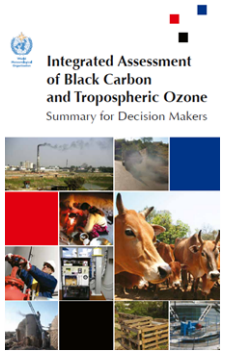
Measures to Limit Near-Term Climate Change and Improve Air Quality

The UNEP/WMO integrated assessment of Black Carbon and Tropospheric Ozone.



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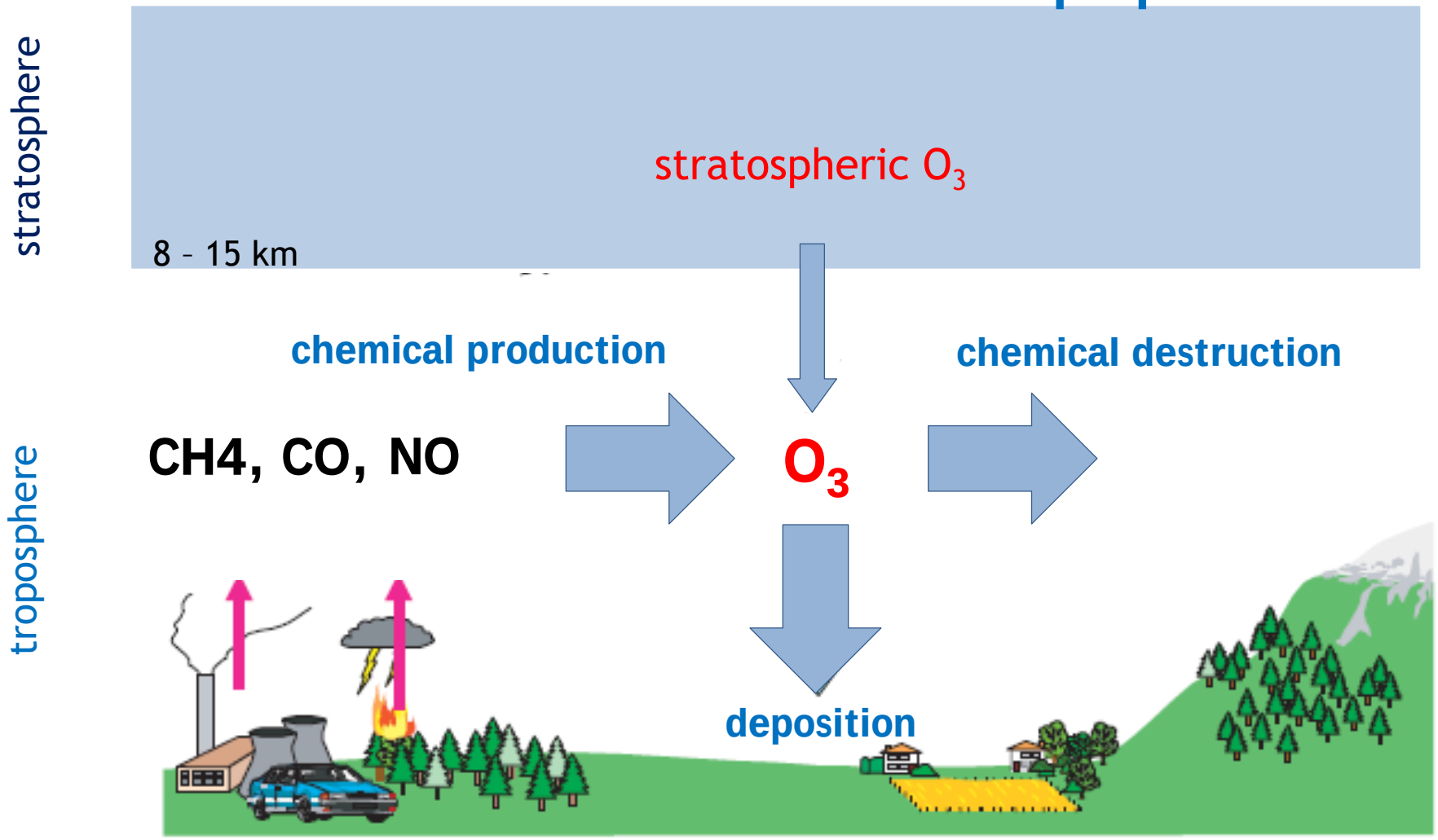
Tropospheric Ozone



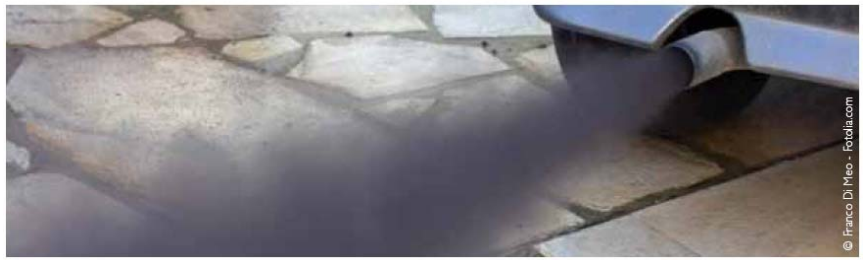
cattle
gas leaks
mining
biofuels
fossil fuels

increase of precursor emissions by man has **more than doubled** the concentration of tropospheric ozone since pre-industrial times!

Black Carbon

- carbon-containing **particulate matter (PM)**
- absorbs light
- results **from inefficient and incomplete combustion**
- emitted together with CO_2, CO, *organic particulate matter, SO_2*

~5%



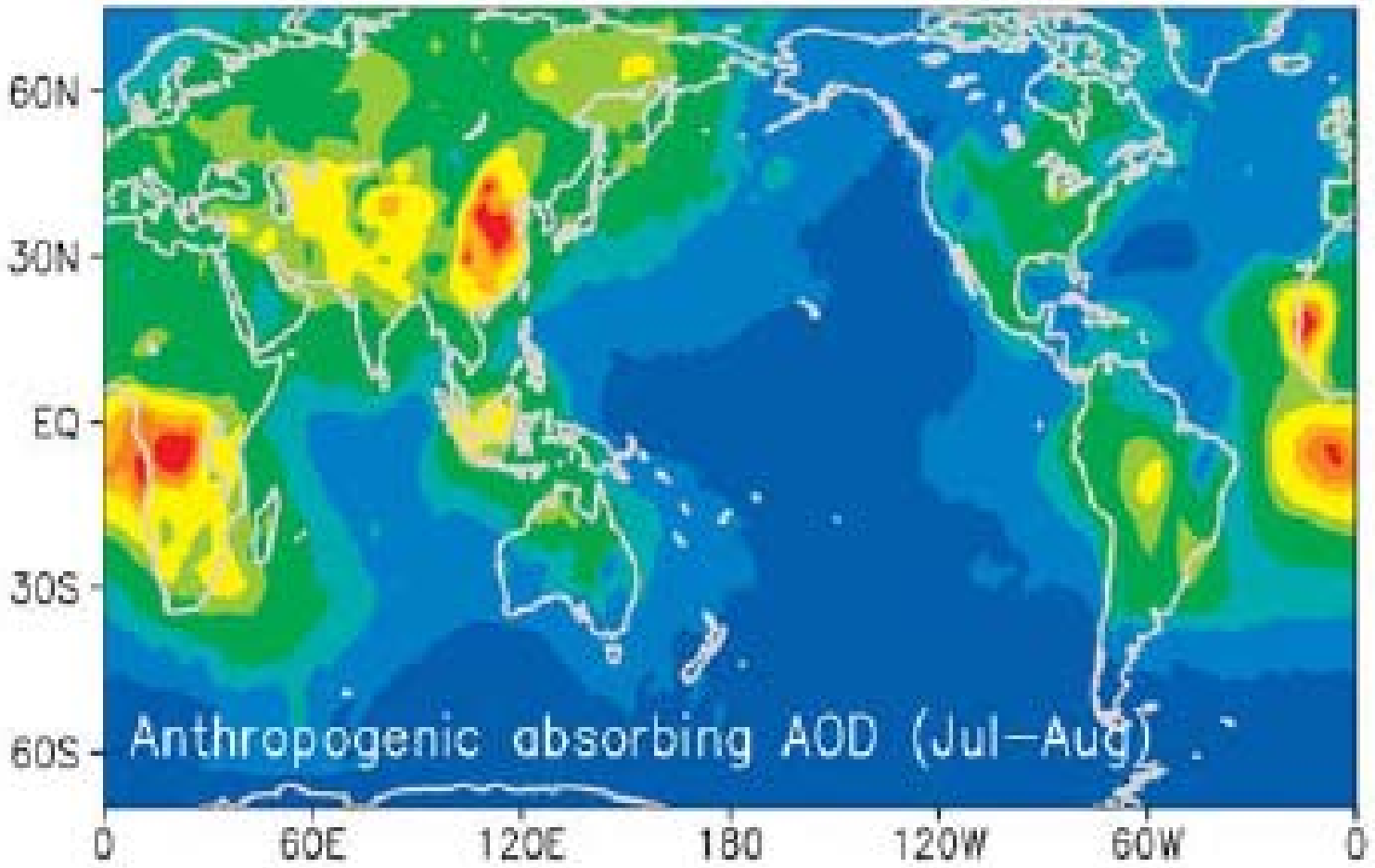
~5%

~40%
of global
BC emissions

~40%

some 60% of the *total* BC emissions is amenable to control

BC is main component of “Atmospheric Brown Clouds”



Ramanathan et al., , JGR, 2007

Present impacts of BC and tropospheric ozone

1. On air quality!

•Black carbon, a component of PM, leads to premature deaths worldwide.

•Ozone is the main responsible for reducing crop yields, and thus affects food security.

2. On global climate

•Changes in their burdens over the 20th Century results in a global warming potentially similar to that of CO_2

3. On regional climate !

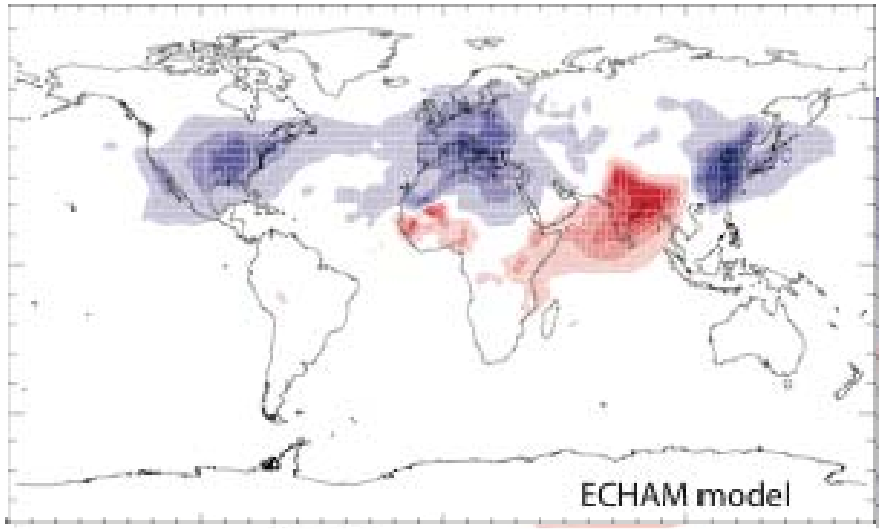
•Atmospheric heating by BC disturbs tropical rainfall and regional circulation patterns such as the Asian monsoon.

•Black carbon deposition on snow, along with atmospheric heating, leads to faster melting of a.o. the Arctic, the Himalayas.

NCO-P web-cam images of Khumbu valley

Source: CNR ISAC

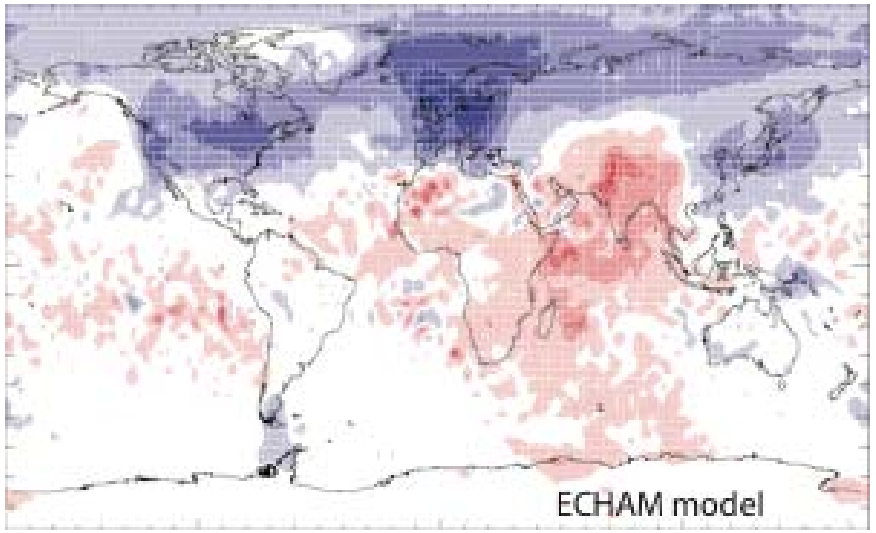
UNEP/WMO, 2011



μg/m3

change in PM2.5:
2005 to 2030
reference scenario

UNEP/WMO, 2011

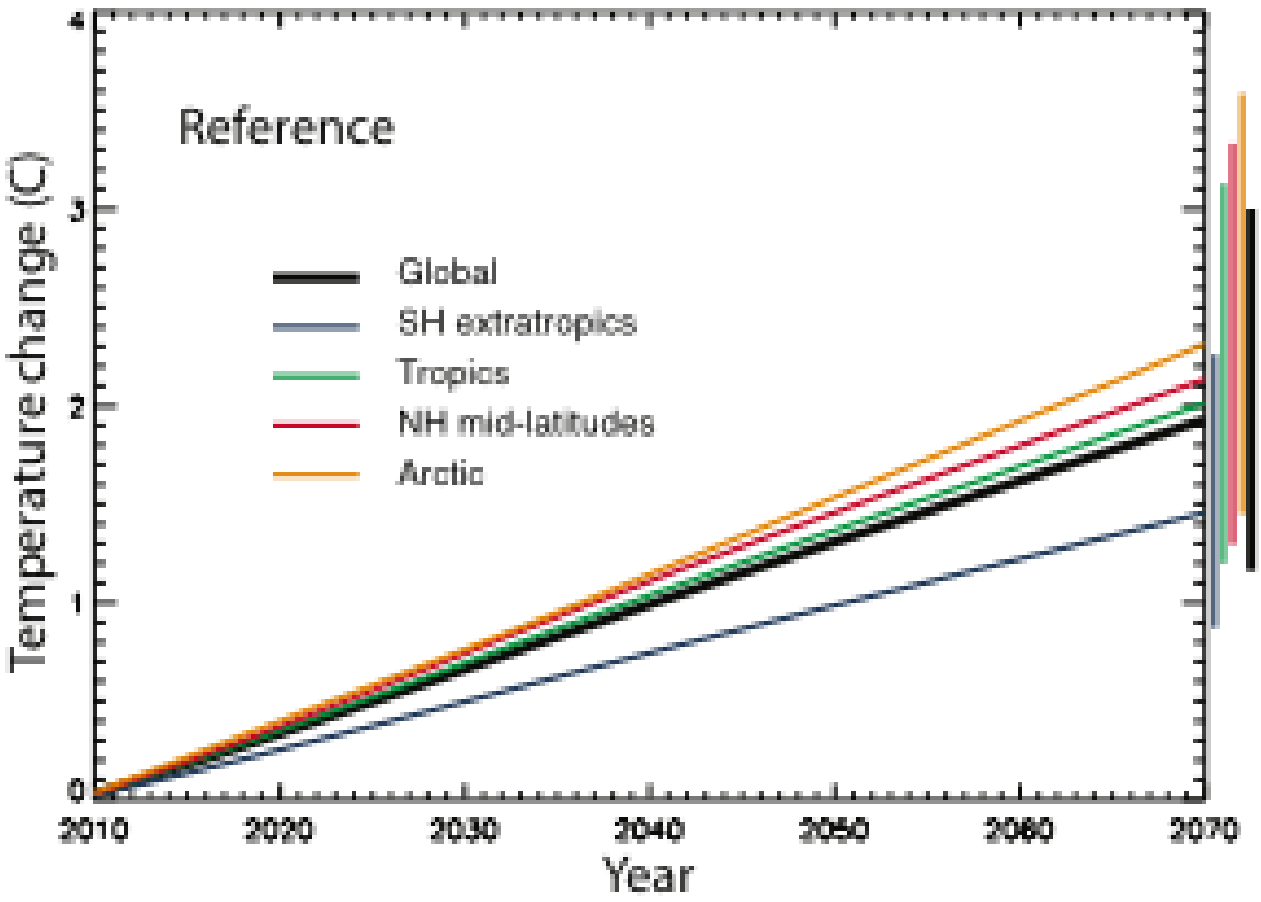


%

change in
BC deposition:
2005 to 2030
reference scenario

Change in temperature: 2009 to 2070

reference scenario

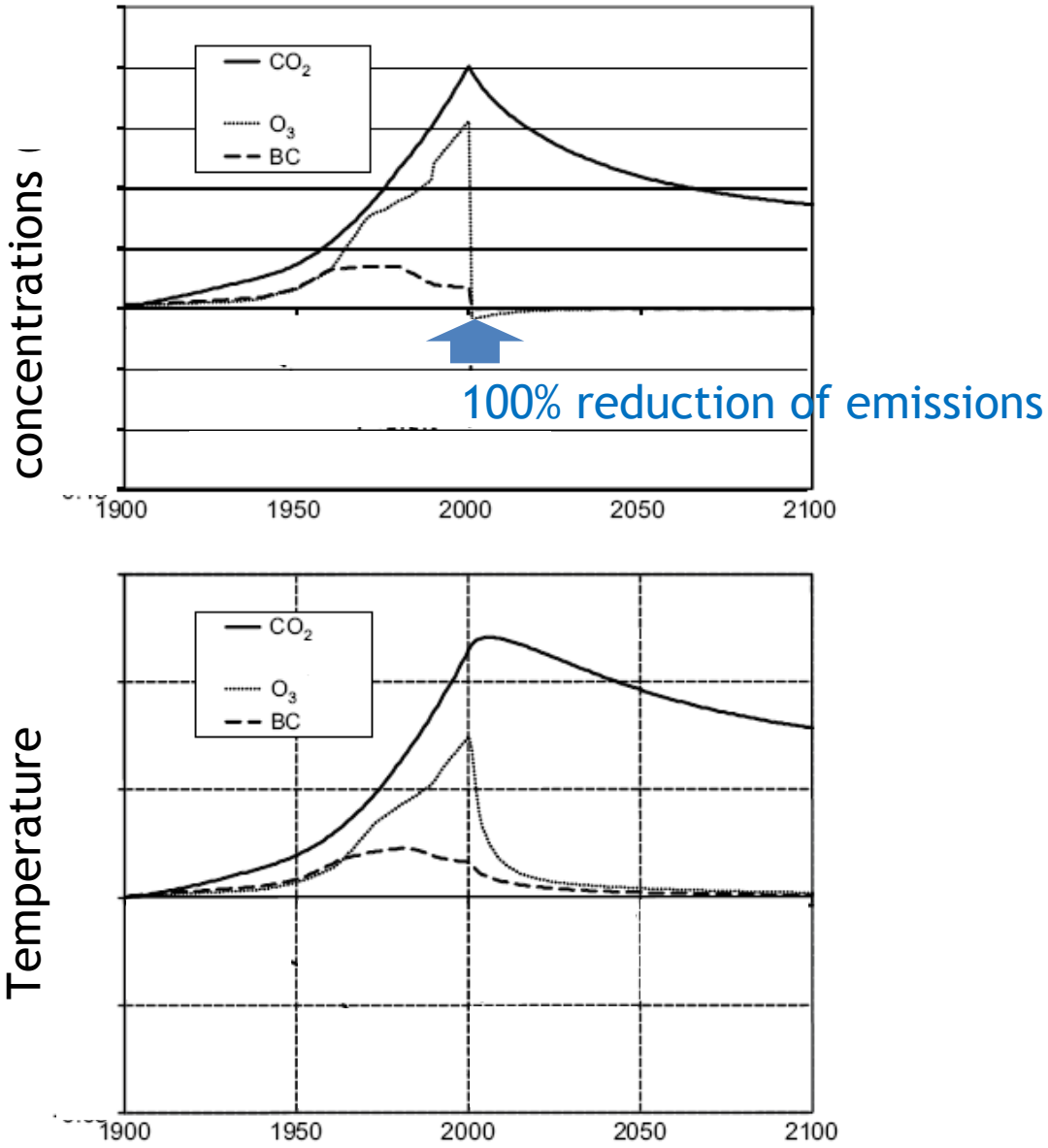


global and regional temeprature changes due to changes in CO_2, methane, ozone and aerosols

UNEP/WMO, 2011

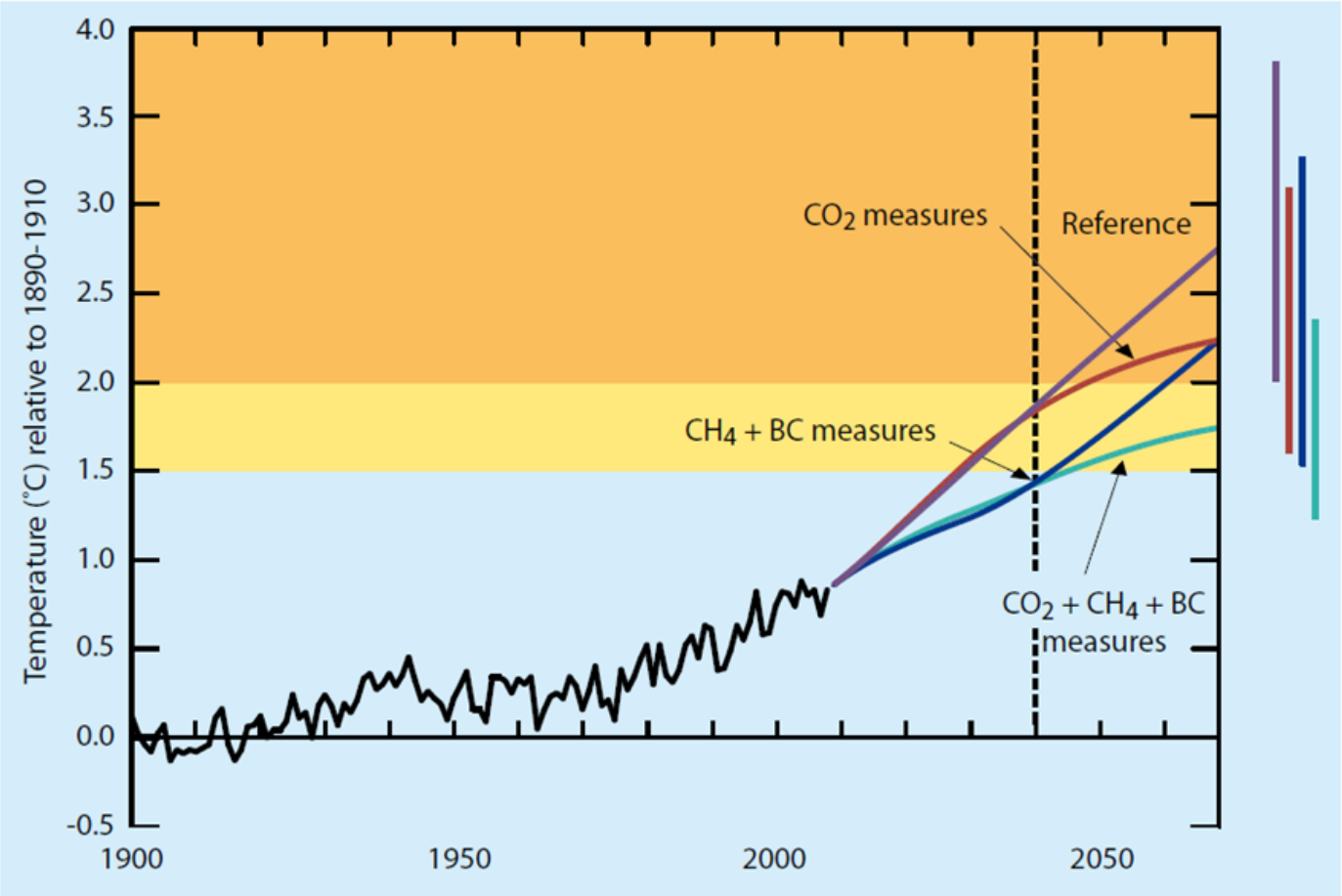
One addition reason to control BC and tropospheric ozone

compared to CO_2, they are short-lived in the atmosphere



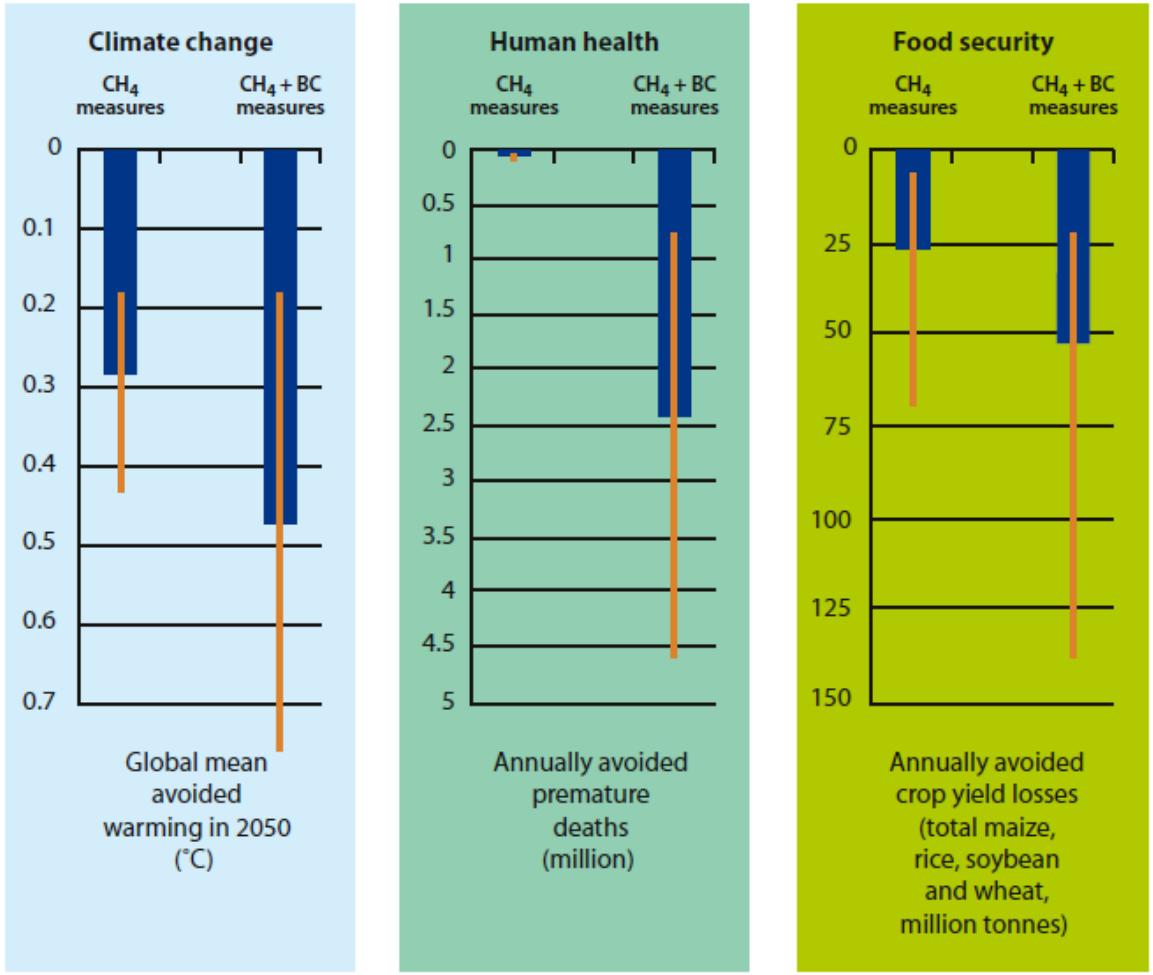
based on: Fuglestvedt, 2009, Atm. Env.

Result for Global Temperature Change (hybrid of results from GISS and ECHAM models informed by the literature) added to the historical record



UNEP/WMO, 2011

Global benefits from full implementation of the measures in 2030 compared to the Reference scenario



UNEP/WMO, 2011

Conclusions

Based on our knowledge of the behaviour of BC and ozone in the atmosphere, and of their impacts on **air quality**, and on **global** and **regional climate** in the 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**.

"kill two birds with one stone"

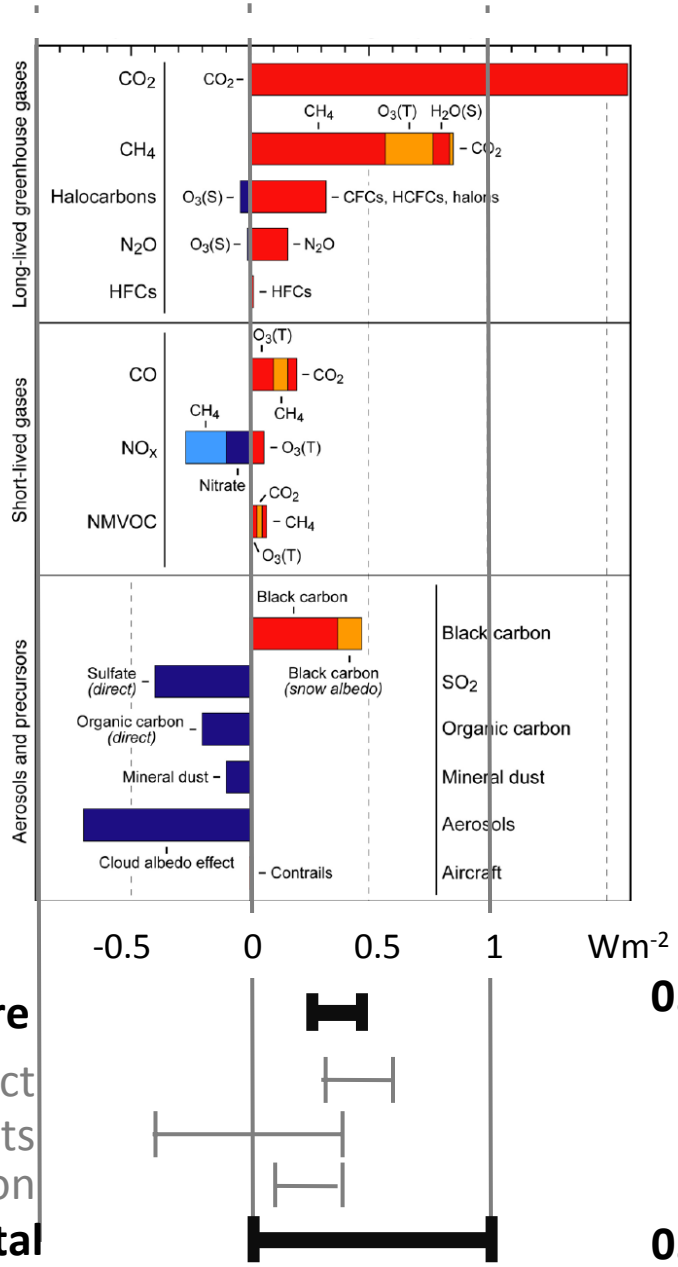
"kill several birds with 16 stones"

World Meteorological Organization

UNEP

present day TOA radiatve forcing by past emissions

CO_2 **1.5 - 1.7 Wm^{-2}⇒ 1.2 – 1.4 °C**



O_3,troposphere **0.25 - 0.45 Wm^{-2}⇒ 0.1 – 0.4 °C**

BC direct effect

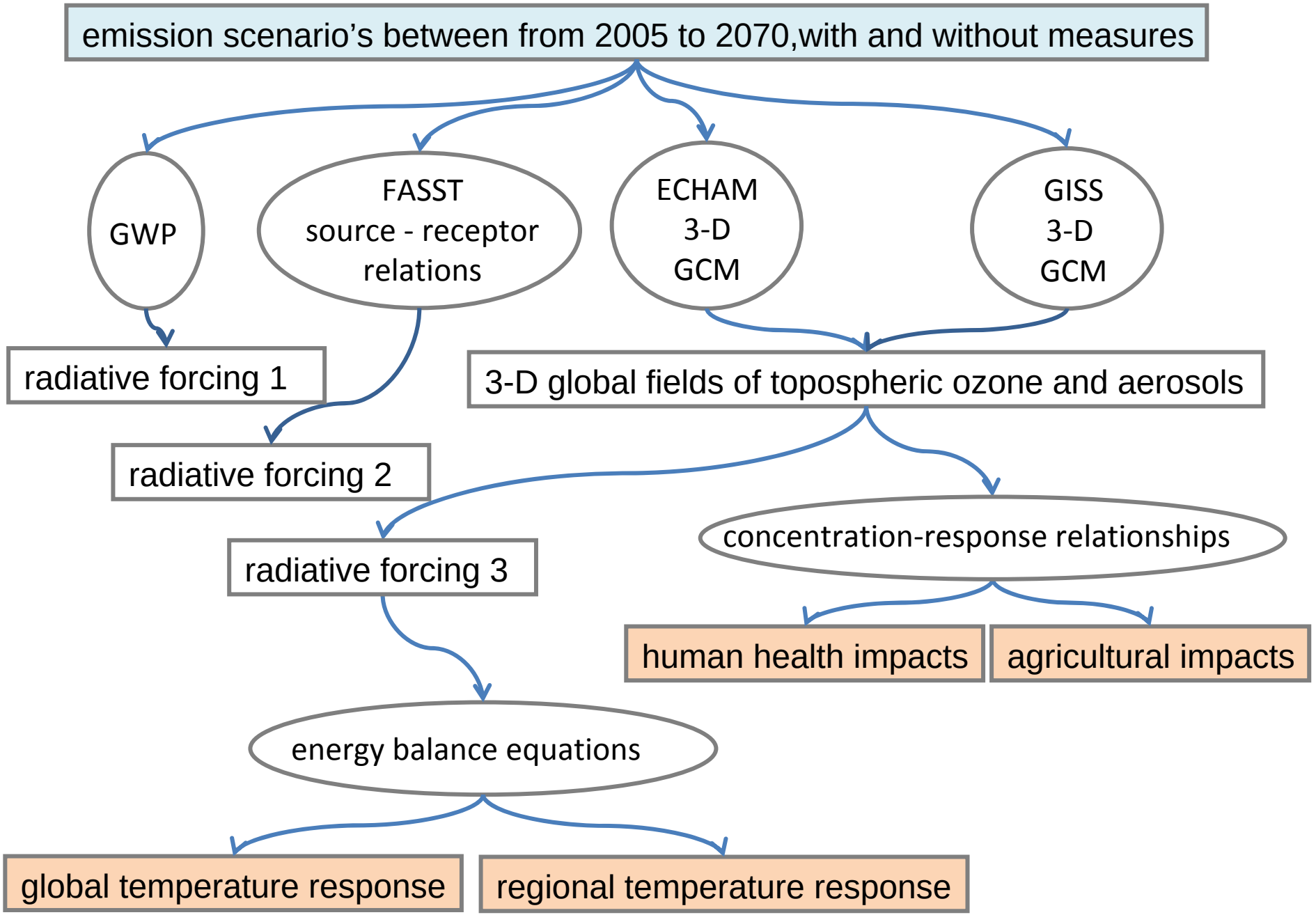
BC indirect effects

BC deposition

BC total **0.0 – 1.0 Wm^{-2} ⇒ 0.0 – 0.8 °C**

IPCC 4AR, 2007

UNEP, 2011


emission scenario's between from 2005 to 2070,with and without measures
GWP
FASST
source - receptor
relations
ECHAM
3-D
GCM
GISS
3-D
GCM
radiative forcing 1
3-D global fields of topospheric ozone and aerosols
radiative forcing 2
concentration-response relationships
radiative forcing 3
human health impacts
agricultural impacts
energy balance equations
global temperature response
regional temperature response