Transport, Black Carbon & Climate Change

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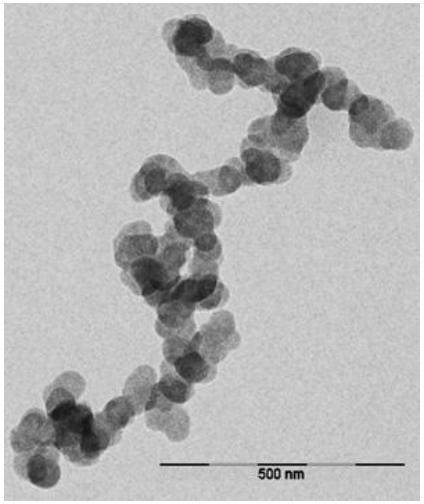
Black carbon (Soot)

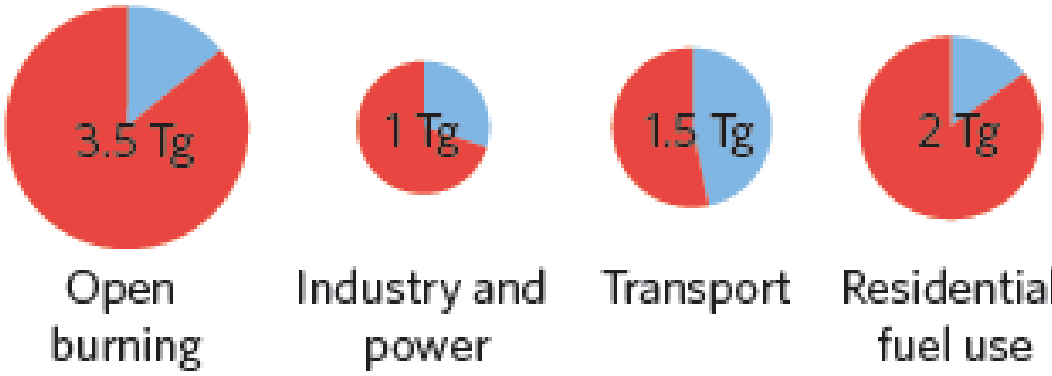


Source: Incomplete combustion of fuel

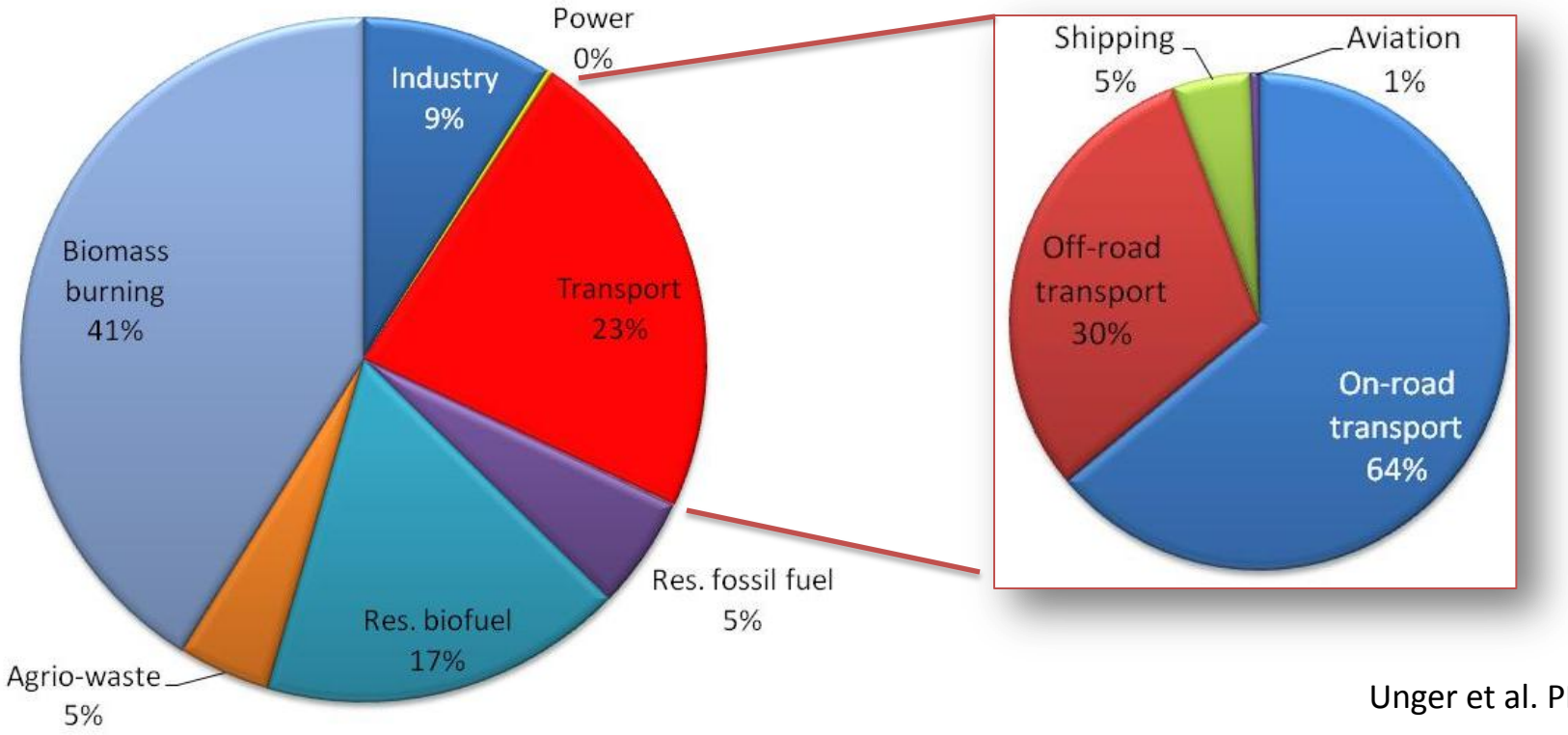
Size: ~ few nanometers to10 micrometer

Atmospheric life-time: few weeks

Relative importance of BC Sources: Global

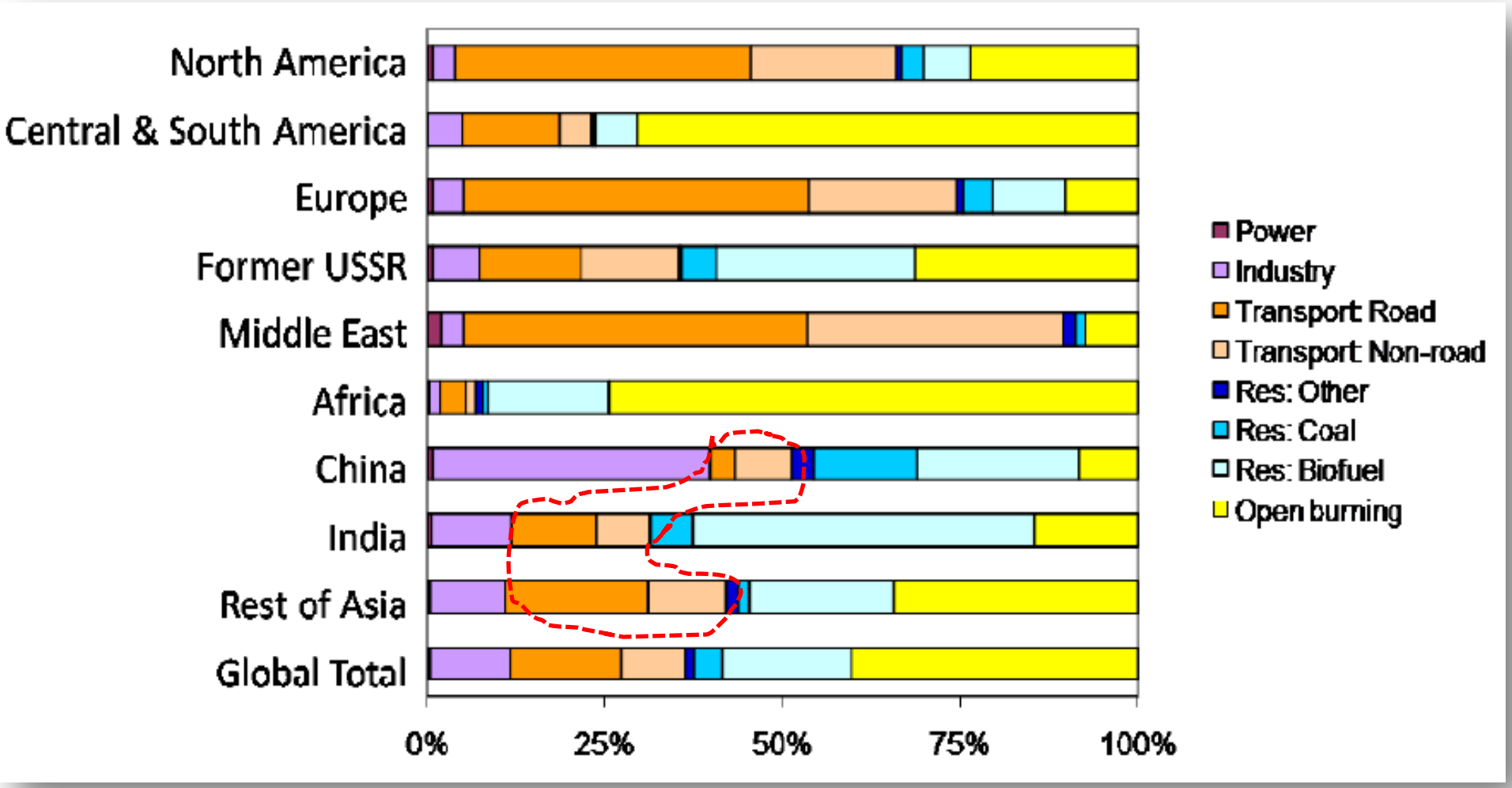


Grieshop et al, 2009



Unger et al. PNAS, 2010

Relative Importance of BC Sources: Regions



Transport : 3rd largest energy-related source of BC in Asia

Bond et al, JGR, 2004

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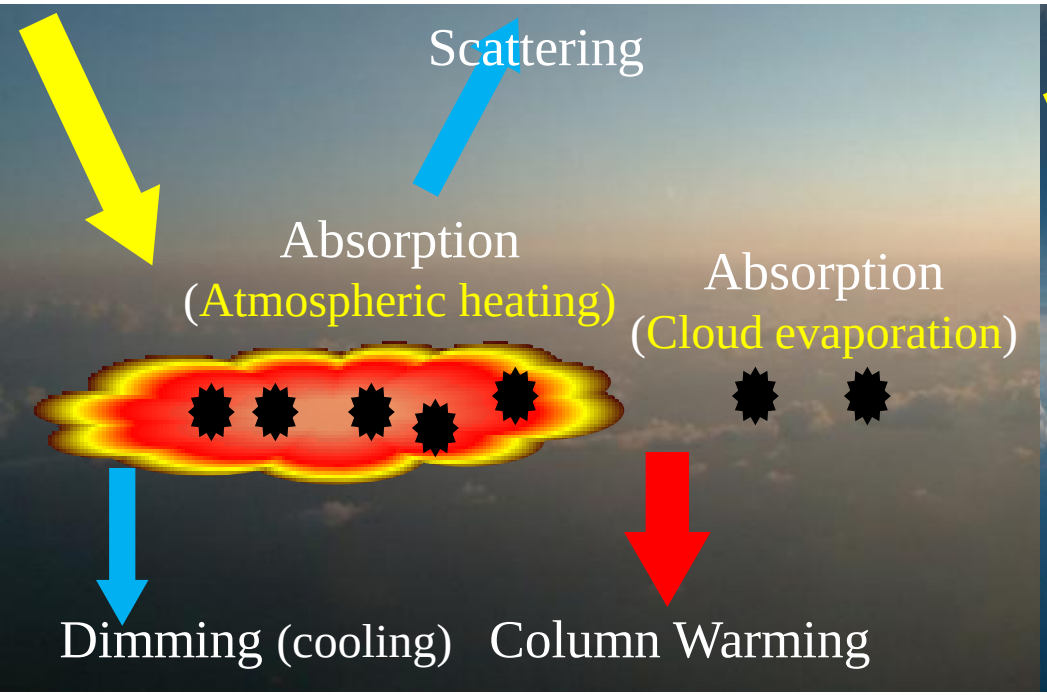
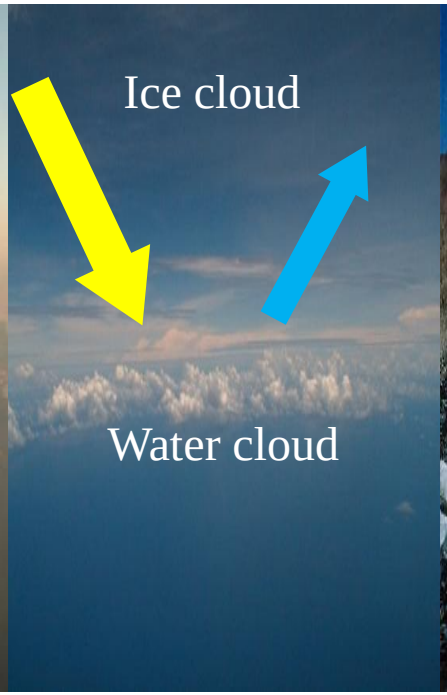


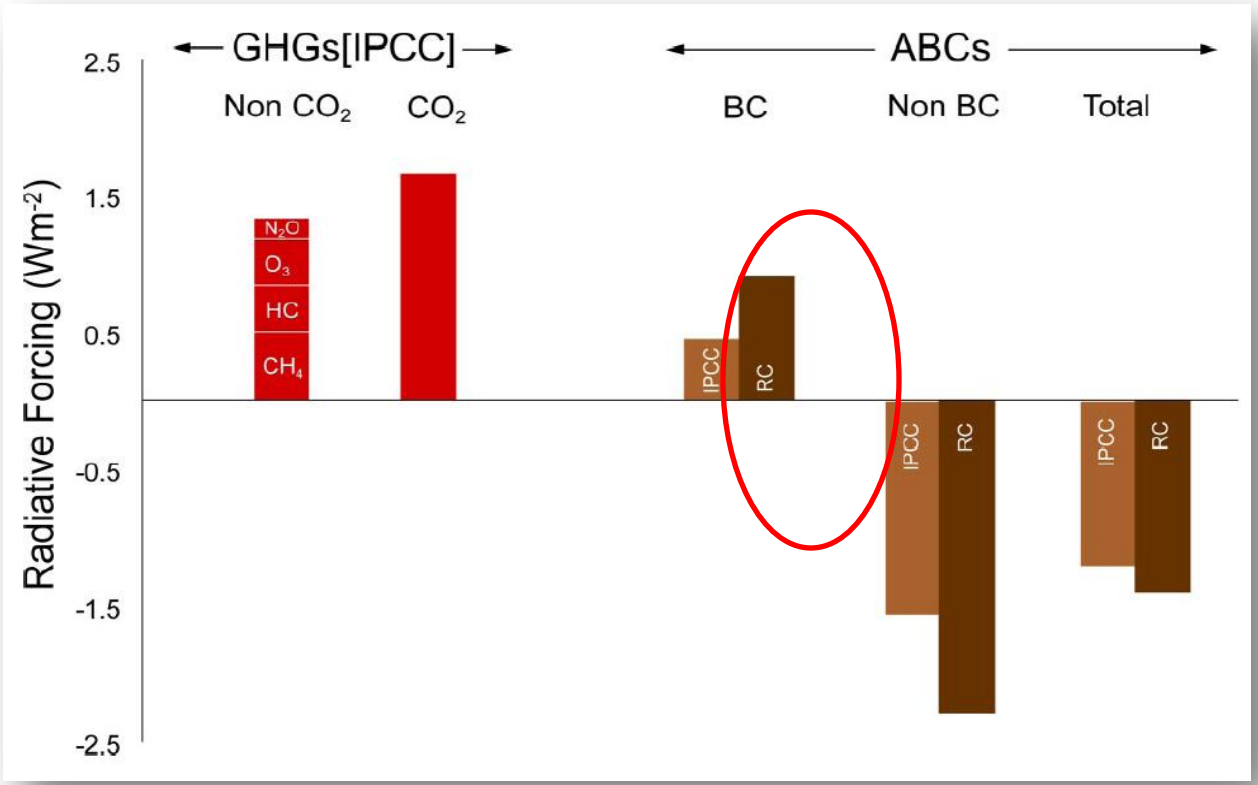


Radiative effect (Net Warming) **Cloud properties** **Snow-albedo**

- Global warming potential of BC (20 yrs) : ~ 2000-3000 times that of CO_2.
- In addition, BC deposition on snow is attributed to accelerated melting of snow/ice in Arctic and glacier melting in the Himalayas.

Menon et al., *ACPD*, 2010, Flanner et al. *ACP*, 2009

Black Carbon & Climate Change



Ramanathan and Feng, *PNAS*, 2009
Ramanathan and Carmichael, *Nat. Geosci.*, 2008

- BC Forcing: +0.9 Wm^{-2} (+0.4 -+1.2 Wm^{-2}), ~ 55 % of CO_2 forcing (1.66 Wm^{-2}). BC is 2nd or 3rd strongest contributor to global warming after CO_2.
- Powerful regional climate forcing (atmospheric heating + BC deposition on snow/ice) due to inhomogeneous distribution of sources.

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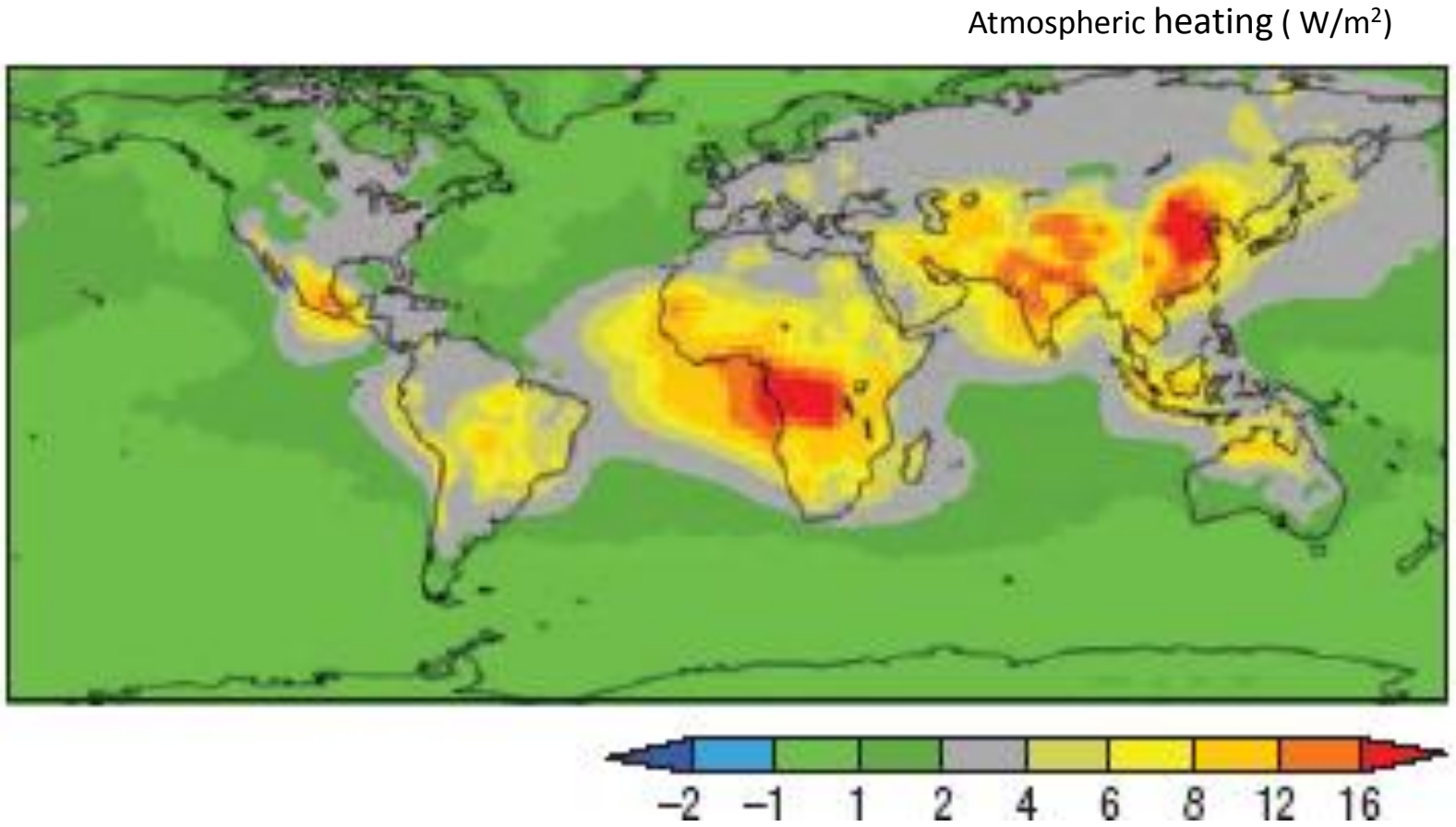

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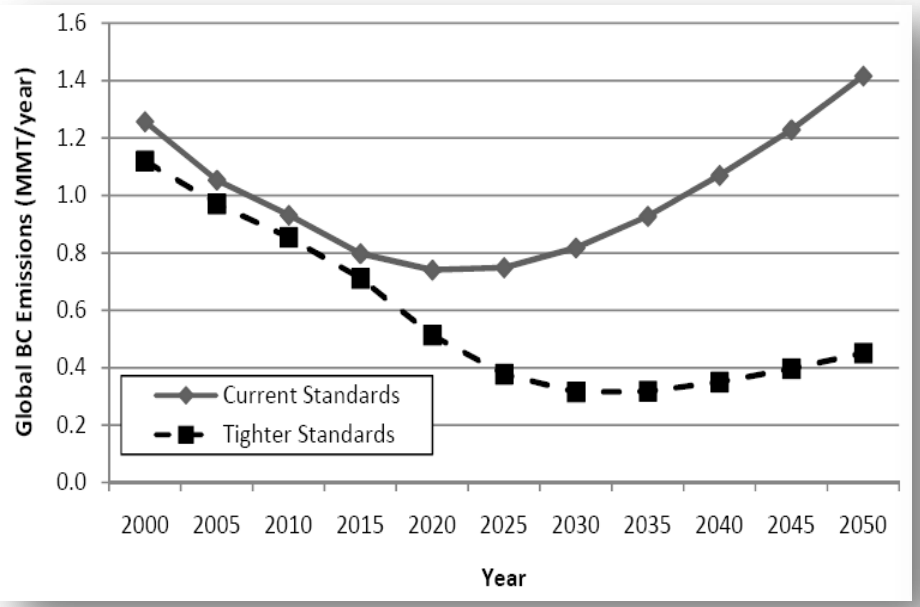
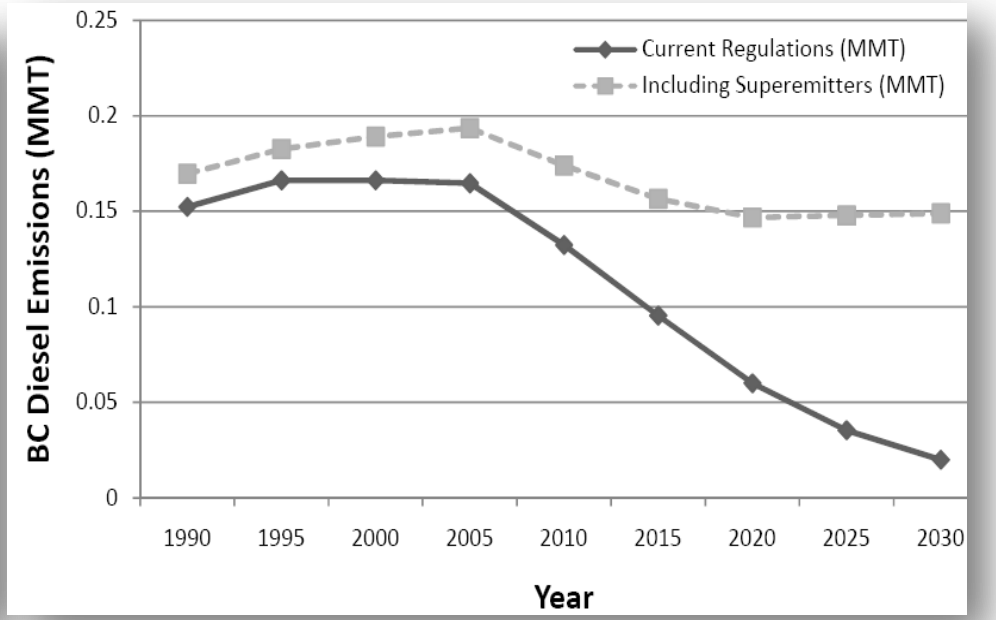
Mitigation of BC from Transport Sector

Projected on-road BC emissions





Potential importance of "superemitters"

Superemitters: ~ 15% vehicles in Asia

Bond 2009, Walsh , *PCFV,*2009

Mitigation of BC from Transport

- **Technical:**

  Technologies exist to reduce most emissions of BC without limiting the underlying activities.

  - **Fuels Switch (LPG, CNG, electricity) etc.**
  - **Low sulfur fuel (required for PDF).**
  - **Diesel Particle filter (DPF) for both New and Old vehicles**
  - **Engine Modification,**
  - **Stringent emission standards (new engine standards, replacement of old vehicles) and inspection/maintenance programs**

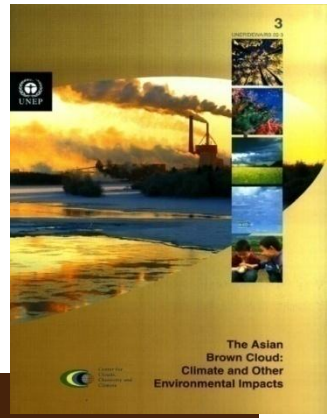
- **Economical:**

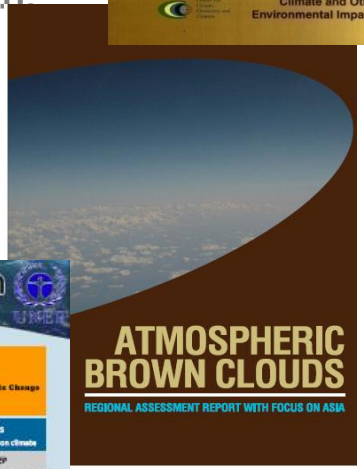
  Typically amenable to lower cost end-of-pipe control or equipment fixes which are readily deployable.

Project Atmospheric Brown Cloud (ABC)

ABC-Asia, ABC-Africa and ABC-Latin America

- **ABC -Asia**
  - 1. Observation — Aerosol and climate, precipitation chemistry, High altitude observatories
  - 2. Impact Assessment — Climate Change, Water Budget, Agriculture and Human Healt
  - 3. Mitigation — Emission Inventory and Project SURYA
  - 4. Knowledge Management
  - 6. Awareness and Consensus for policy

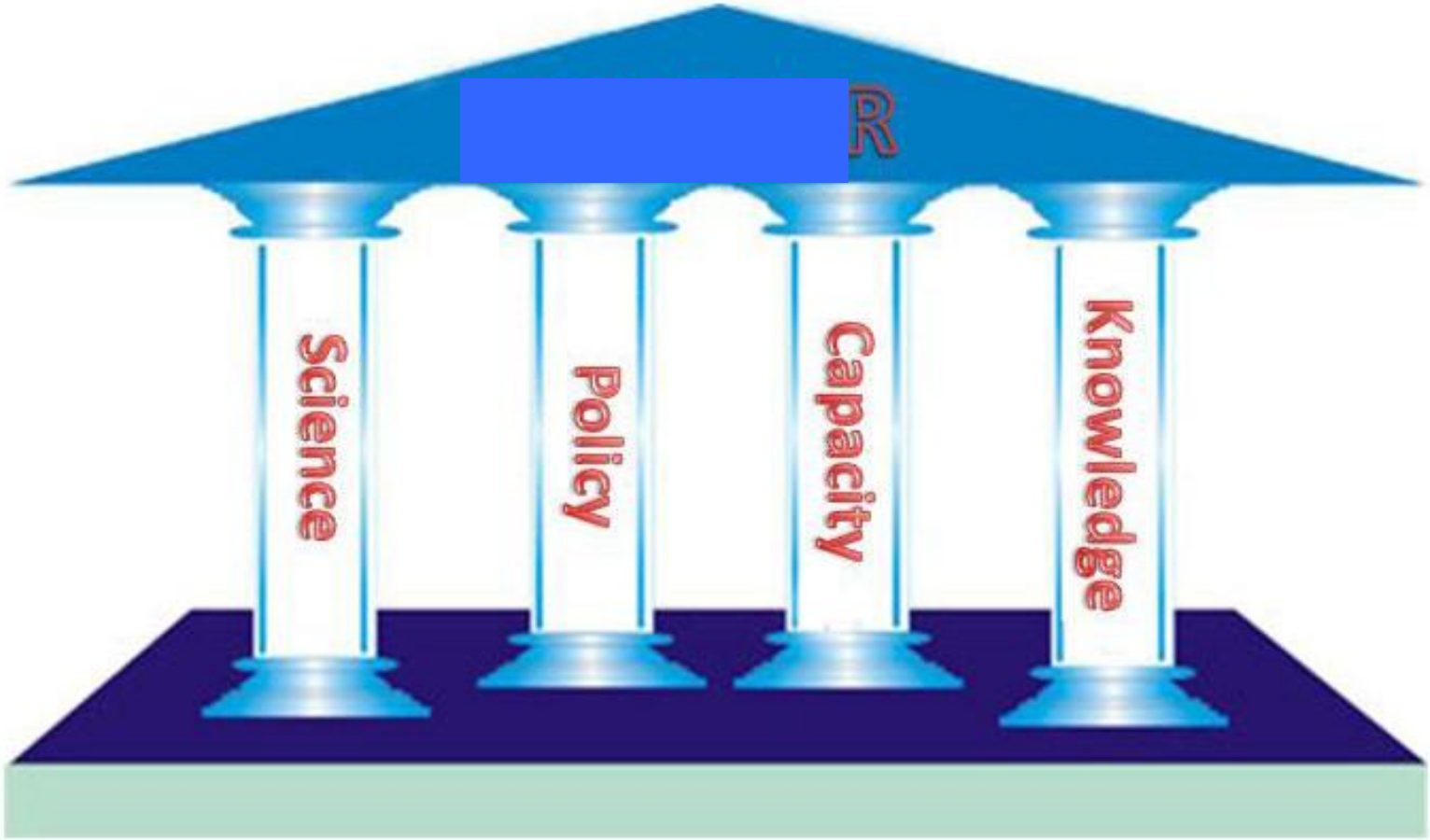




www.rrcap.unep.org/abc

AIT-UNEP Regional Resource For Asia and the Pacific:

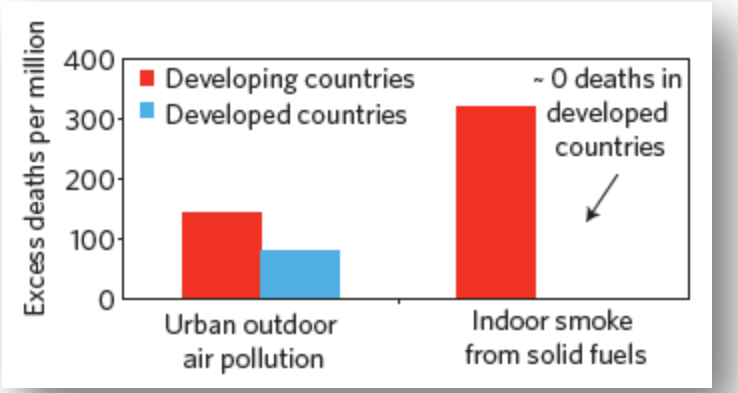
Regional Center of Excellence in Atmospheric Resources



SUMMARY

- **BC reduction from transport sector will result in immediate climate benefit in a short-period. But it will require matching Sulfur emission reduction, alongside a long term CO2 reduction.**

- Controlling particulate matter pollution (including BC) from diesel vehicles in developing Asia also results in very large health benefits



Grieshop et al, 2009

- Control of transport-based BC emissions should be an essential part in any comprehensive BC control strategy as well as Environmentally Sustainable Transport Strategies in Asia.