Limiting Near-Term Climate Changes and Improving Air Quality

Opening: Dr. Ashbindu Singh (UNEP-Washington), Drew Shindell, Frank Raes

Drew Shindell *(NASA-GISS, USA)*
- overview of the assessment, approach and main findings.

Frank Raes *(European Commission, Italy)*
- introduction to black carbon (BC) and tropospheric ozone (O_3) and their impacts

Teppei Yasunari (*NASA-GSFC , USA)*
- deposition of black carbon in the Himalayas

Markus Amann *(IIASA,Austria)*
- emissions, selection of emission control measures and their potential impacts

Erika Rosenthal *(Earth Justice,USA)*
- real world examples of BC and O_3 precursors emission reductions

Martin Williams *(Kings College, United KIngdom)*
- scope for global and regional policy responses

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an introduction to black carbon and tropospheric ozone and their impacts on human health, ecosystems, and climate,

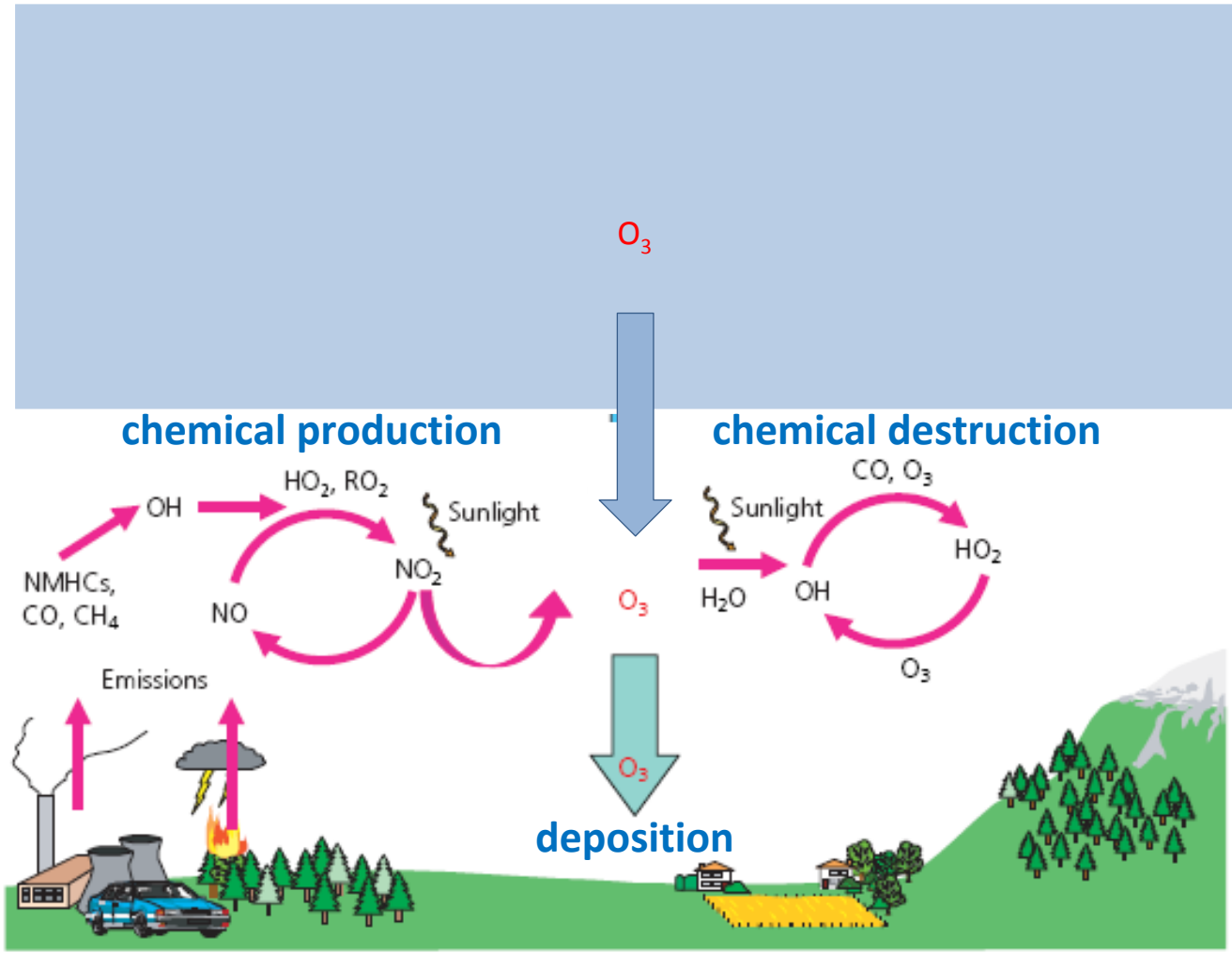
Frank Raes

production and removal of tropospheric ozone

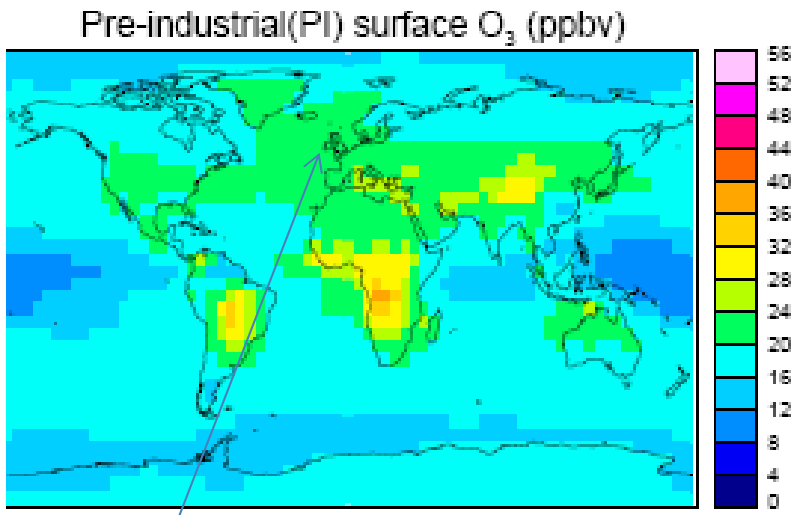
stratosphere

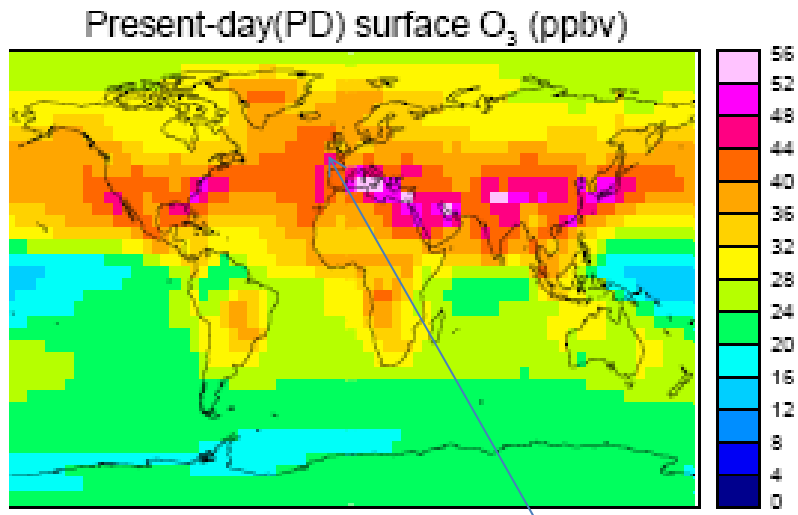
8 – 15 km

troposphere

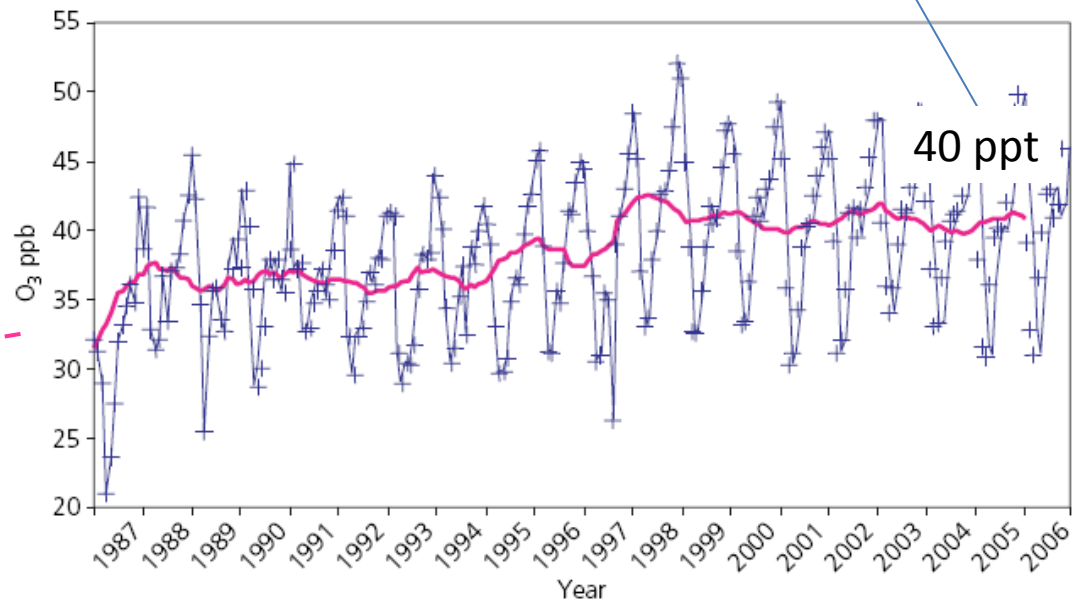


surface ozone: past and present





Measurements at Mace Head ,Ireland

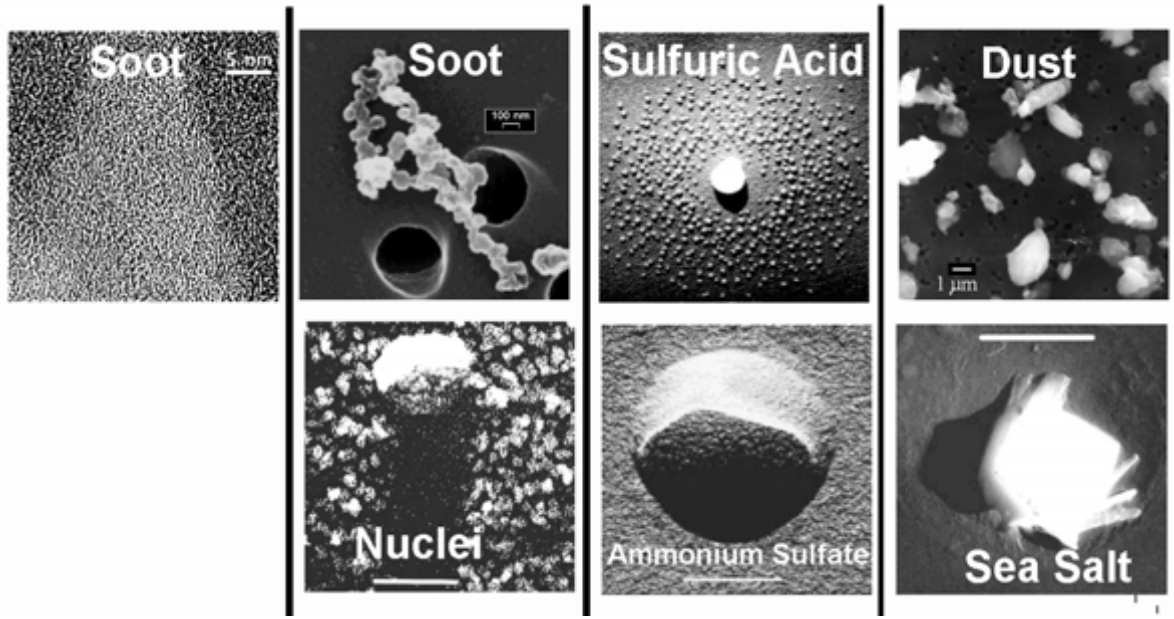


20 ppt

ATMOSPHERIC AEROSOL PARTICLES

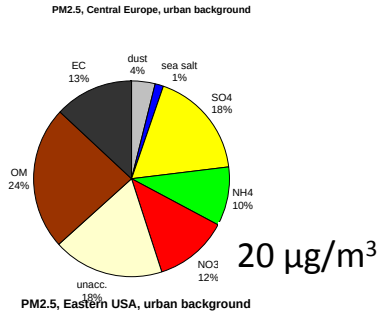
or: Particulate Matter

size, chemical composition, morphology



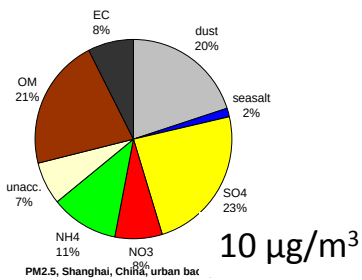
chemical composition of PM2.5, worldwide (2000 – 2010)

Central Europe



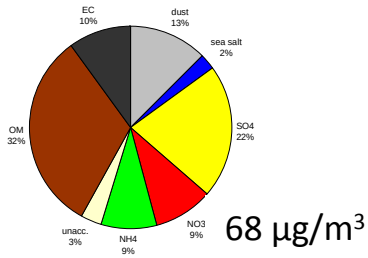
20 µg/m³

Eastern USA



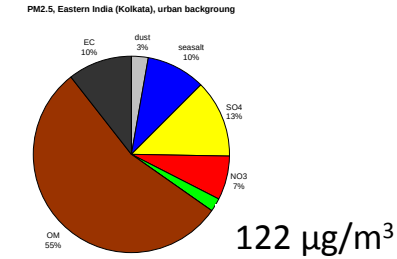
10 µg/m³

China Shanghai



68 µg/m³

Northern India



122 µg/m³

urban background

- Elemental carbon
- *Organic Matter*
- Unaccounted
- Ammonium
- Nitrate
- Sulfate
- Seasalt
- Dust

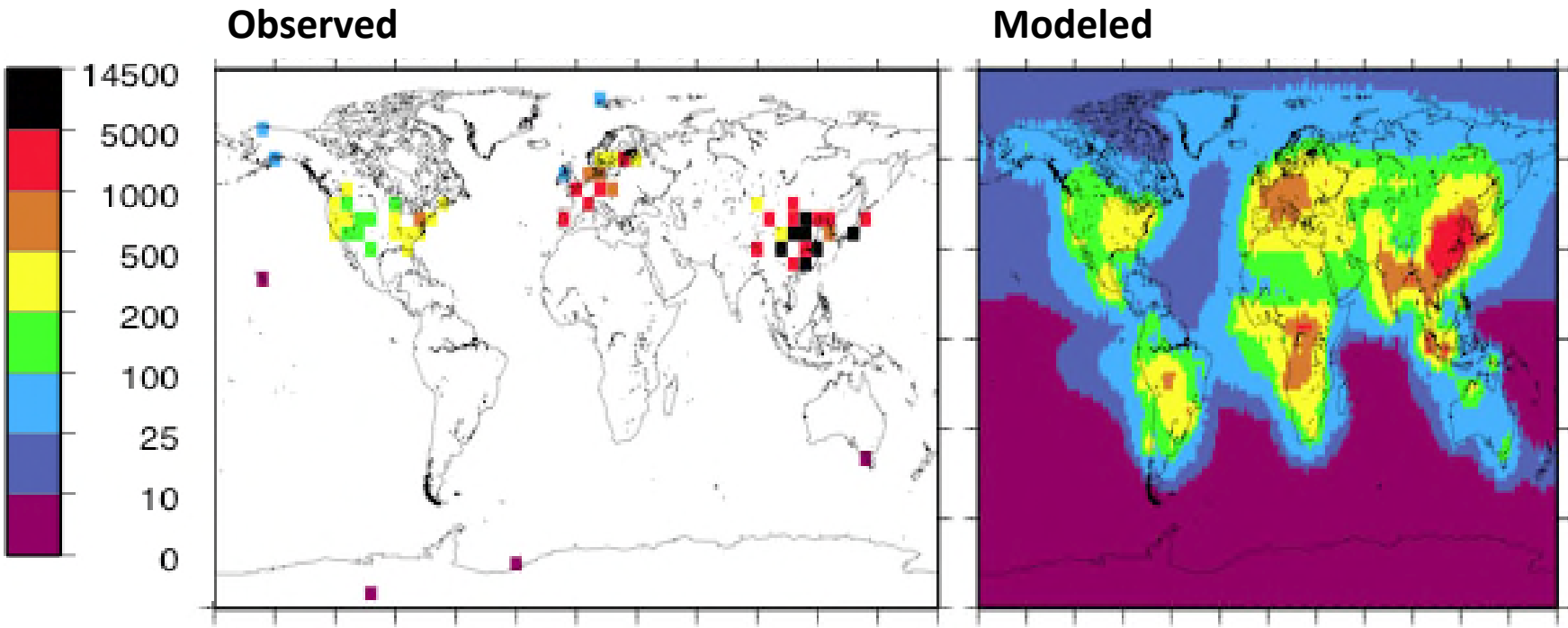
Source, J.P. Putaud, JRC

BLACK CARBON PARTICLES

"Black Carbon" or "Elemental Carbon" is:

- carbon-containing particulate matter, resulting from incomplete combustion
  - it withstands high temperatures
  - it is black, hence absorbs light
- emitted together with CO_2, CO, NMHC, organic particlate matter)

Measuring and modeling BC surface concentrations



Koch et al., 2009

impacts of BC and tropospheric ozone

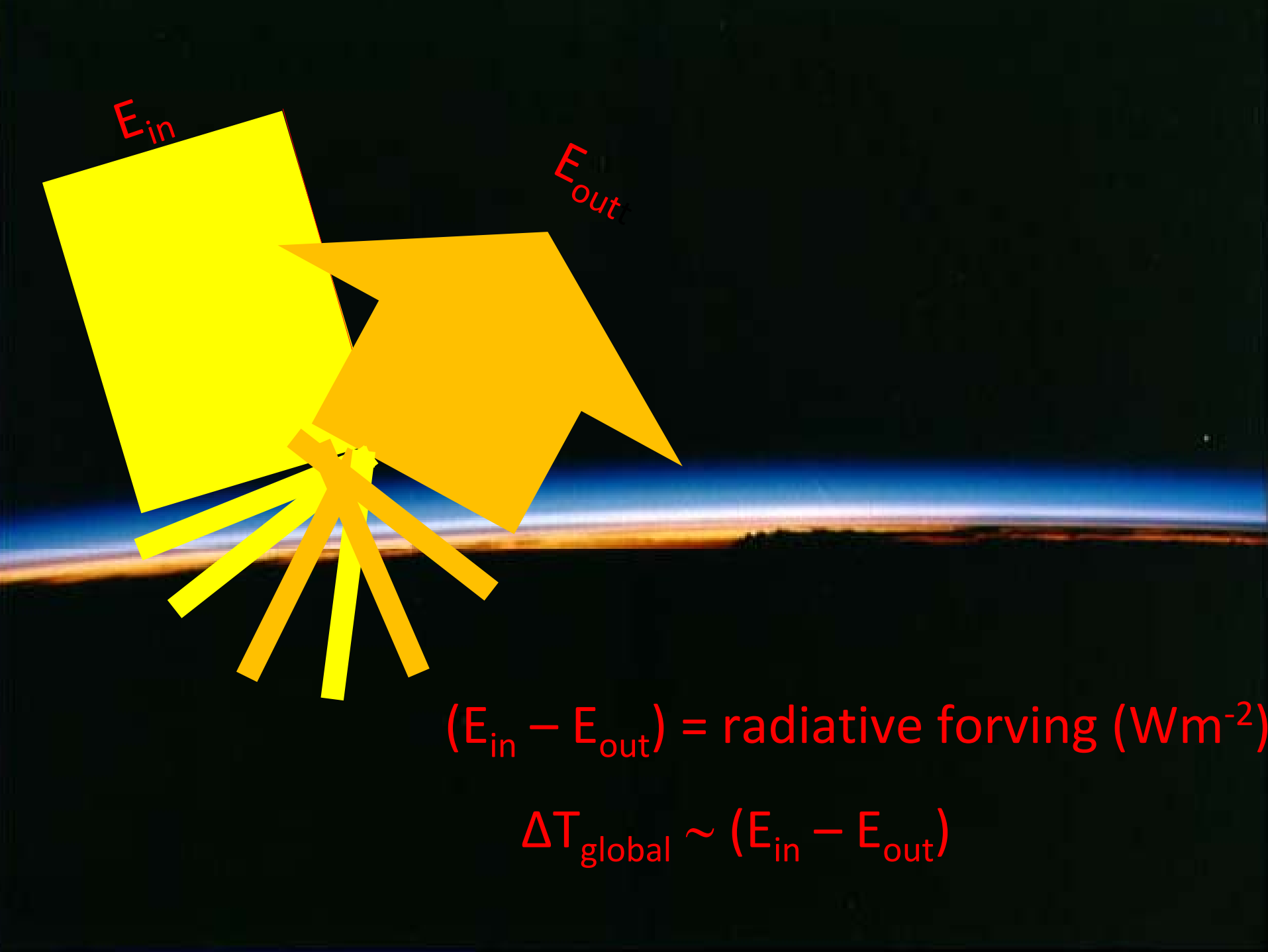
On air quality

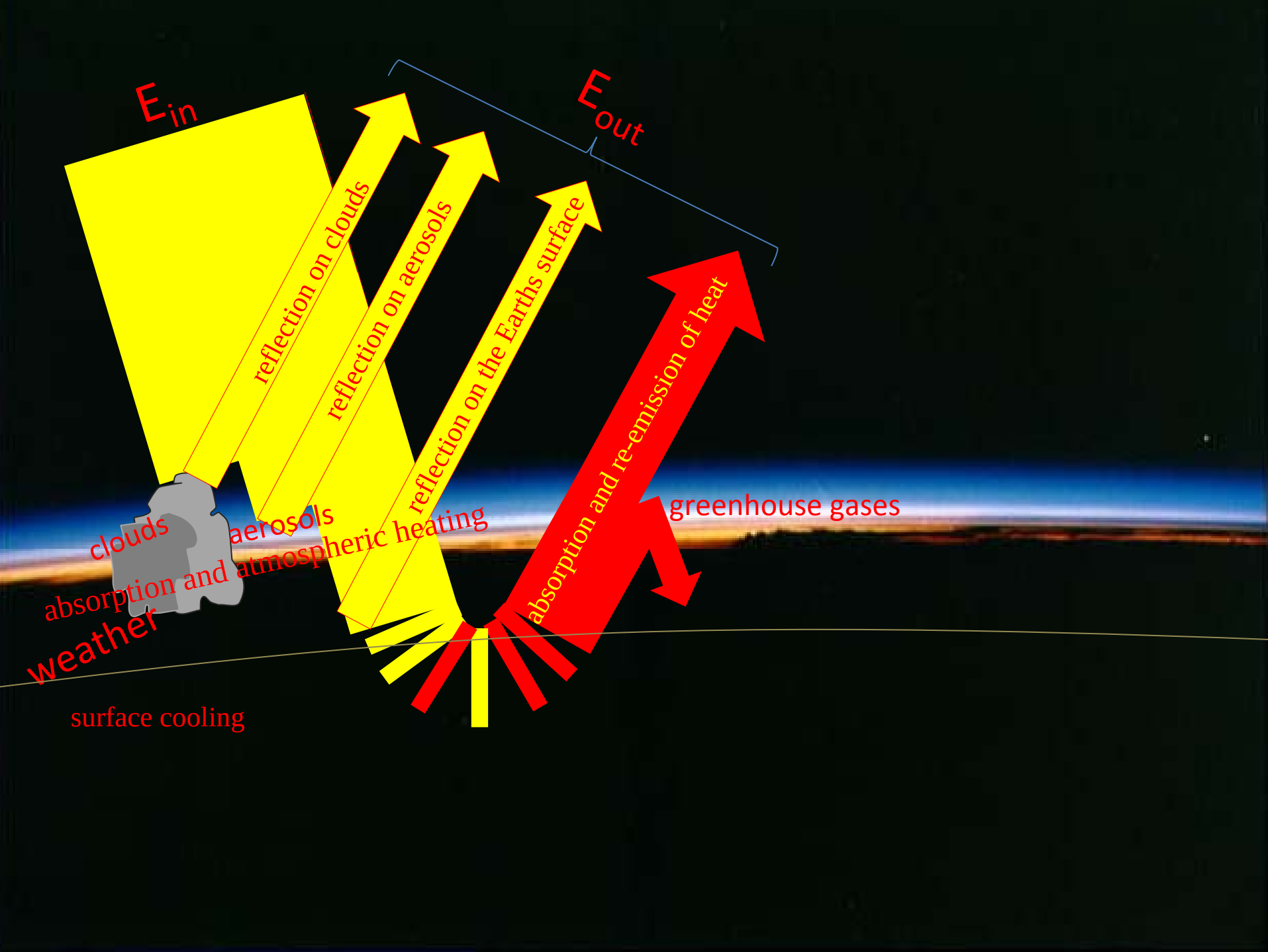
Black carbon and ozone in the lower atmosphere are harmful air pollutants affecting health of humans and ecosystems

Black carbon, a component of particulate matter, and ozone both lead to premature deaths worldwide. (PM2.5: ~2 million per year , WHO)

Ozone is also the most important air pollutant, responsible for reducing crop yields, and thus affects food security.

On global and regional climate ?


E_{in}
E_{out}
$(E_{in} - E_{out})$ = radiative forving (Wm^{-2})
$\Delta T_{global} \sim (E_{in} - E_{out})$


E_{in}
E_{out}
reflection on clouds
reflection on aerosols
reflection on the Earths surface
absorption and re-emission of heat
greenhouse gases
clouds
aerosols
absorption and atmospheric heating
weather
surface cooling

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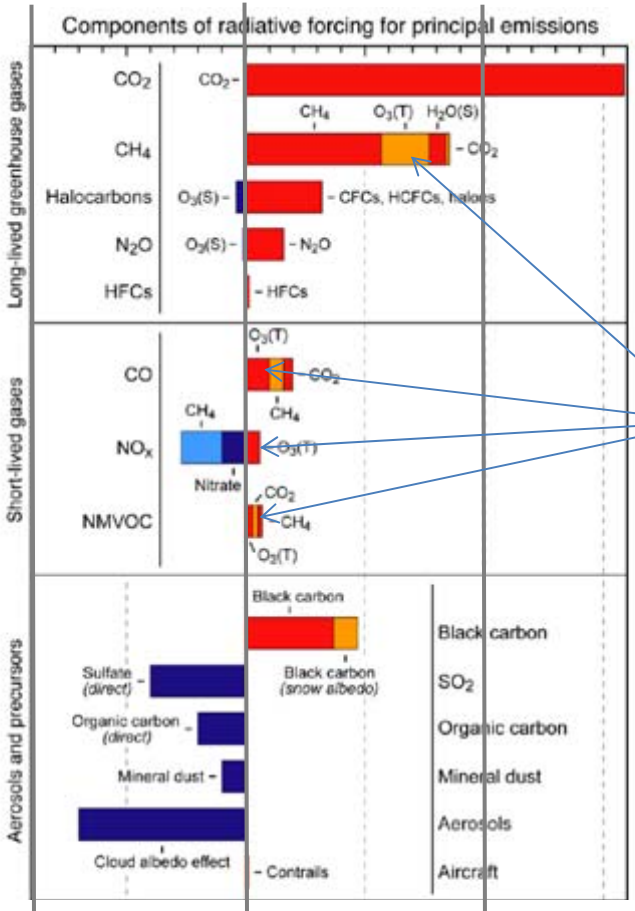
present day TOA radiatve forcing by emissions



O_3,troposphere
0.25 - 0.45 Wm^{-2}

BC direct effect

BC indirect effects

BC deposition

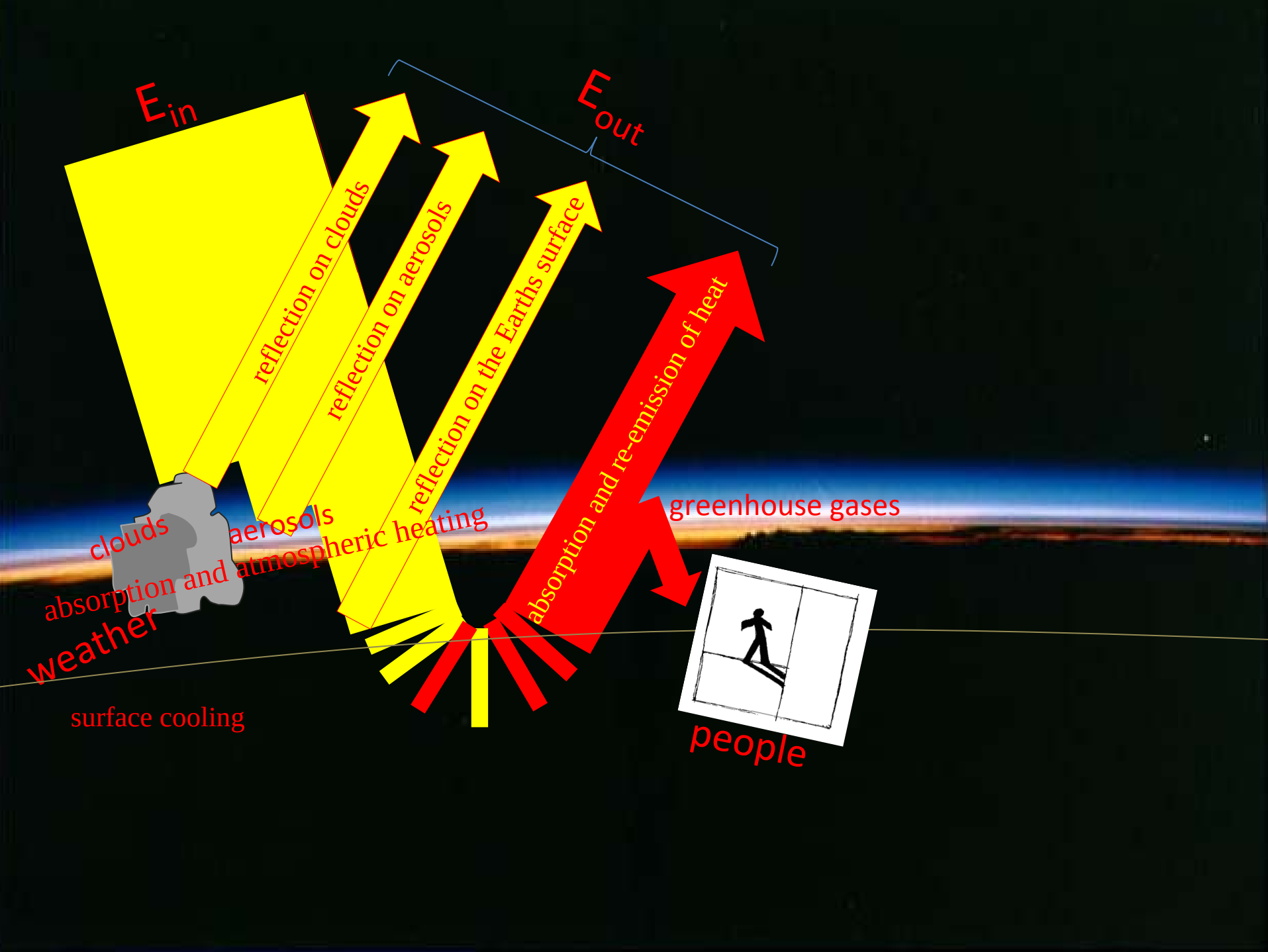
BC total

0.0 - 1.0 Wm^{-2}

IPCC 4AR, 2007

UNEP, 2011

Joint Research Centre


E_{in}
E_{out}
reflection on clouds
reflection on aerosols
reflection on the Earths surface
absorption and re-emission of heat
greenhouse gases
clouds
aerosols
absorption and atmospheric heating
weather
surface cooling
people

present impacts of BC and tropospheric ozone

On global and regional climate

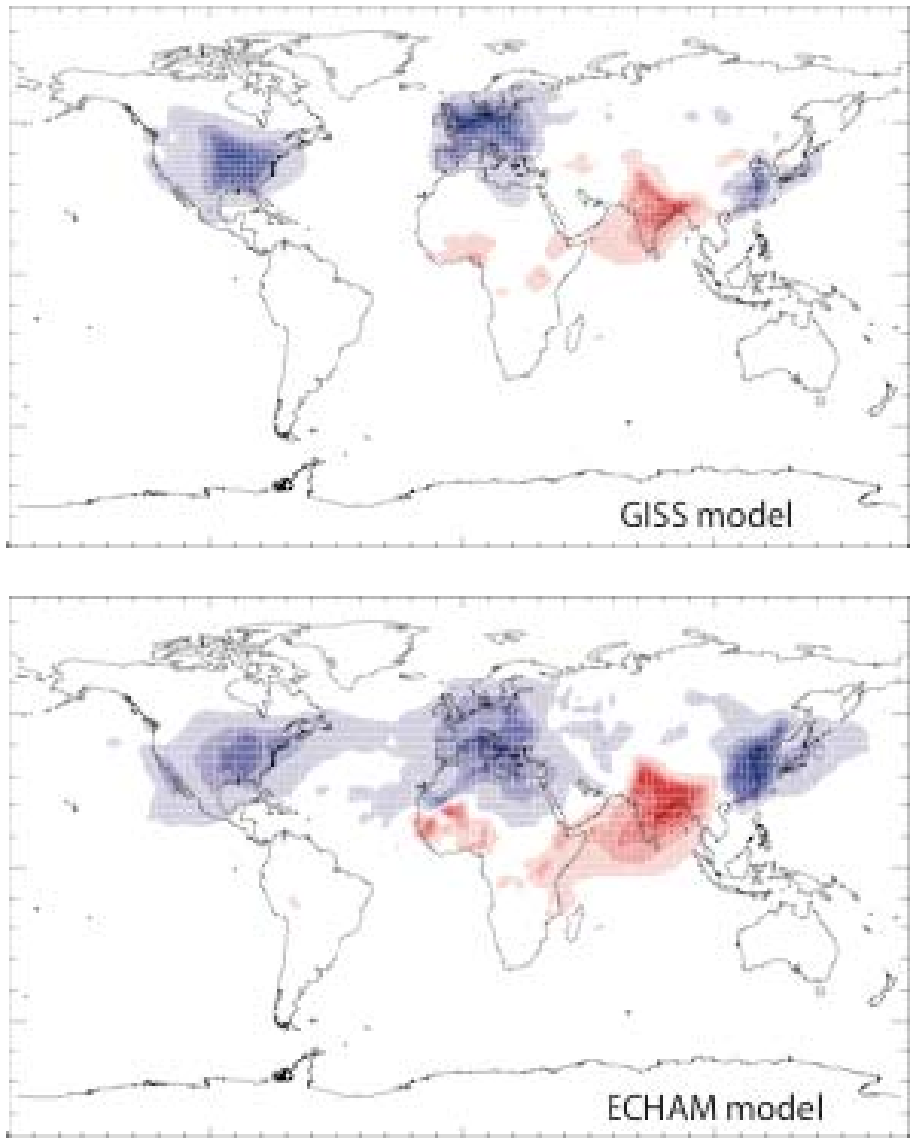
Changes in their burdens over the 20th Century result in an expected equilibrium global warming of 0.0-0.8°C due to BC and 0.1-0.4°C due to O_3. (The equilibrium warming expected from CO2 is about 1.3 C.)

Atmospheric heating by BC disturbs tropical rainfall and regional circulation patterns such as the Asian monsoon.

Black carbon's darkening of snow and ice surfaces increases their absorption of sunlight, which, along with atmospheric heating, exacerbates melting of snow and ice around the world, including in the Arctic, the Himalayas.

change in PM2.5: 2005 to 2030

refernce scenario

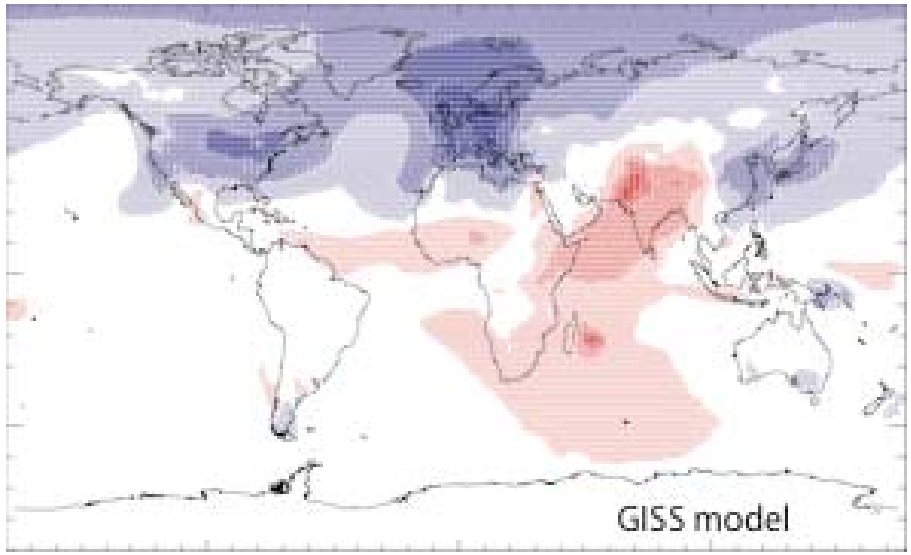


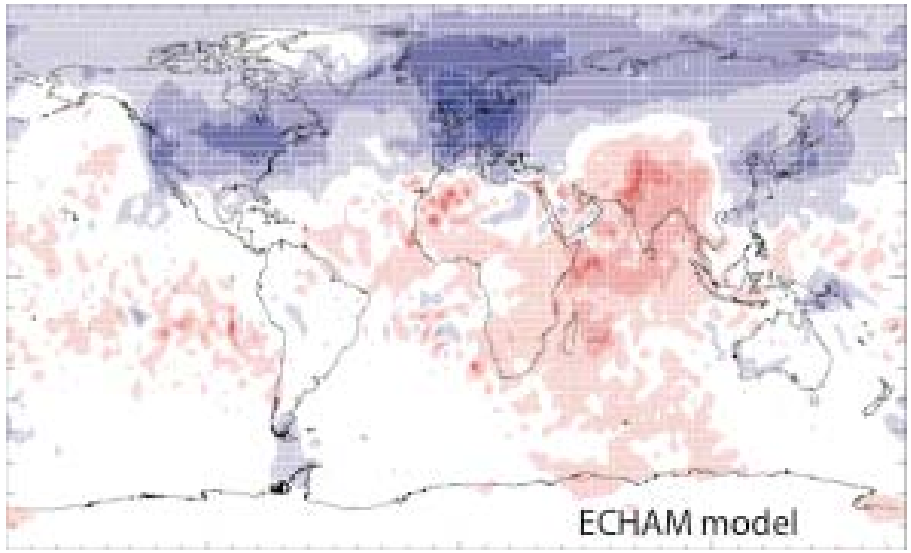
µg/m3

UNEP, 2011

change in BC deposition: 2005 to 2030

reference scenario

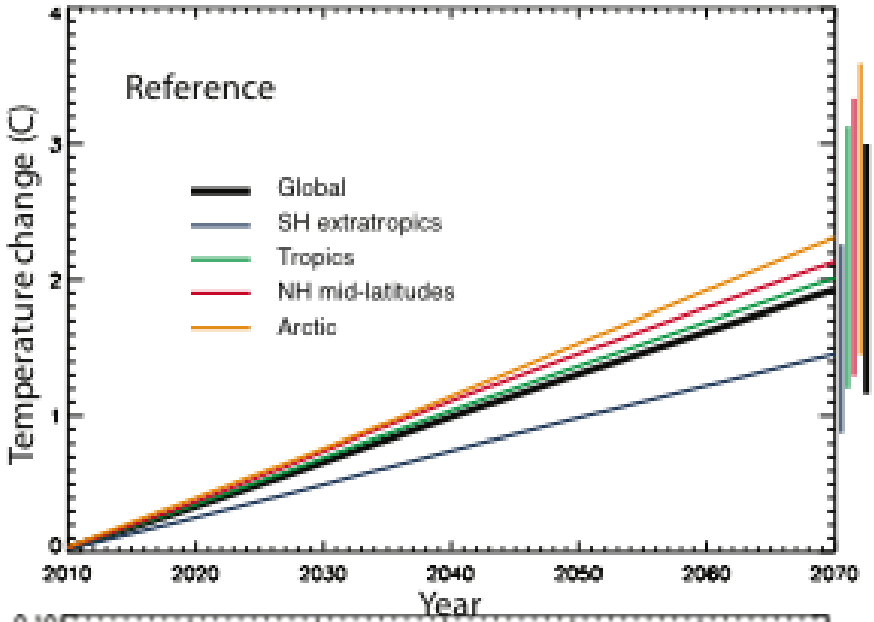




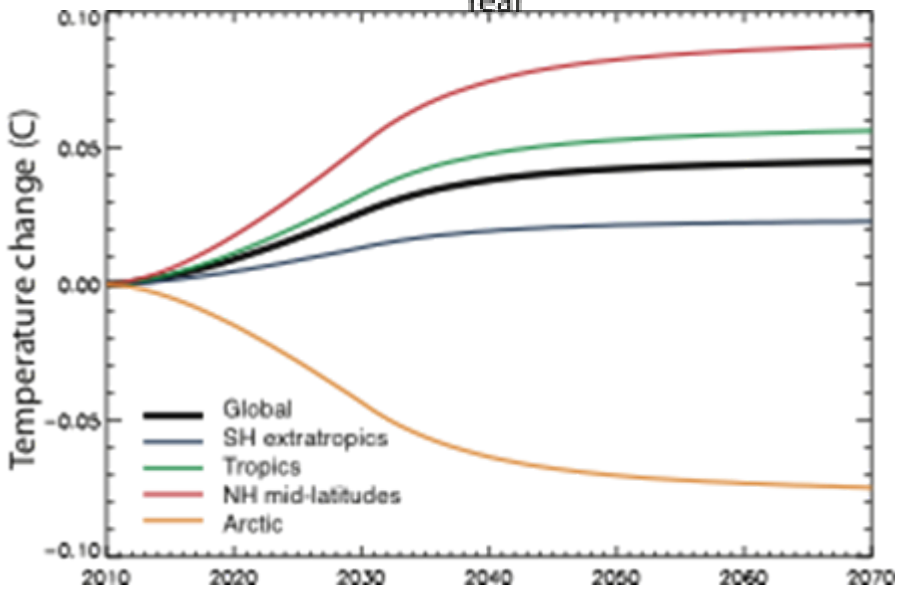
UNEP, 2011

change in temperature: 2009 to 2070

reference scenario



global and regional temeprature changes due to changes in CO2, methane, ozone and aerosols



contribution of methane, ozone and aerosols

UNEP, 2011

expected impacts of BC and tropospheric ozone

ireference scenario: 2005 to 2030

Avoidance of 0.2-1.8 million premature deaths per year, in North America, East Asia, SE Asia & Pacific, While increase by 0.1-2.0 million in South, West & Central Asia and Africa..

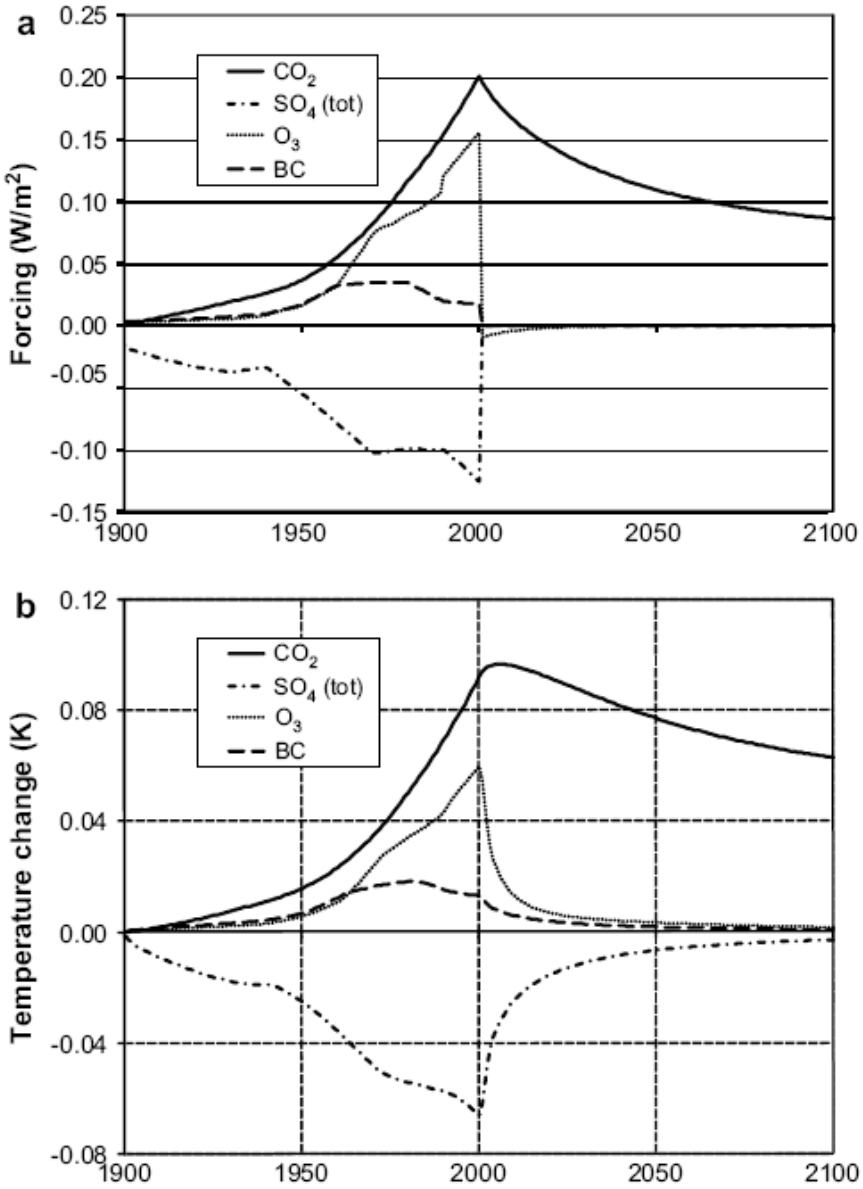
Decreasing production of wheat, rice corn and soy by 7 to 120 million tonnes across Asia with an associated economic loss of US$ 1 – 20 billion. Increasing crop yields in US and Europe.

The compensating warming and cooling impacts of changes in BC, ozone and other aerosols lead to a small net warming of less than 0.1°C globally

Black carbon’s darkening of snow and ice and atmospheric heating, keeps exacerbating melting of snow and ice in the Himalayas

BC and ozone as short-lived climate forcers

Contribution of transport sector only



radiation forcing follows atmospheric concentration

global temperature reacts with the reaction speed of the climate system

Fuglestvedt, 2009, Atm. Env.

Conclusions so far:

based on our knowledge of the behaviour of BC and ozone in the atmosphere, and of their impacts on air quality, And on lobal and regional climate in teh near term

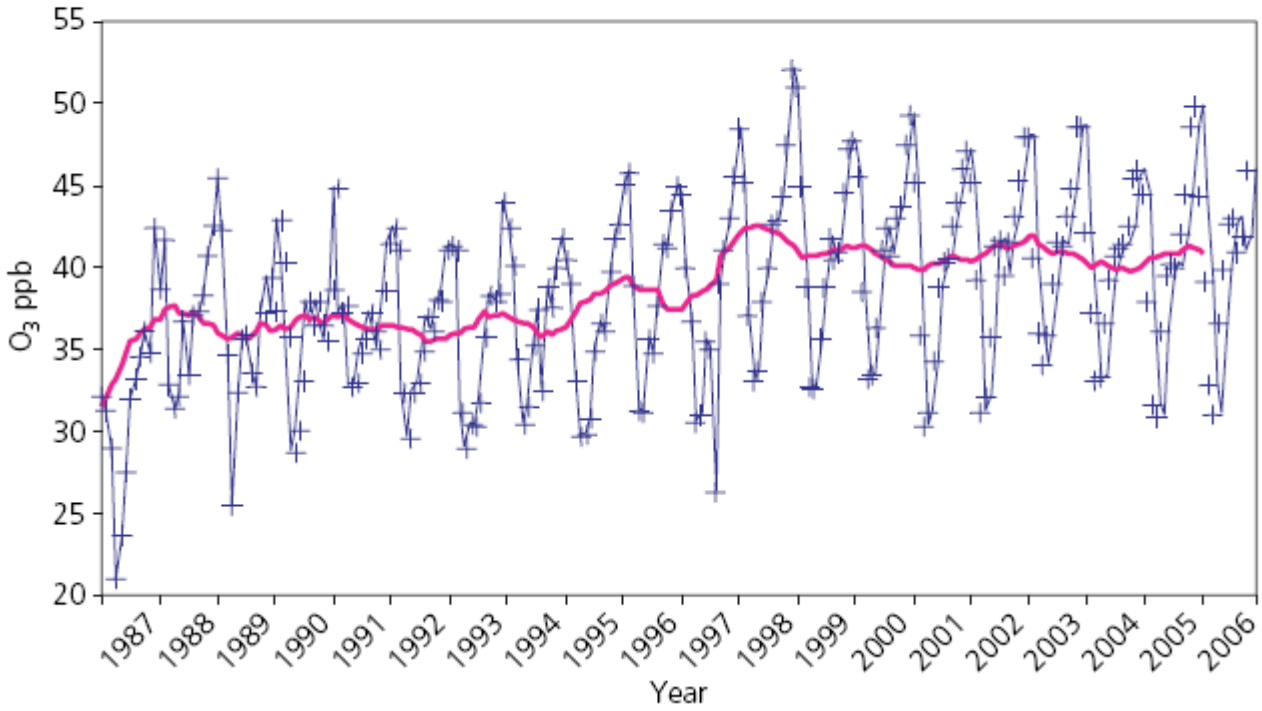
it makes a lot of sense to look for measures that specifically target the emissions of BC and ozone precursors in order to solve a range of important problems at once.


thanks


Black carbon is the 2nd biggest contributor to global warming.
An EU black carbon strategy today means a cooler planet tomorrow.
THE PARLIAMENT
Come and join a panel debate on this issue.
Paul Henri Spaak Building, European Parliament, June 22nd, 11h30-13h00.
For more information go to www.theparliament.com/blackcarbon

backround tropospheric ozone still increases

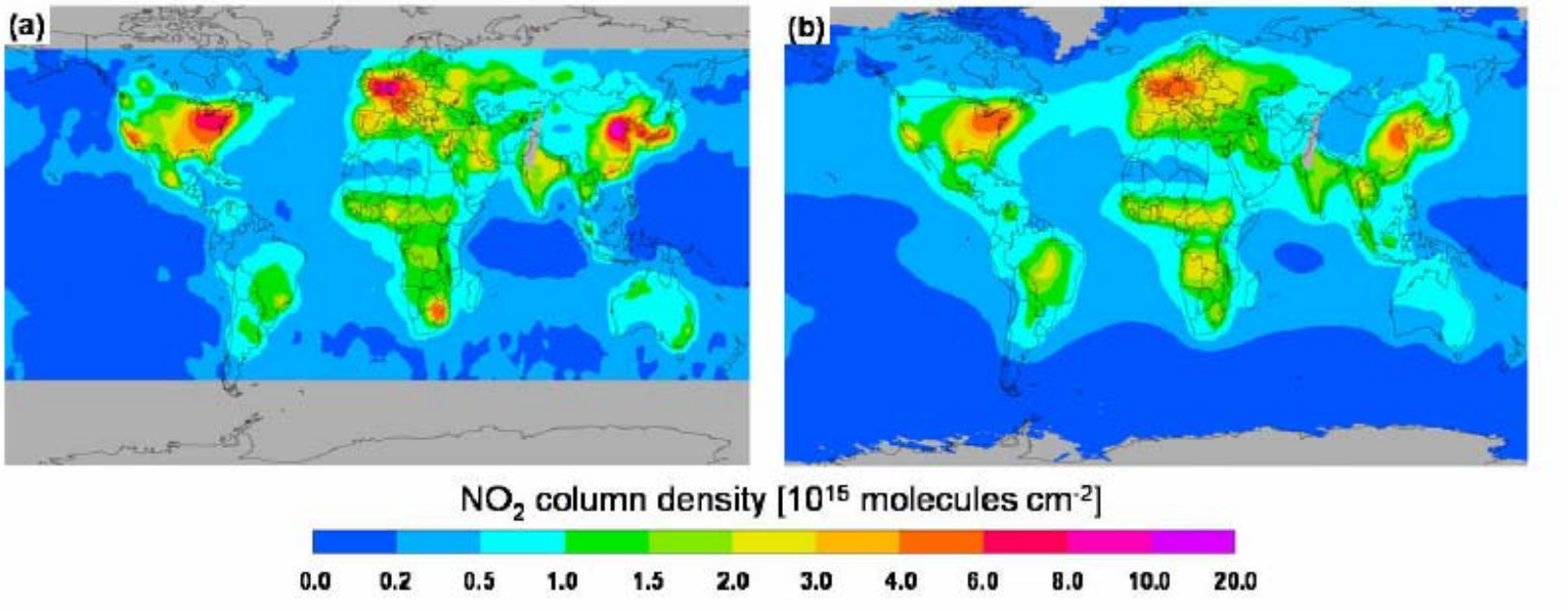
Figure 3.11 Trends in the monthly mean and 12-month running mean (solid line) baseline O_3 concentration from April 1987 to April 2007 at Mace Head, Ireland. Source: Derwent et al. 2008.



measuring and modeling global NO_2

measured from satelites, GOME

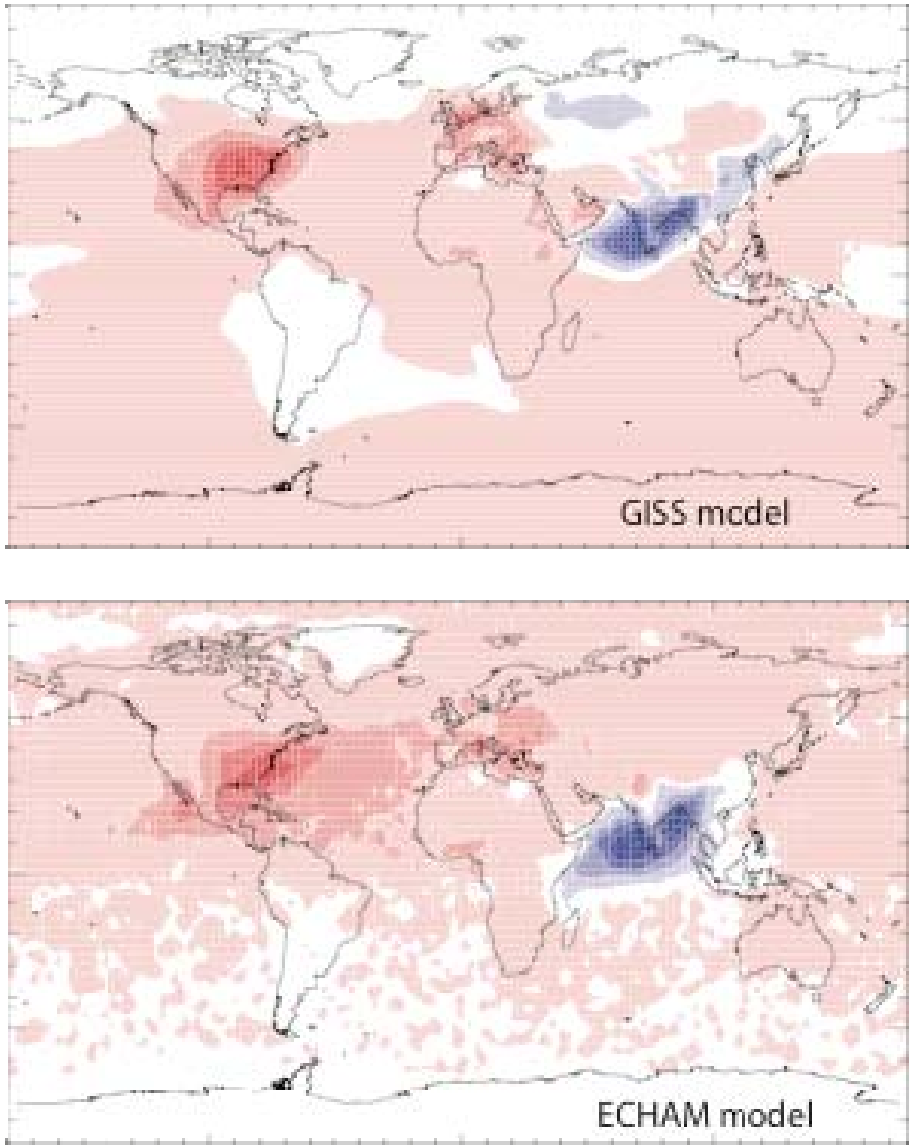
average of 17 global models



IPCC 4AR Ch7

change in *TOA* forcing: 2005 to 2030

reference scenario



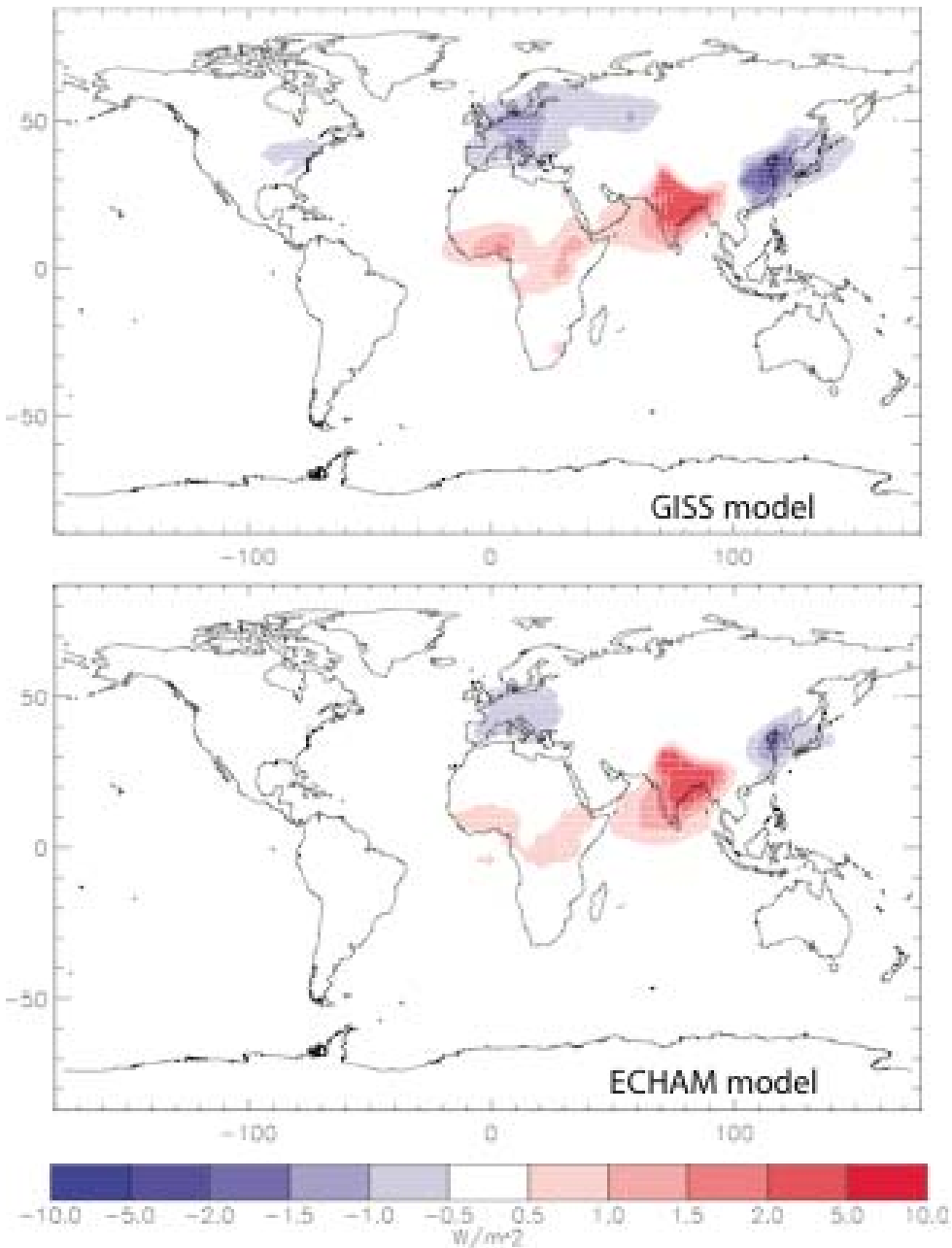
radiative forcing due to: methane, ozone and direct effect of aerosols

Wm^{-2}

UNEP, 2011

change in *atmopheric* forcing: 2005 to 2030

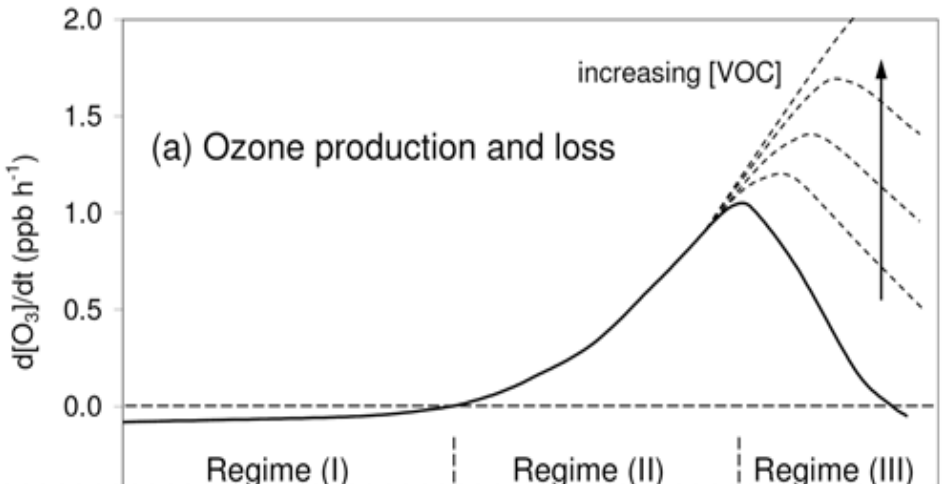
reference scenario



radiative forcing due to: methane, ozone and direct effect of aerosols

UNEP, 2011

Wm^{-2}


2.0
1.5
1.0
0.5
0.0
d[O3]/dt (ppb h-1)
increasing [VOC]
(a) Ozone production and loss
Regime (I)
Regime (II)
Regime (III)