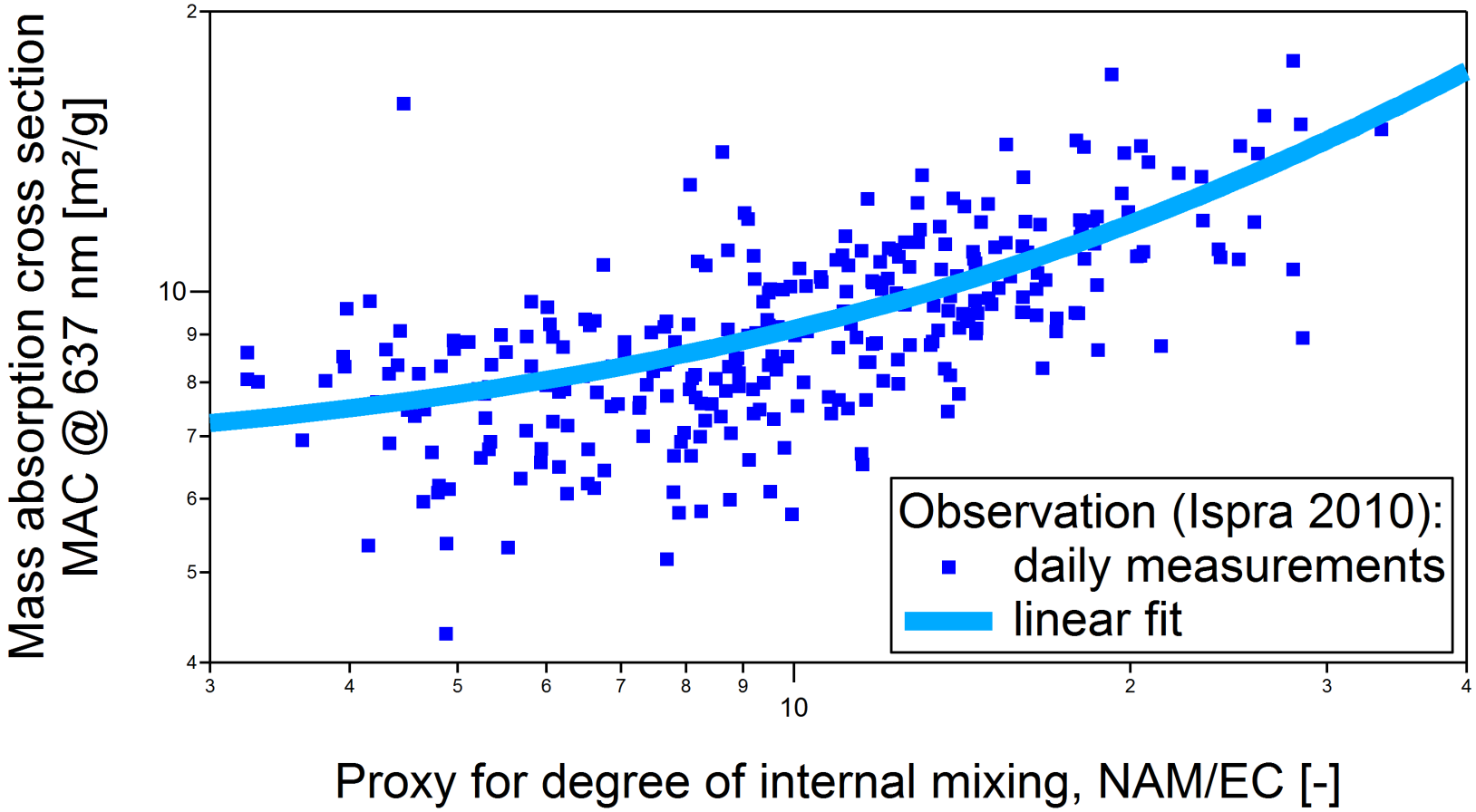
Black Carbon and Climate

- BC absorbs solar light and warms the atmosphere.
- Global warming due to BC might be much larger than previously thought.
- Other impacts on the climate need still to be evaluated.

Black Carbon and Climate – what might be needed?

- More vertical profile measurements
- Mixing state → enhanced absorption
- Life time (wet deposition)
- Improved emission inventories
- Better understanding of BC effects on the circulation
- BC deposition on snow → enhanced melting?
- BC as ice nucleation particle → may be not?

Black Carbon and Climate – Example for Aging

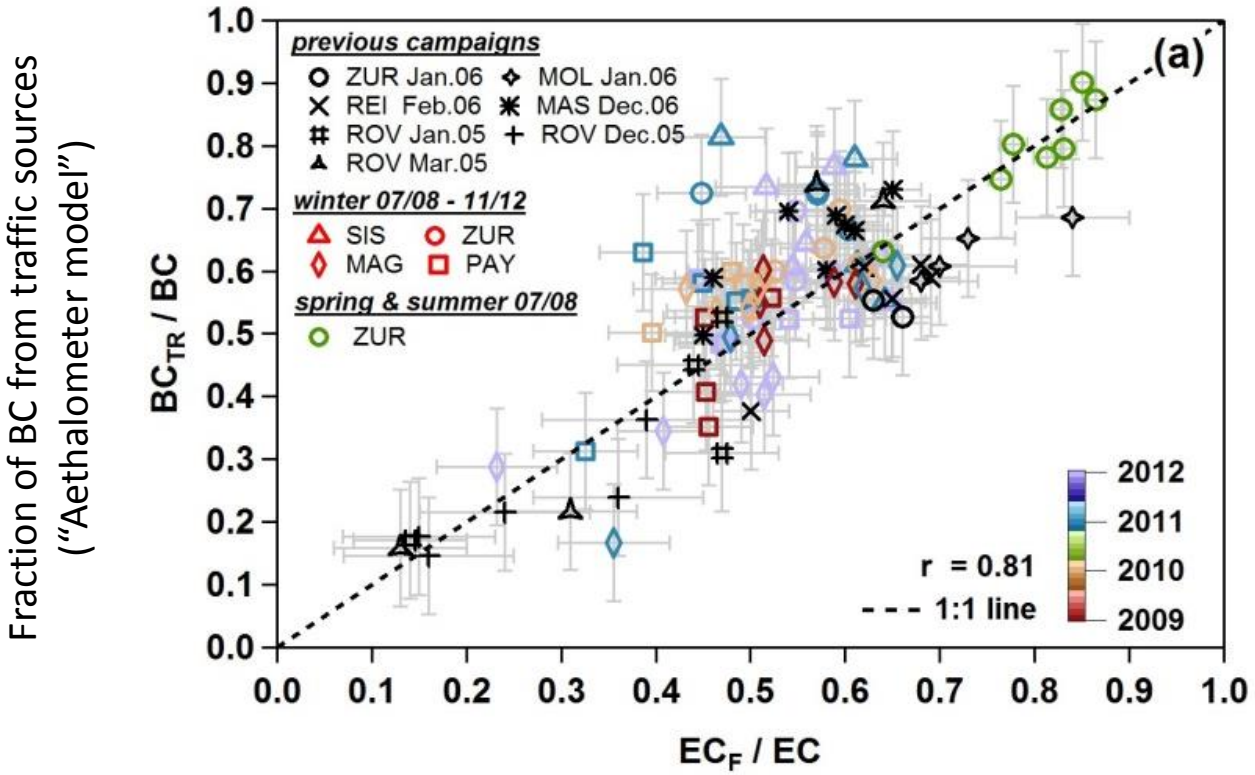


Sources of Black Carbon

- Diesel emissions and domestic heating are major sources of black carbon in industrialized countries.
- Biomass burning due cooking and heating and agricultural waste fires are additional sources in the developing world.
- More effort has to be given in the quantification of different BC emission sources.
- Also a better understand of the contribution of fossil versus modern fuels is needed.

Sources of Black Carbon
- Example Fossil vs. modern fuel

Comparison of radiocarbon (^{14}C) method with "aethalometer model"
→ Example for Switzerland with only wood burning and traffic

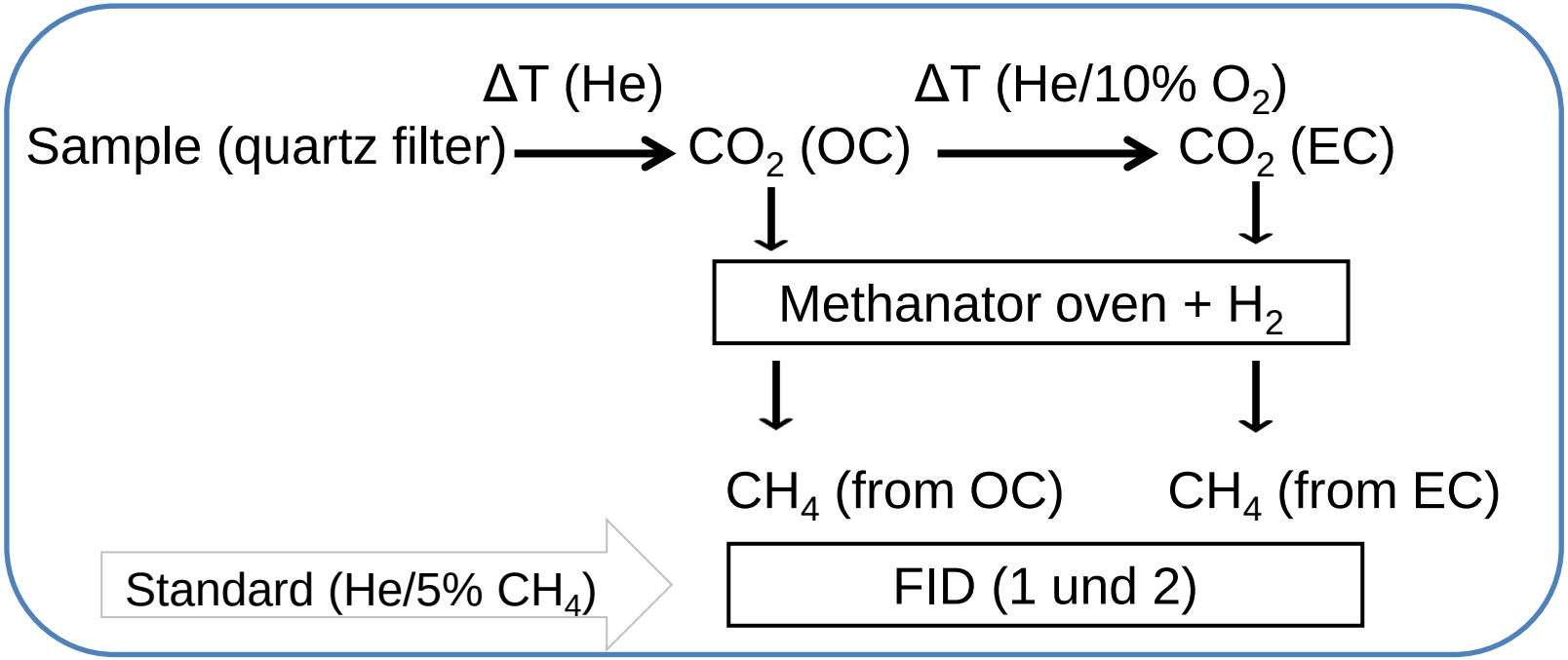


Methods to determine BC

- Due to light attenuation through a filter
  → equivalent BC (& light absorption)
- Photoacoustic
  → light absorption
- Due to thermal desorption (volatility)
  → elemental carbon, EC
- Due to Raman spectroscopy
  → graphitic carbon
- Due to Laser-induced incandescence
  → refractory carbon

There is a need for reference methods (BC & absorption)

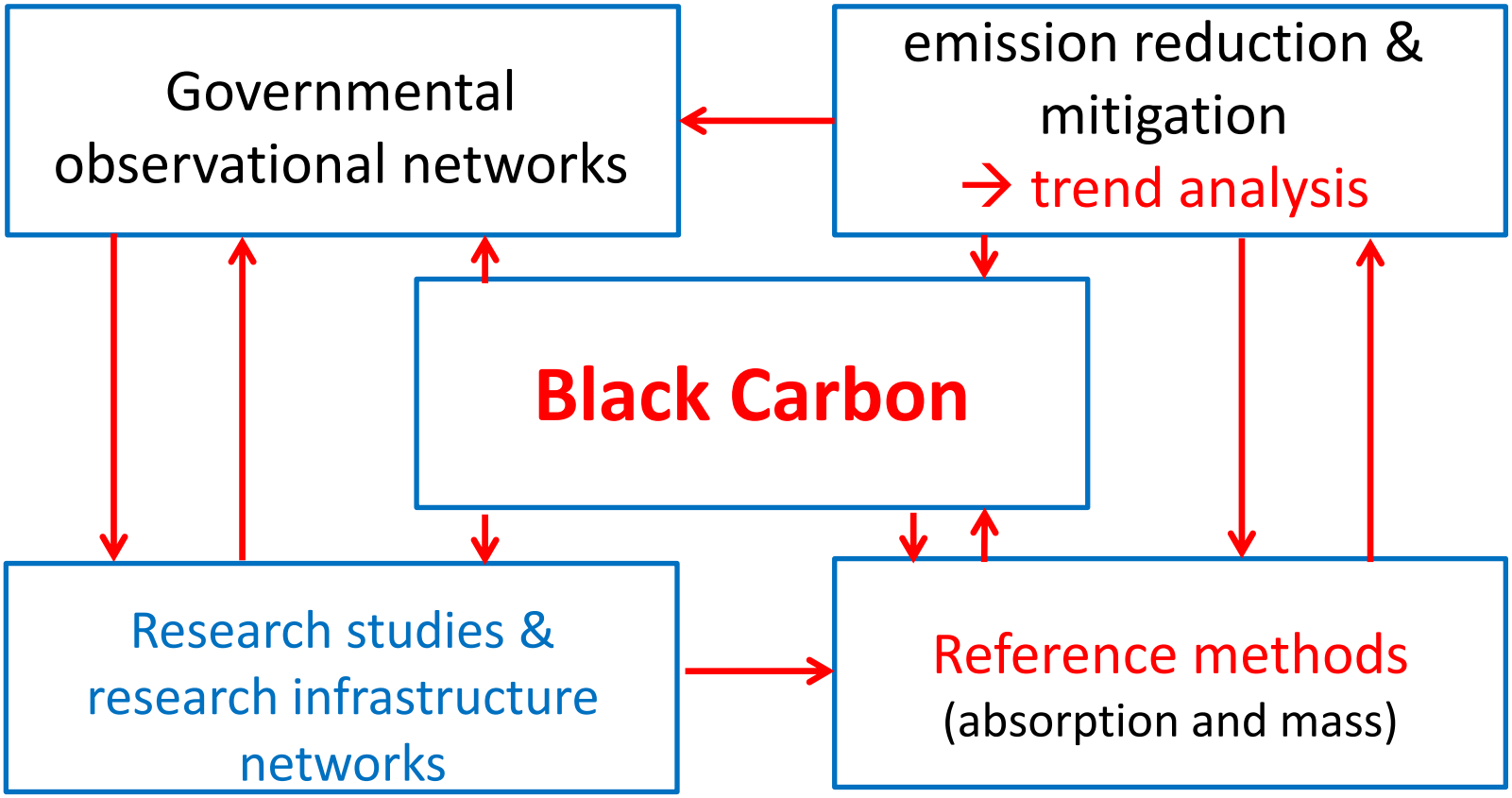
Determination of EC
- Example of Thermal Desorption



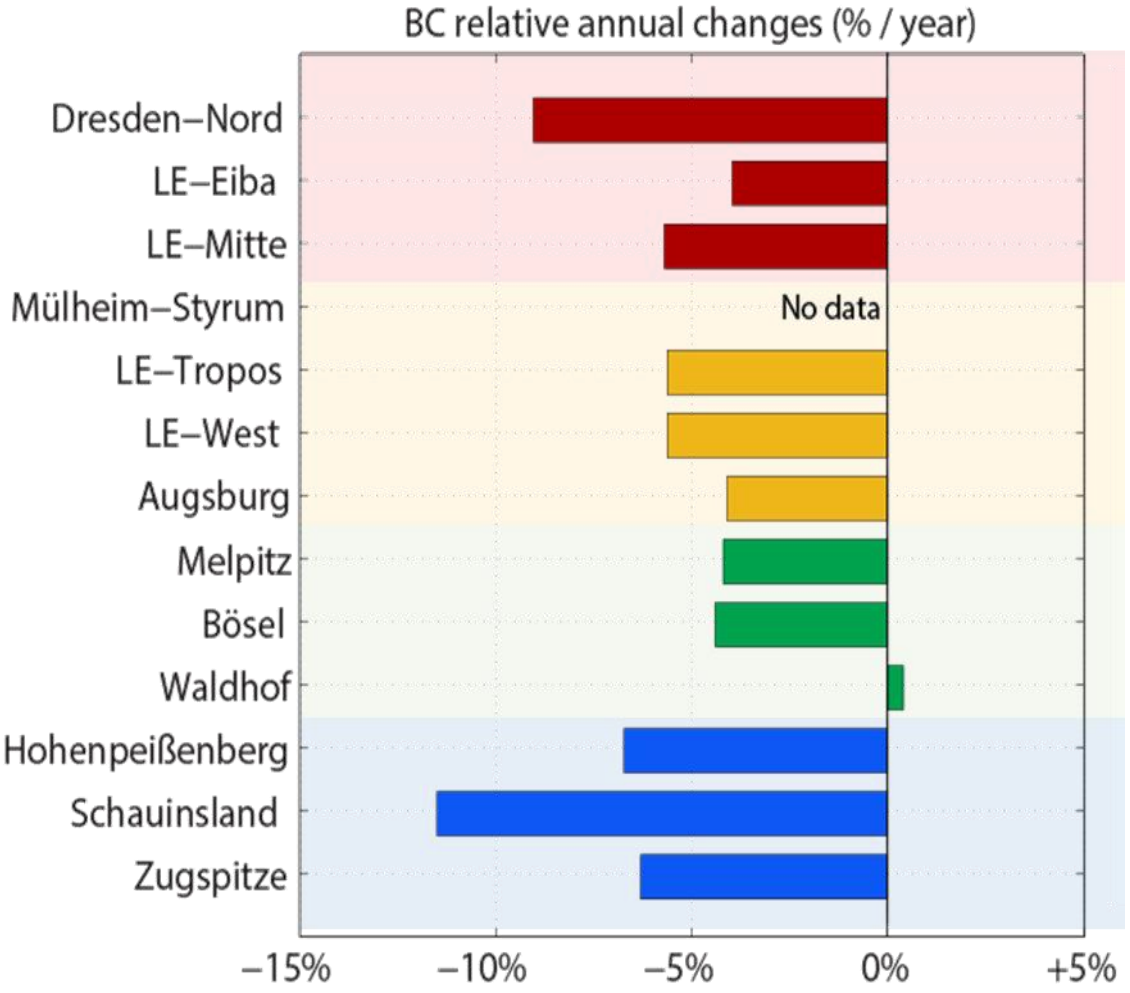
The EUSSAR-2 method is obligatory in Europe now

→ Optical correction due to transmission

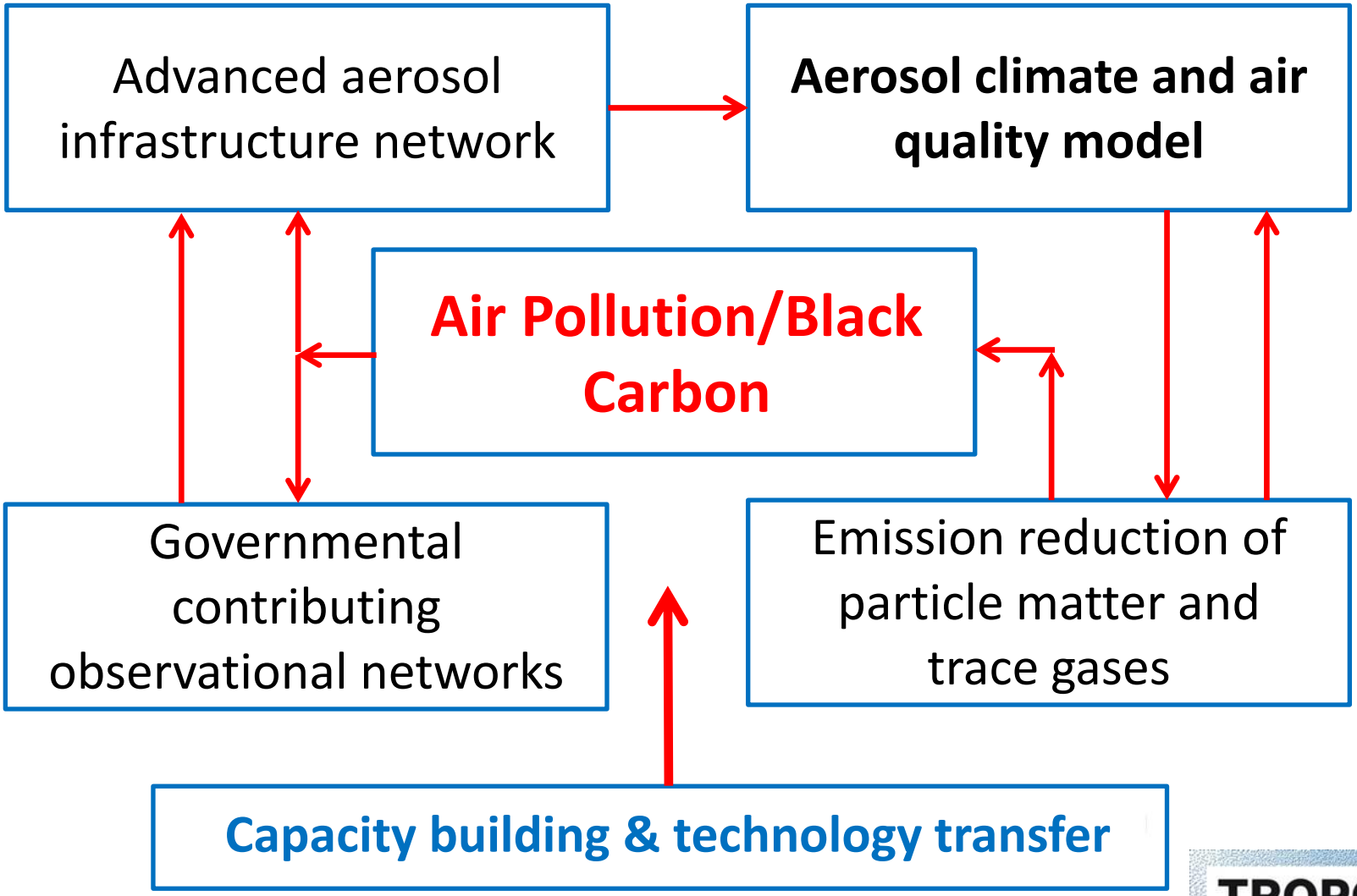
Observational Strategy for Black Carbon



BC Mass Concentrations Trends (2009-2014) in Germany



Integration & Goals



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