GACC

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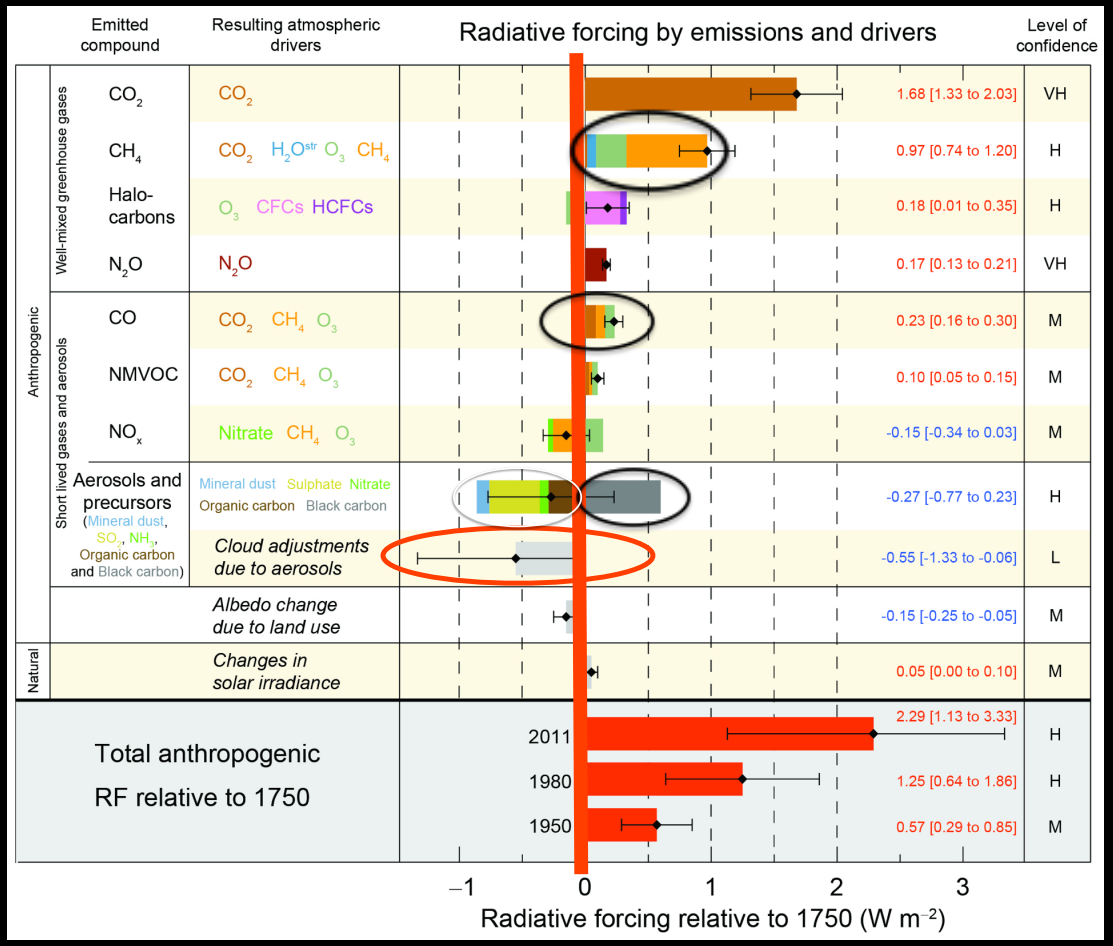
July, 2015

Air Pollutants Contribute to Climate Change

IPCC AR5, 2013



These pollutants are important not just at the surface!

Progression in Scientific Understanding

Direct BC Forcing:

0.34 (0.09–0.59) W m^{-2} in IPCC AR4 (2007)

0.45 (0.20-0.90) W m^{-2} in UNEP/WMO (2011)

0.71 (0.08-1.27) W m^{-2} in Bond et al. (2013)
0.54 (0.10-1.03) W m^{-2} in IPCC AR5 (2013)

Based on observations and models!

Indirect BC Forcing:

0.0 (-0.6 to 0.5) W m^{-2} in UNEP/WMO (2011)

0.2 (-0.5 to +1.1) W m^{-2} in Bond et al. (2013)
No estimate in IPCC AR5 (2013)

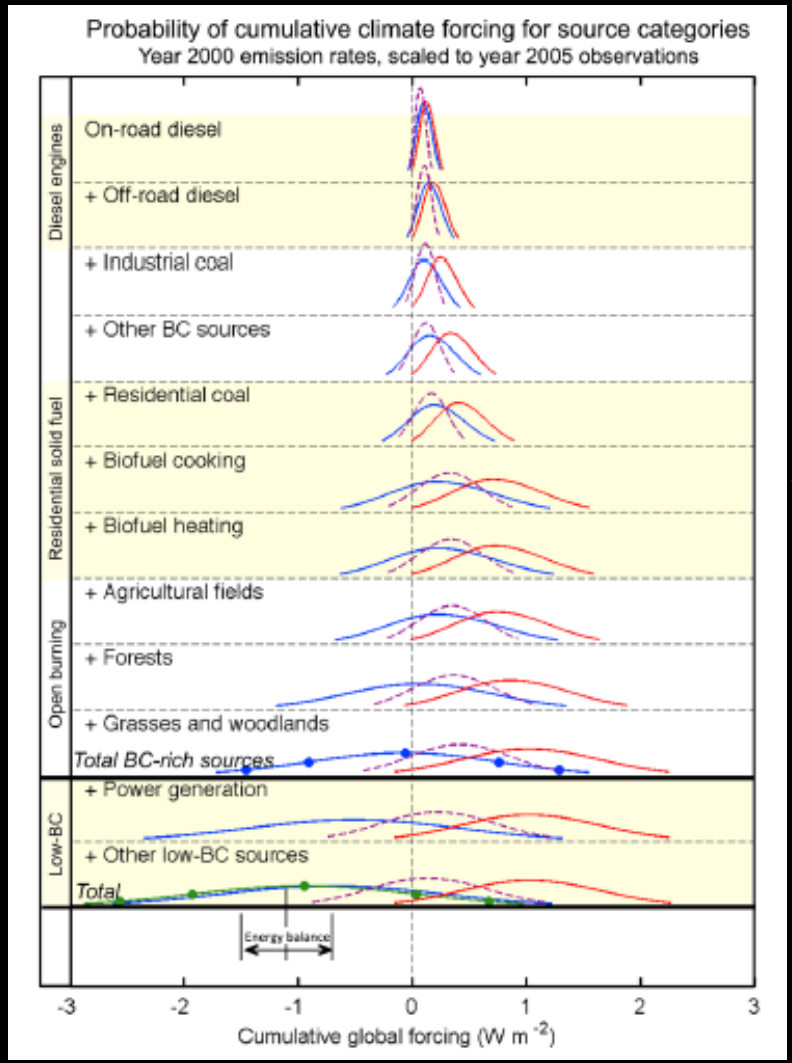
Health Impacts (ambient):

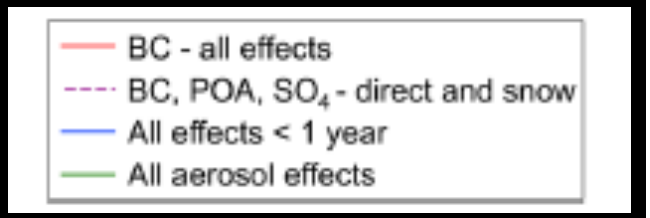
800,000 premature deaths yr^{-1} due to urban PM2.5 in GBD 2004

~3.6 million due to PM2.5 & ozone in UNEP 2011

~3.4 million due to PM2.5 & ozone GBD 2012 (Lim et al, Lancet)

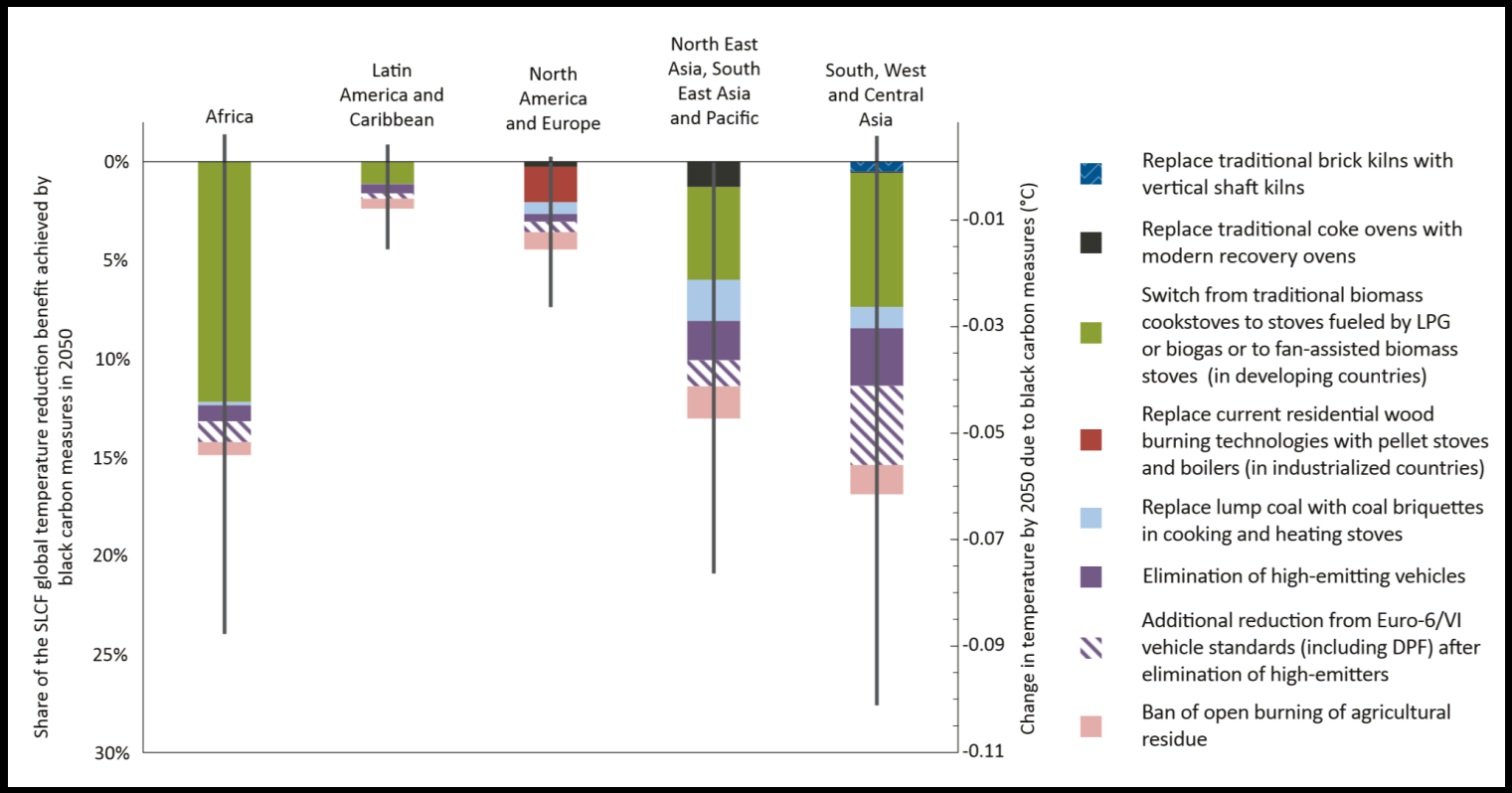
Uncertainties: Global





Bond et al, JGR, 2013

Avoided Warming from Black Carbon Measures in 2050



UNEP/WMO, 2011

Regional variation

Figure 6: Average Radiative Forcing Estimates for the Himalayas for a Range of Potential Black Carbon Emissions Reductions

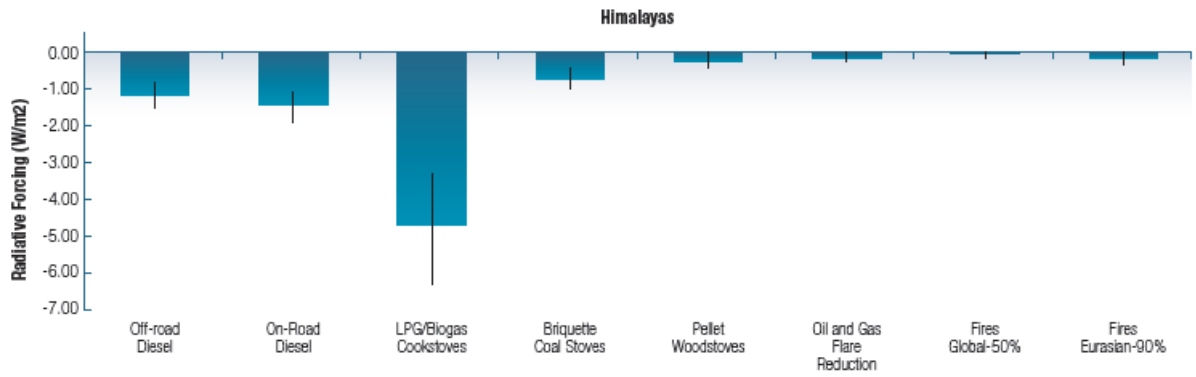
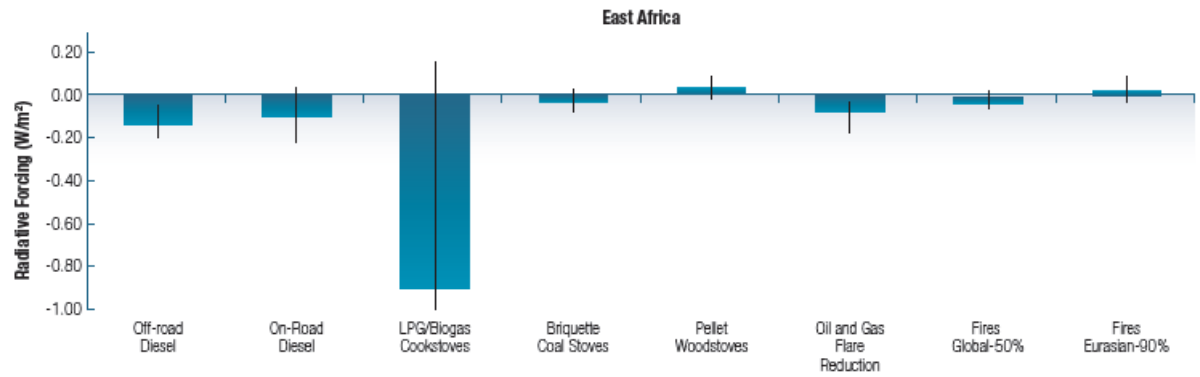


Figure 8: Average Radiative Forcing Estimates for East Africa from Black Carbon Emissions Reductions

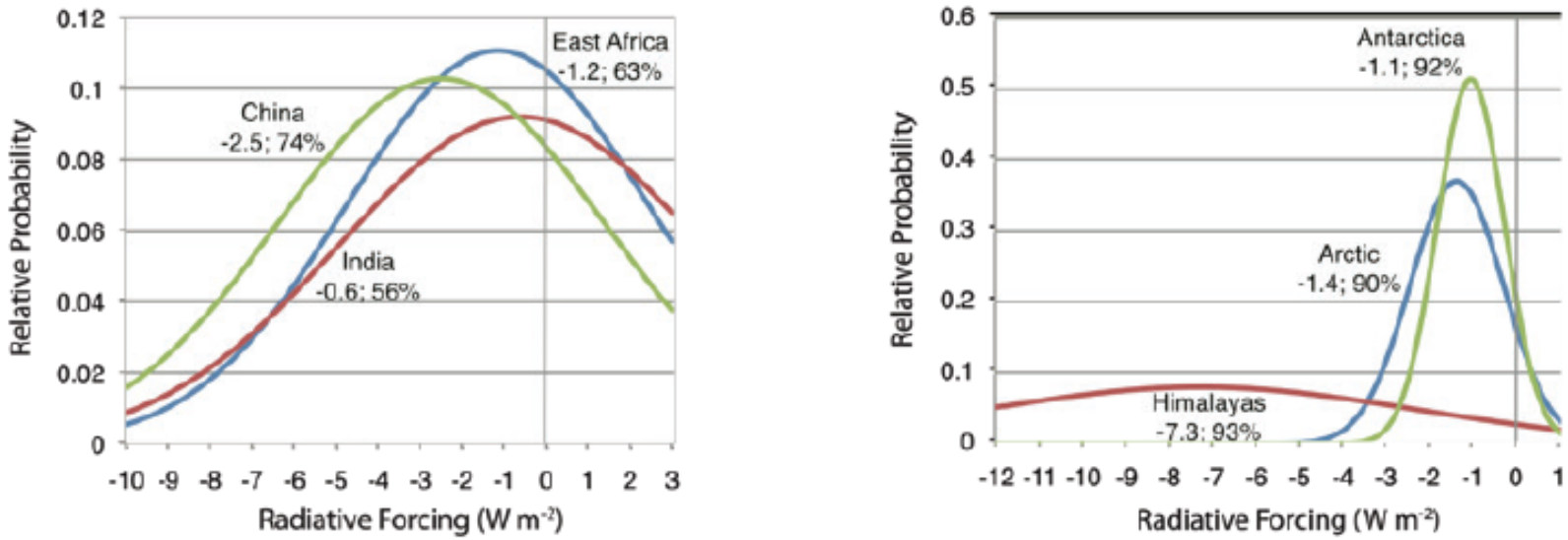


Note: Error bar for cookstove measure extends down to –1.97 W/m².

From "On This Ice", ICCI/WB, 2013

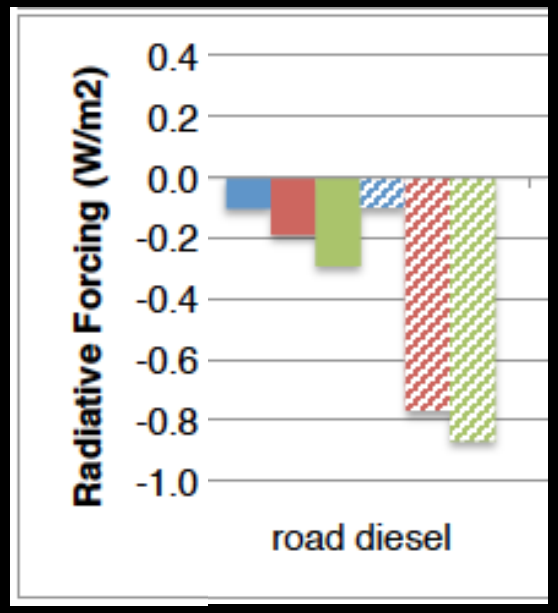
Regional variation

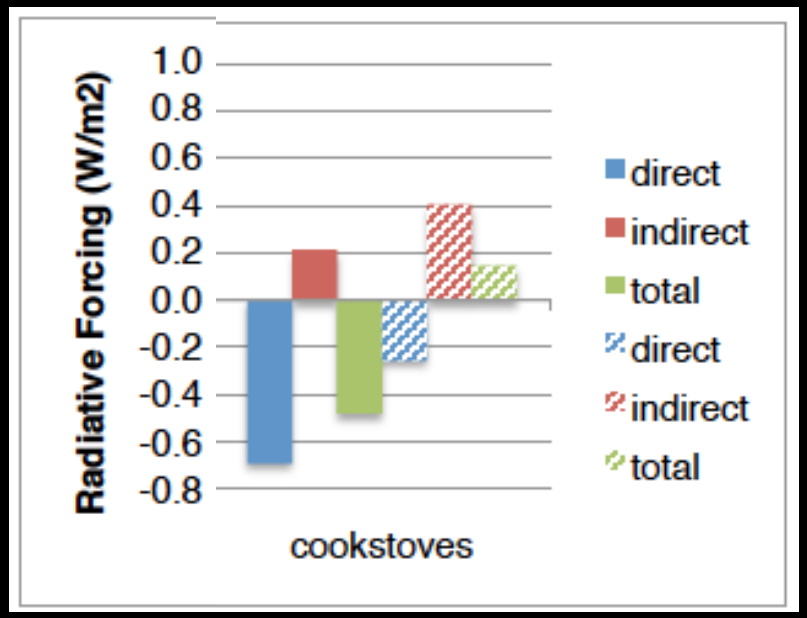
Figure 18: Probability Density Functions (pdfs) for the Total Forcing due to All the Measures. PDFs are calculated using the mean of three methods (UNEP-based, Bond-based, and the mean of those two for direct plus GISS internally calculated indirect) as the central estimate and the largest of the three standard deviations as the range. Numerical values are central estimate (W m^{-2}); probabilities for RF<0. Values for the Andes are -0.3 W m^{-2}; 68%.



From "On This Ice", ICCI/WB, 2013

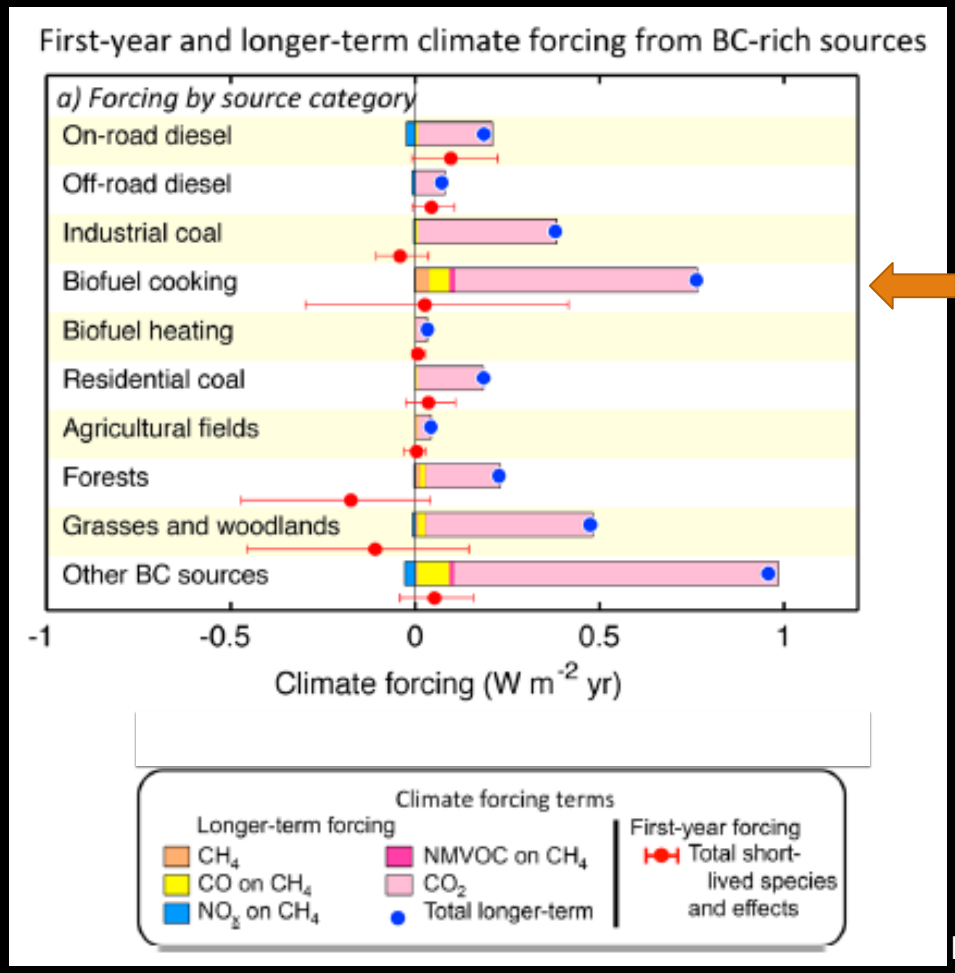
Intermodel variation (*i.e. physics uncertainties*)





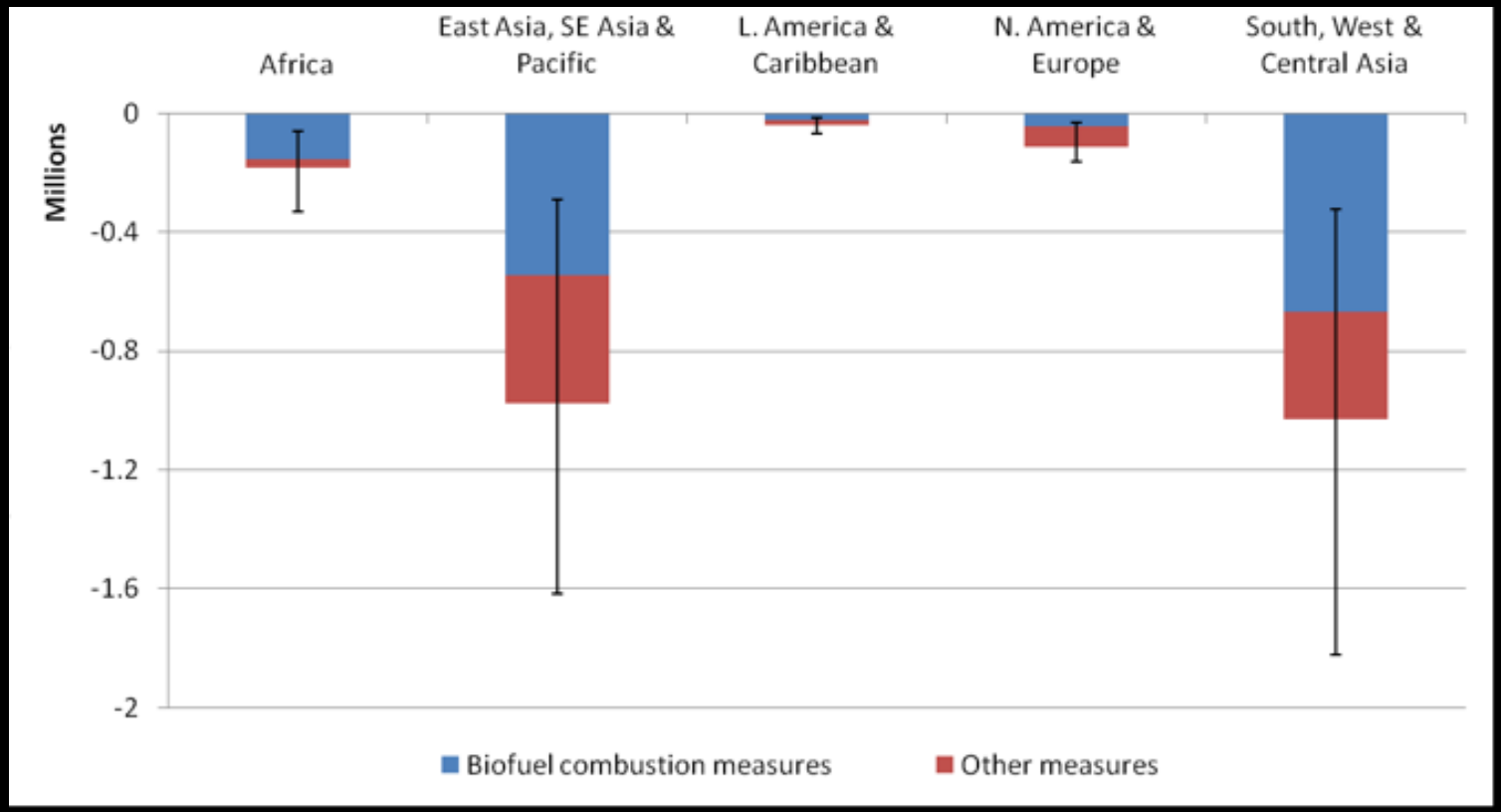
GISS model analysis, impact of reducing E & S Asia emissions
mass-based aerosol model (solid) vs full aerosol microphysics (dashed)

Including CO2



Bond et al, JGR, 2013

Avoided Deaths from Black Carbon Measures in 2030



UNEP/WMO, 2011

Multiple Benefits of Clean Air

	Certainty of major SLCP-related climate benefit*	Aggregate level of potential health benefit†	Main health benefit(s)	Potential level of CO_2 reduction cobenefit
Household air pollution and building design				
Improved cook stoves and fuel switching to reduce solid fuel use	Medium to high	High	Improved air quality, lower injury risk from carrying fuel, lower violence risk during fuel collection, fewer burns	Medium§
Improved lighting to replace kerosene lamps	Medium	Medium	Improved air quality, fewer burns	Low to medium
Electricity				
Switch from fossil fuels to renewables††	Low	High (coal and oil) or low to medium (gas)	Improved air quality, fewer occupational injuries	High
Control of fugitive emissions from fossil fuel industry	High	Low	Improved air quality	Low to medium‡‡

Scovronick et al, Lancet, 2015

Valuing Clean Air

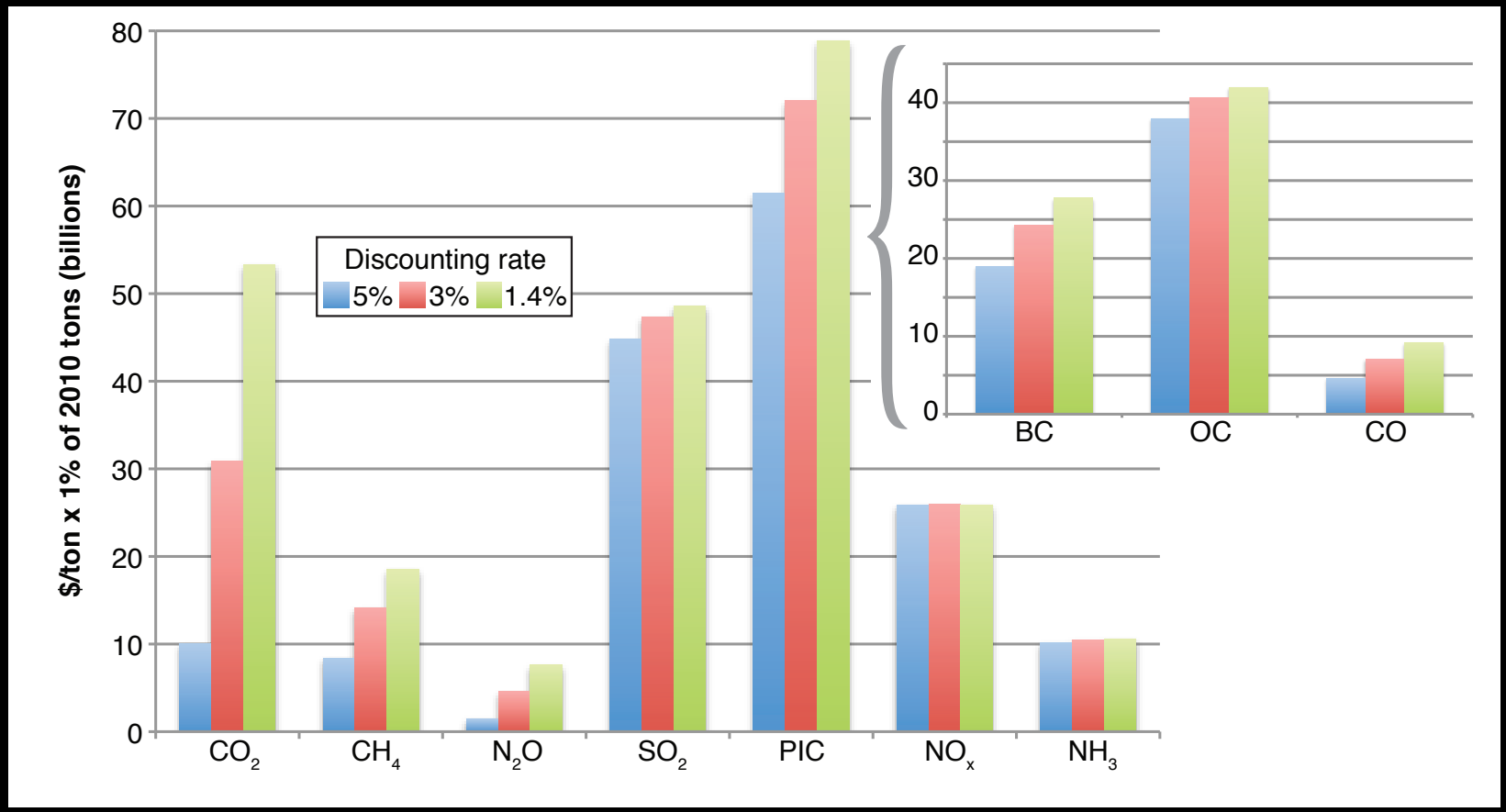
Develop a broader Social Cost that includes impacts on human health, agriculture, etc. via climate & air quality; includes all the key pollutants causing both problems

Model response to emissions of one pollutant at a time

Climate impacts of pollutants other than carbon dioxide

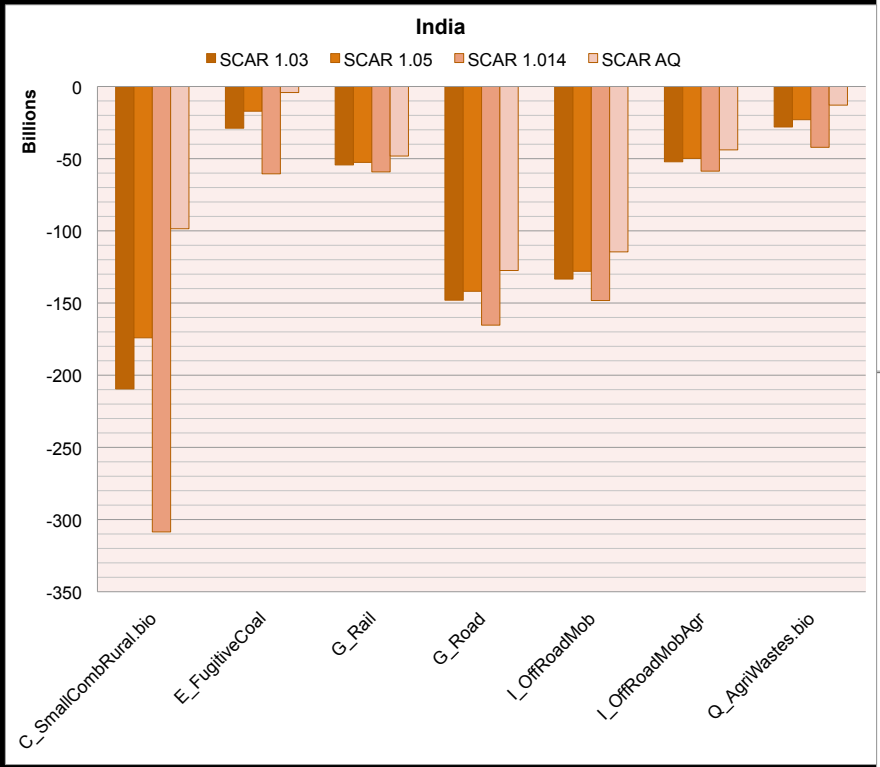
Same valuation methodology for air quality and climate

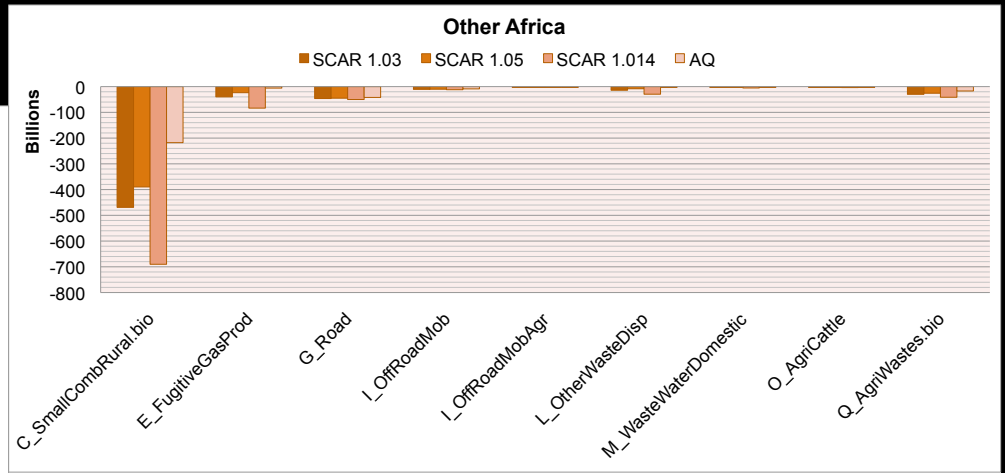
Valuing Emissions

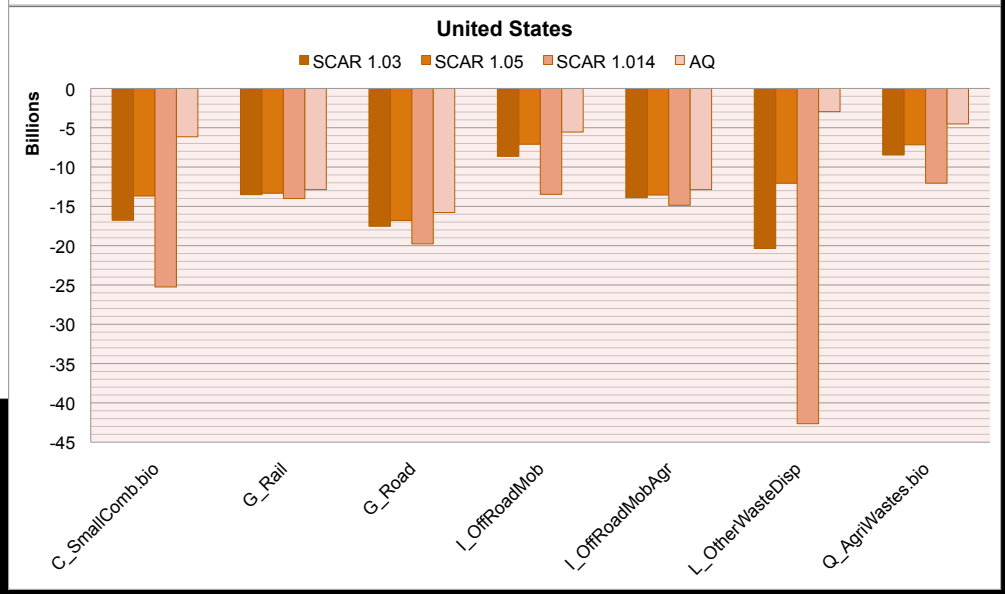


Shindell, Climatic Change, 2015

Valuing Emissions







Preliminary analysis based upon method of Shindell, Climatic Change, 2015; control measures are applied to indicated IPCC emissions categories

How to decide what to do where?

Need to know all the direct emissions (not just PM)

Need to evaluate indirect emissions (CO_2)

While all PM2.5 reductions will be good for health and all emissions reductions will yield net societal benefits, ideally one would maximize benefits when comparing stove options

One could also focus on particular regions for the sake of maximizing climate change mitigation (with ethical consequences of course)