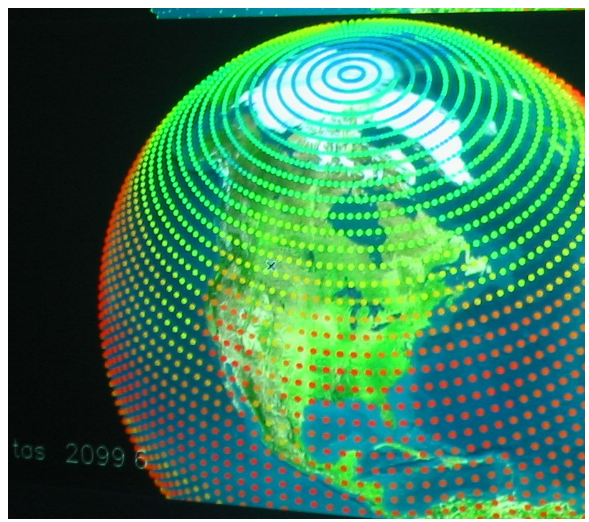
Alliance/EDF Oct 2011

How Earth System Models are reshaping the science/policy interface



Gavin Schmidt

NASA Goddard Institute for Space Studies and
Center for Climate Systems Research, Columbia University

(Couples therapy for the uneasy marriage between science and policy)

Scientists ARE FROM MARS,

Policymakers Are from Venus

The Fundamental Issues

We speak the same language but.... we frame things very differently:

- Scientists tend to focus on individual processes, abundance and concentrations
- Policymakers focus on actions, emissions

Scientists are often single issue

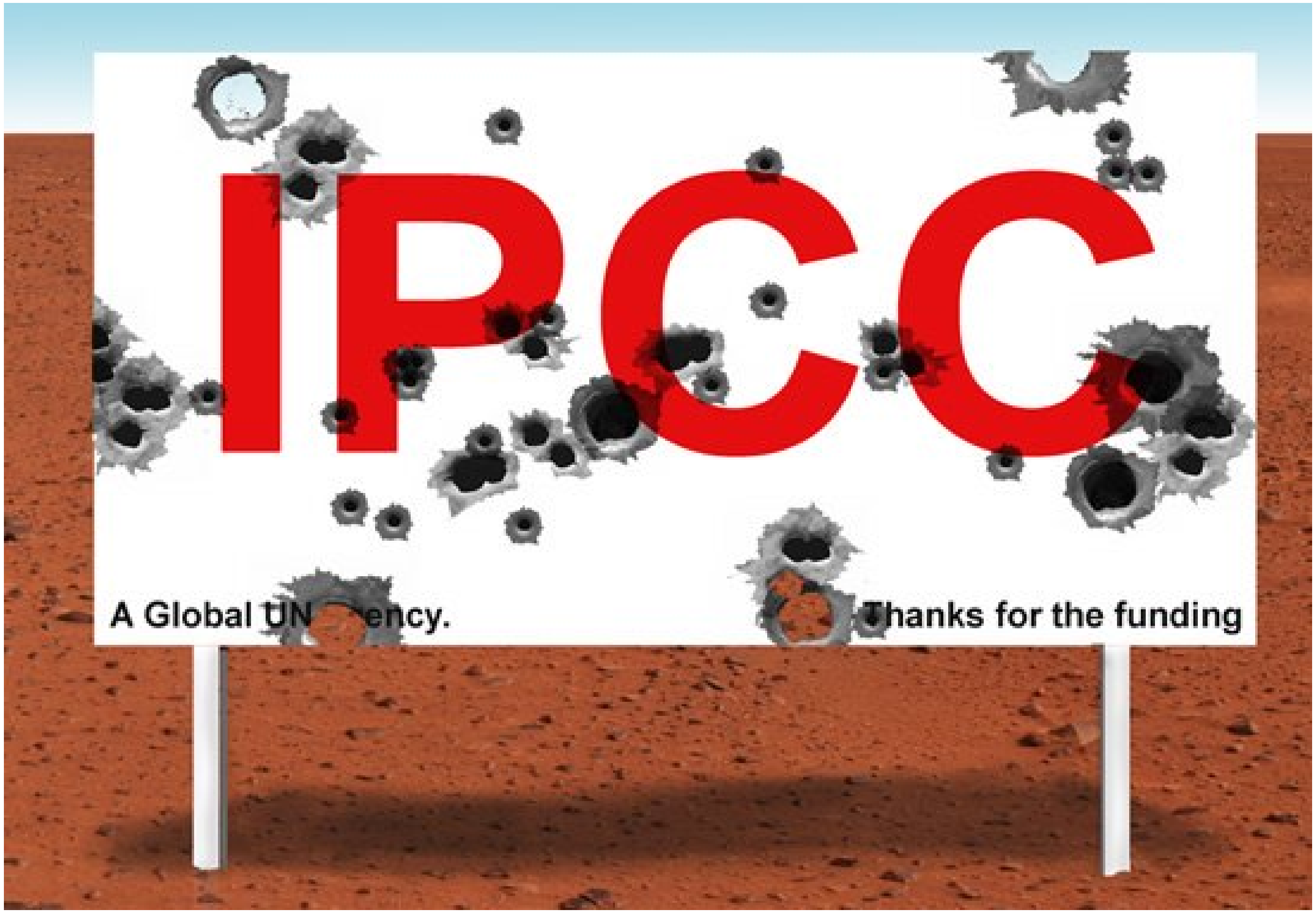
Policymakers are multi-tasking

- i.e. air quality *and* climate *and* biodiversity *and* agriculture *and*...

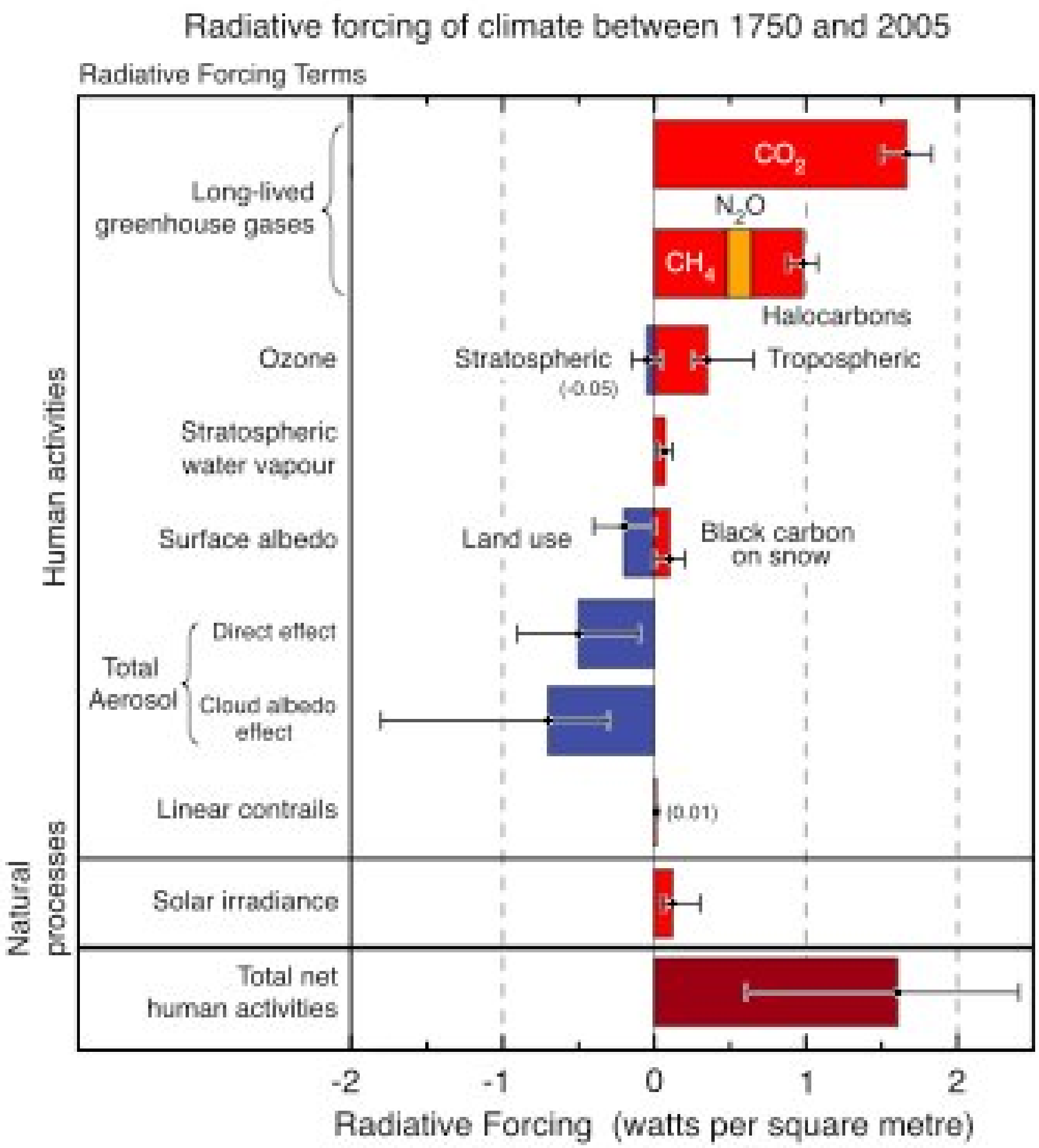
Isn't the IPCC supposed to deal with this?

But IPCC (esp. WG1) is mostly...

Assessment of the science, by the scientists, for the scientists


IPCC
A Global UN ency.
Thanks for the funding

Climate forcings 1750-2000 (Scientists' viewpoint)



IPCC AR4 (2007)

(mostly same as TAR except for a 90º clockwise rotation)

But different forcings are linked!

Each industrial or agricultural activity has a different emission profile

Different emissions affect secondary forcings (ozone, sulphates) through atmospheric chemistry

Net climate forcing or air quality impacts may be very different

Models: What are they good for?

Impacts of policy choices

Single-factors to single-causes

- i.e from CO_2/CH_4 to impacts of power/transportation

Air quality *and* climate forcings

- Requires comprehensive Earth System model
- incl. aerosols, atmospheric chemistry

Need for adaptation

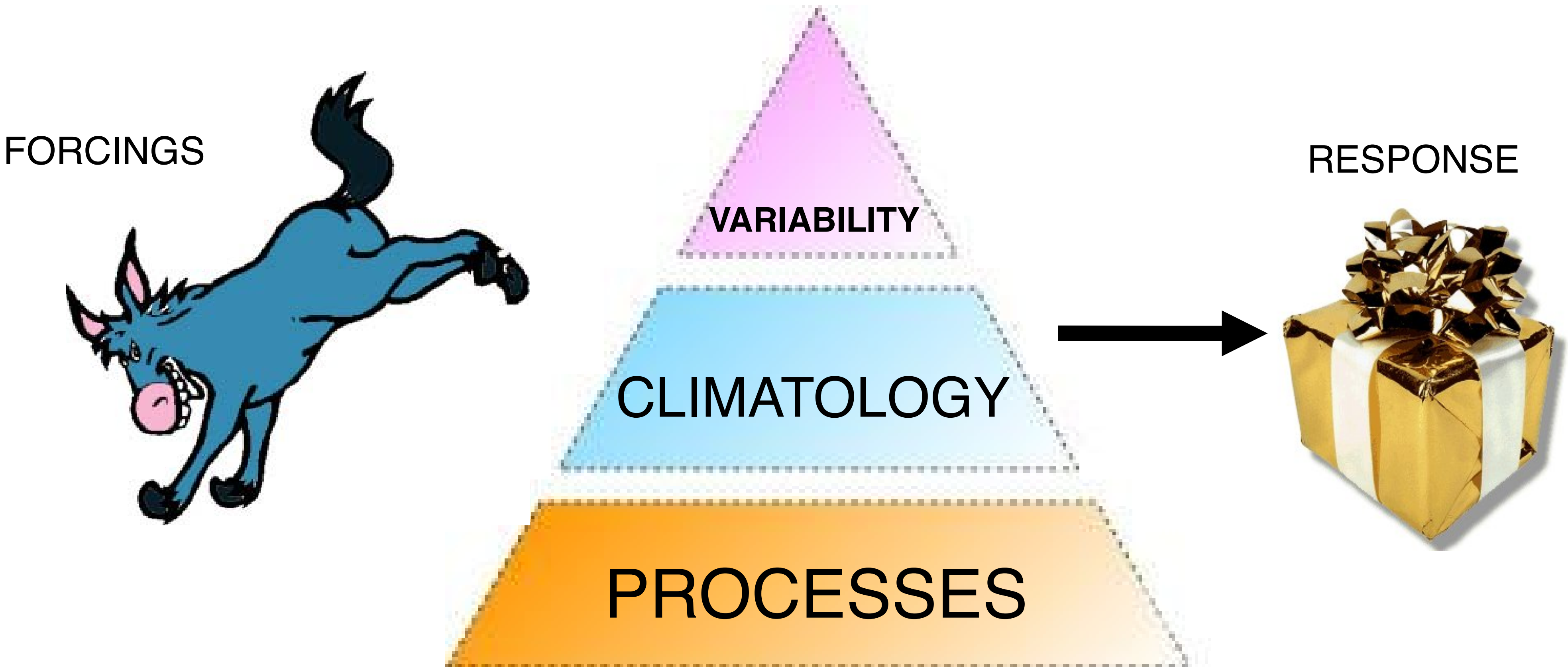
- In conjunction with assessment of local vulnerabilities

Potential impact of "known unknowns"

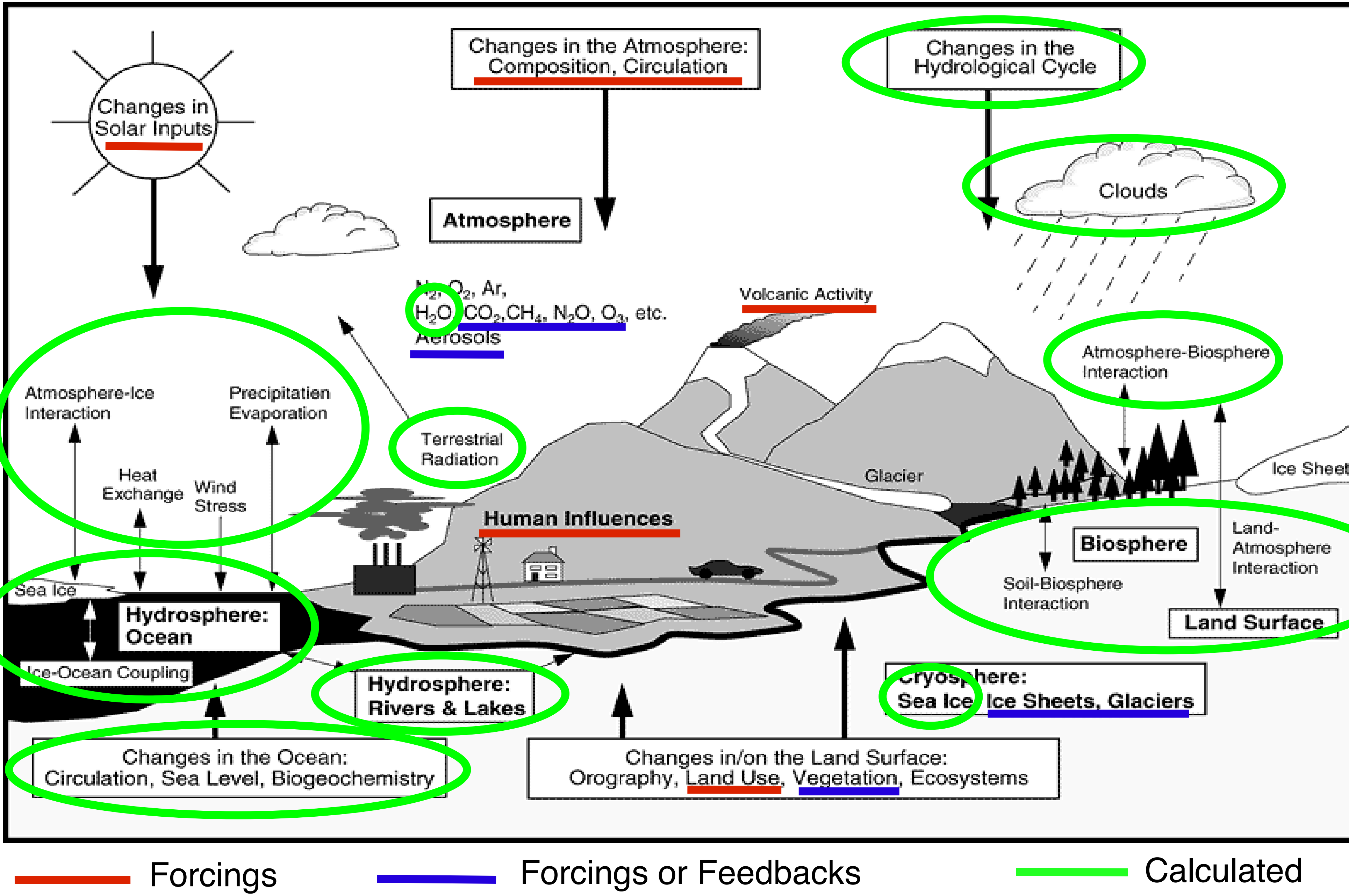
What aren't they good for?

- Perfect short- or long-term predictions
  - Some uncertainty is irreducible – economic inputs, model imperfections, chaotic nature of internal variability
- Solving political issues
  - Cost/benefits and political calculations are not included in any subroutine
- Truly local information
  - Sub-100km information from models is not likely to be reliable any time soon
- Recognizing “unknown unknowns”
  - c.f. polar ozone hole....

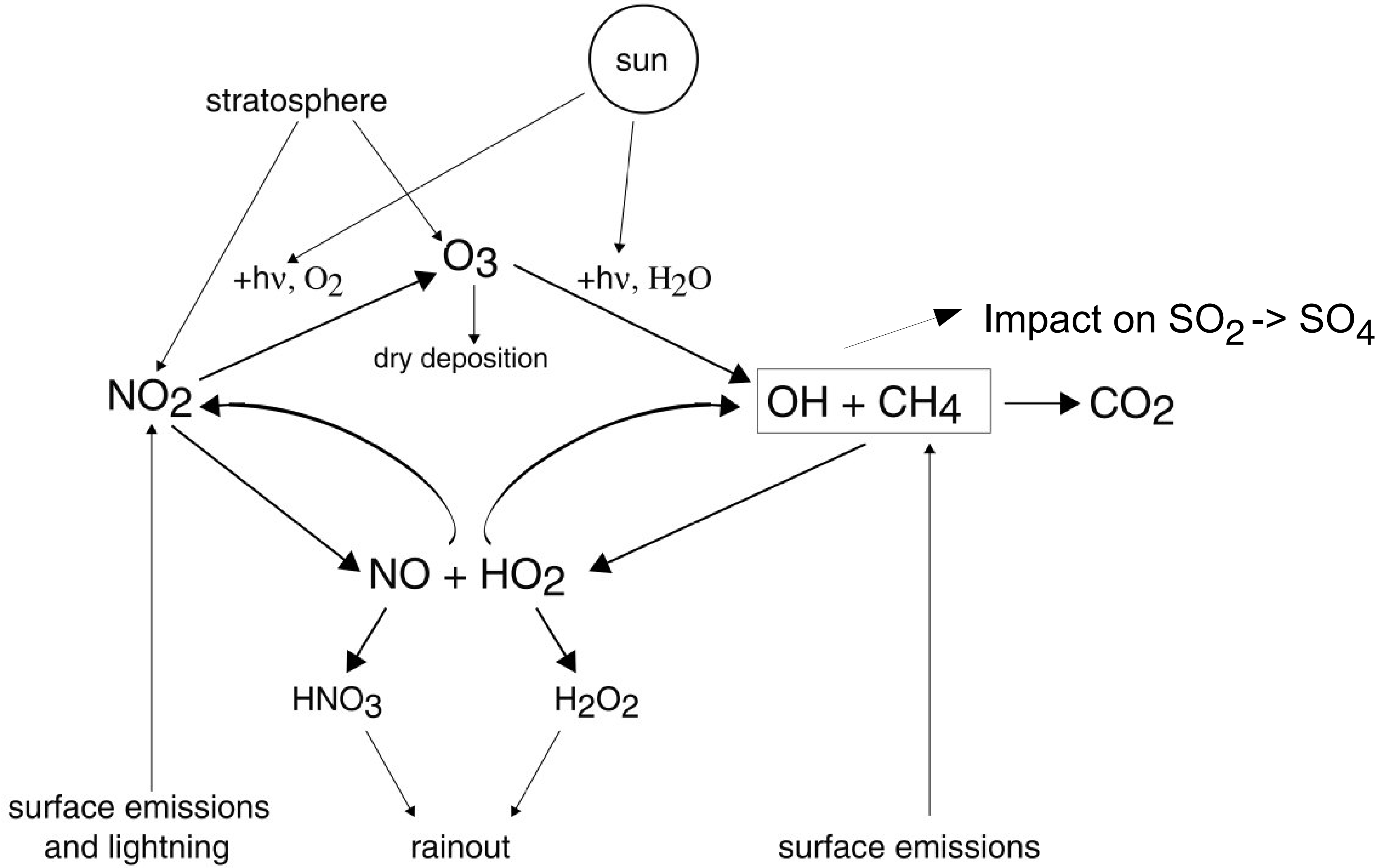
The Climate Pyramid



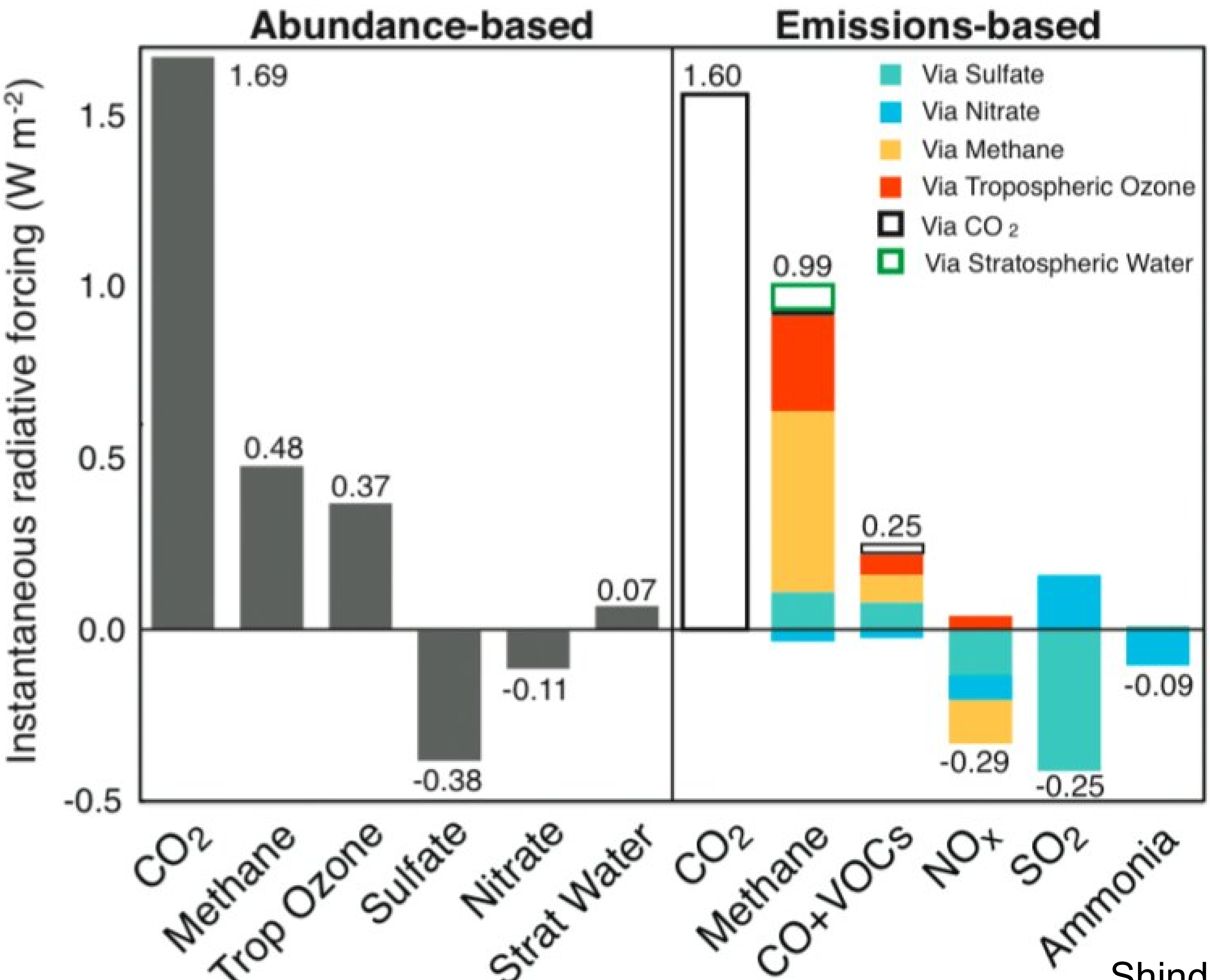
Climate processes



Some key atmospheric interactions

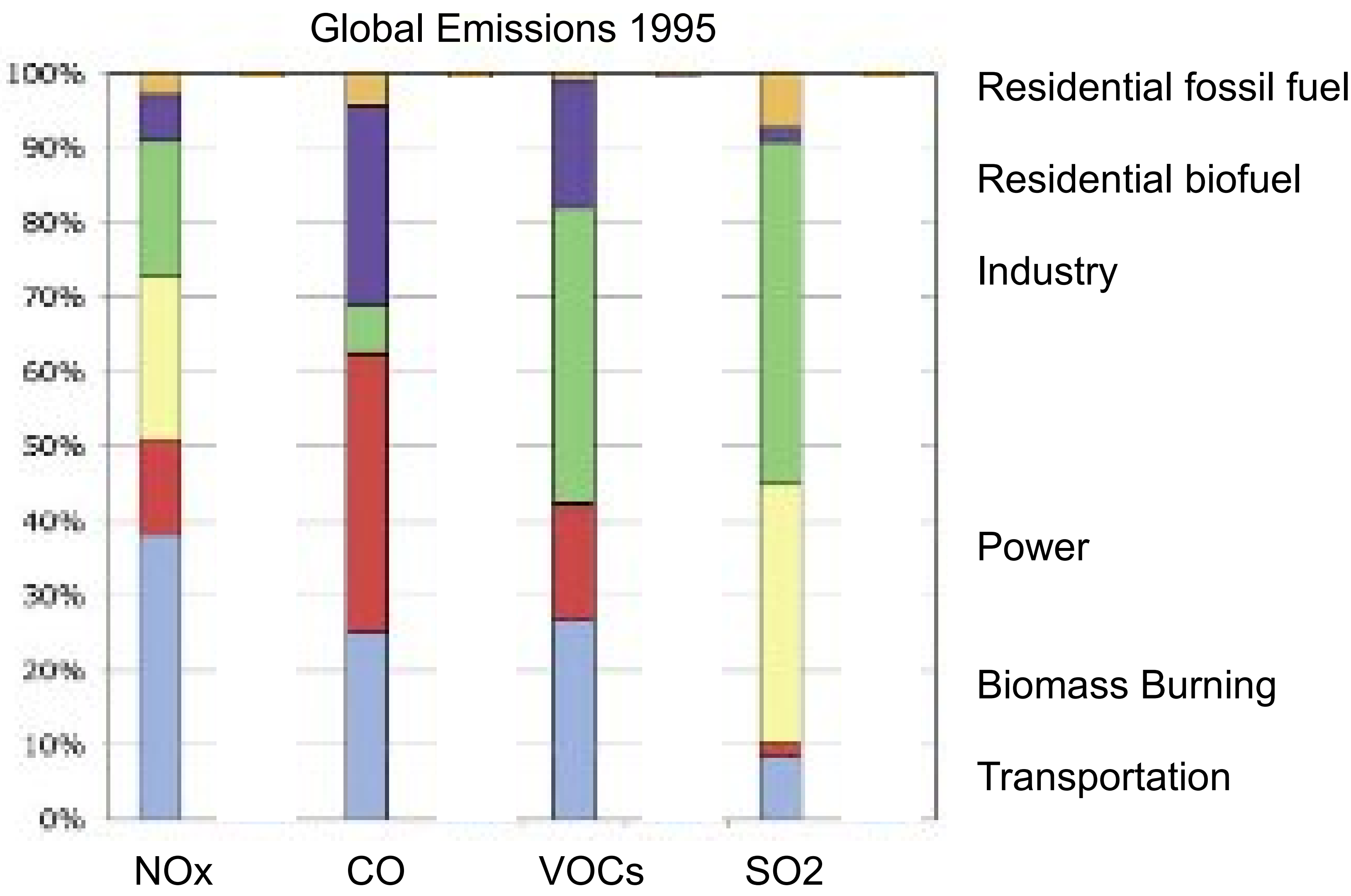


Climate forcings 1750-2000 (Emissions viewpoint)



Shindell et al (Science, 2009)

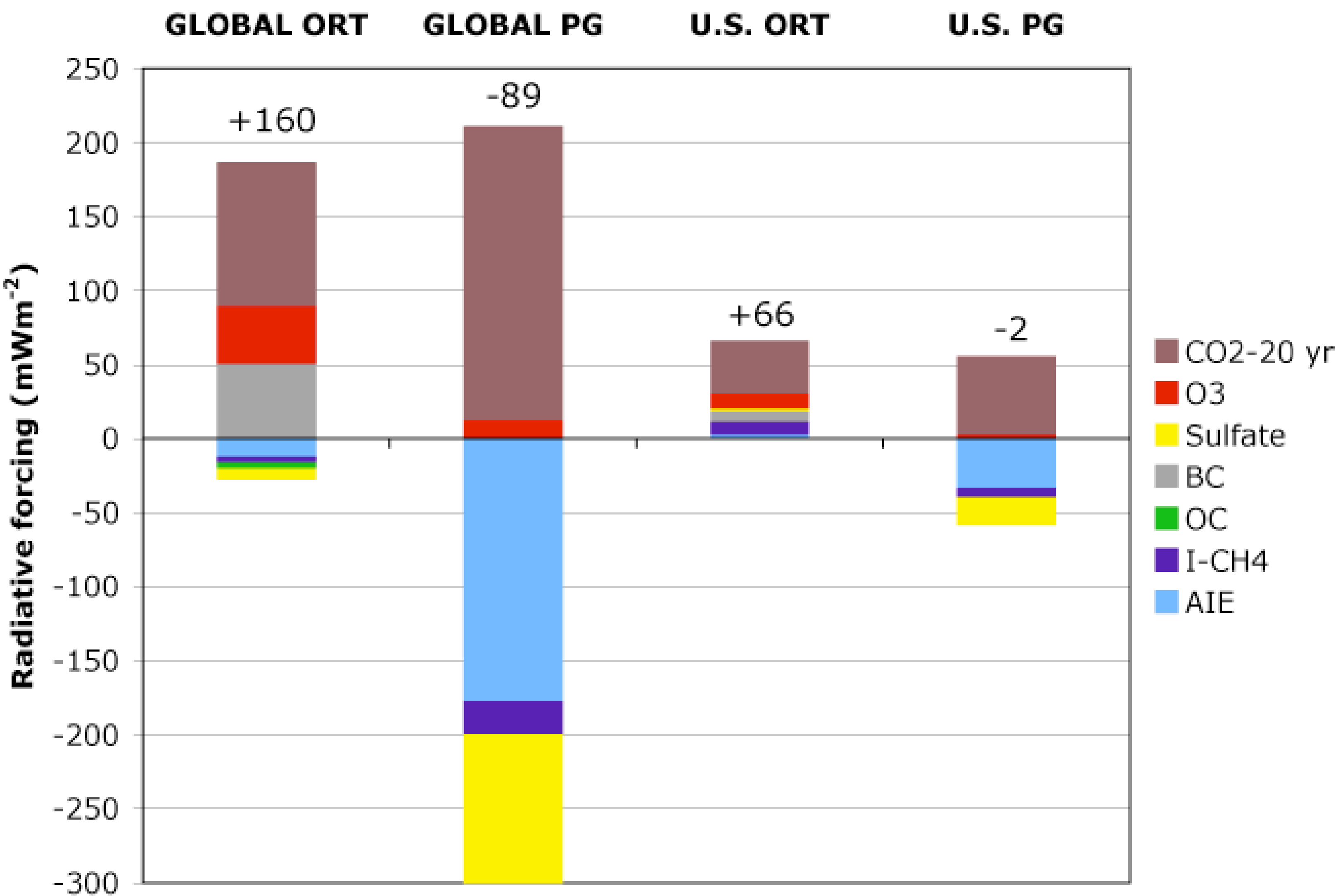
Where do emissions come from?



Focus on transportation sector

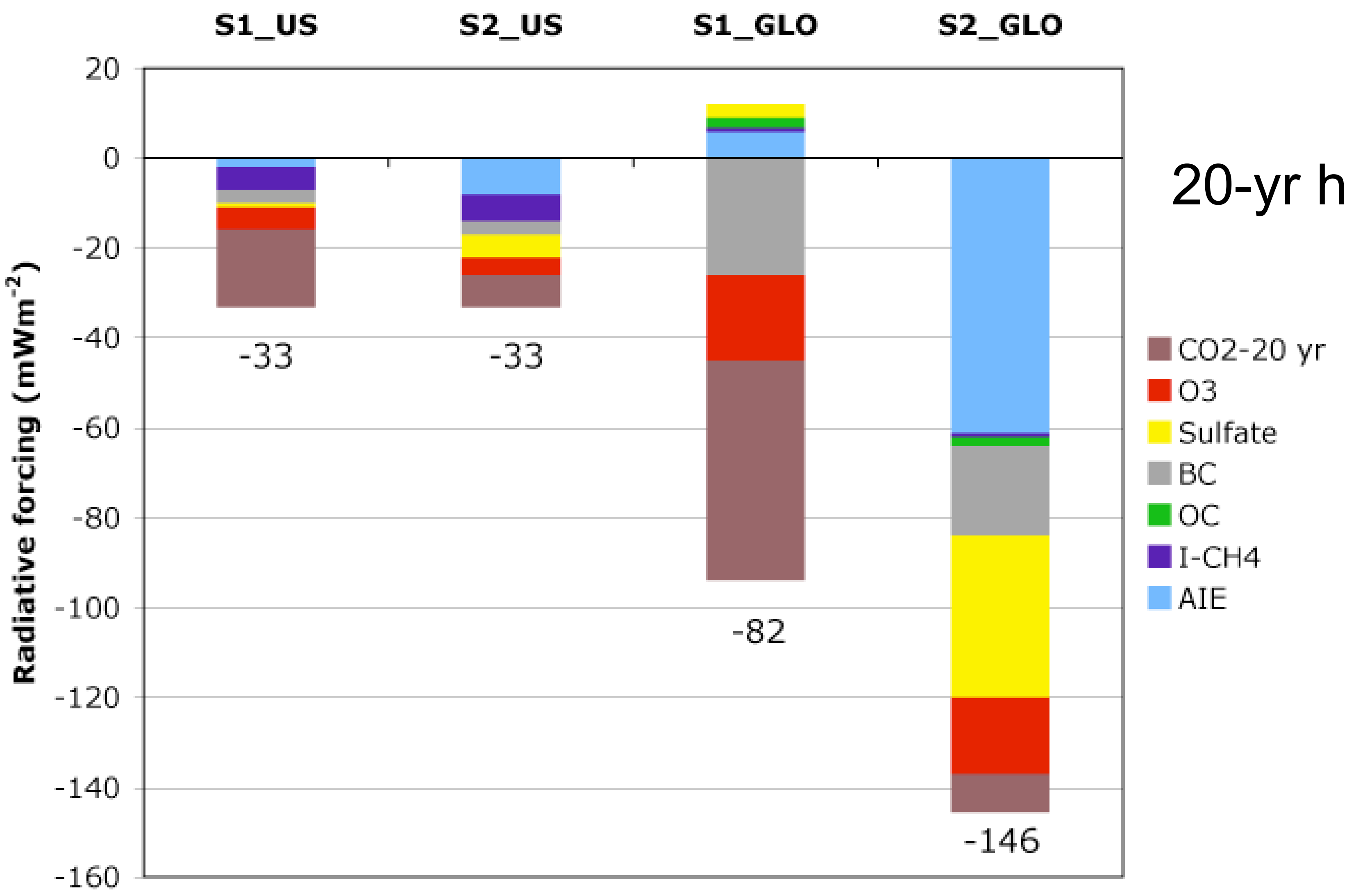
- Surface On-road Transport (ORT)
  - Cars, trucks, trains
  - CO_2, NO_x, BC etc.
  - Ground level, domestically controlled
- Aviation
  - CO_2, NO_x, SO_2, Contrails, water vapour
  - Upper troposphere, international
- Shipping
  - CO_2, Bunker fuel high in SO_2
  - very visible indirect effects (ship tracks)
  - Oceanic, surface, international

Climate Impacts: On Road Transport and Power Generation (20 yr horizon)



Unger et al (2009, Atm. Env)

Future scenarios:
50% reduction ORT emissions



20-yr horizon

S1: (zero emission replacement source)
S2: (current power generation mix)

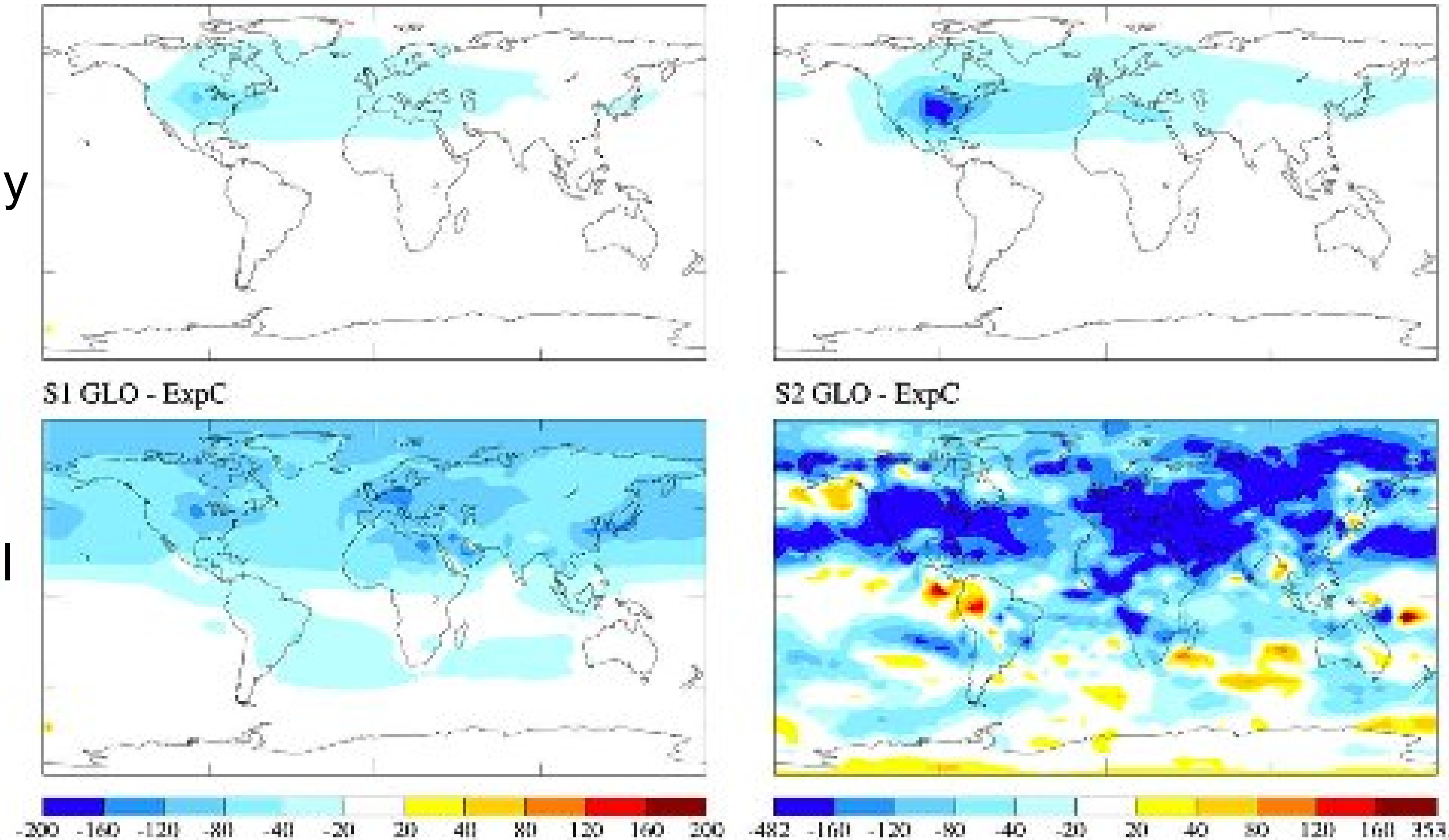
Unger et al (2009, Atm. Env)

Temperature impacts of scenarios

Zero-emission replacement | Current power sector profile

US only

Global



Temperature (mK) | Temperature (mK)

20-yr horizon

Unger et al (2009, Atm. Env)

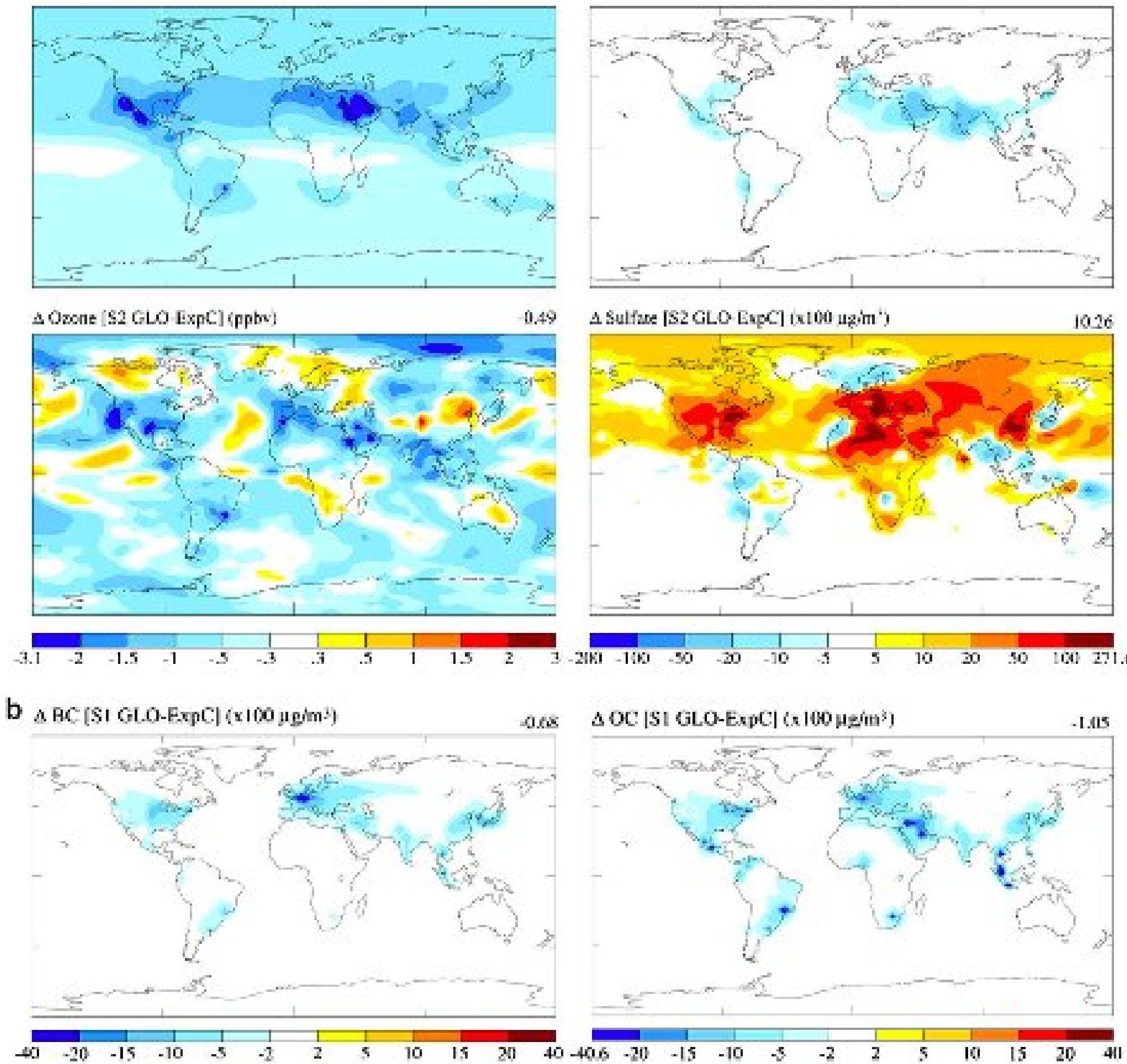
Pollutant impacts

Ozone | Sulphate

Zero-emission replacement

Current PG replacement

BC | OC



Unger et al (2009, Atm. Env)

Summary

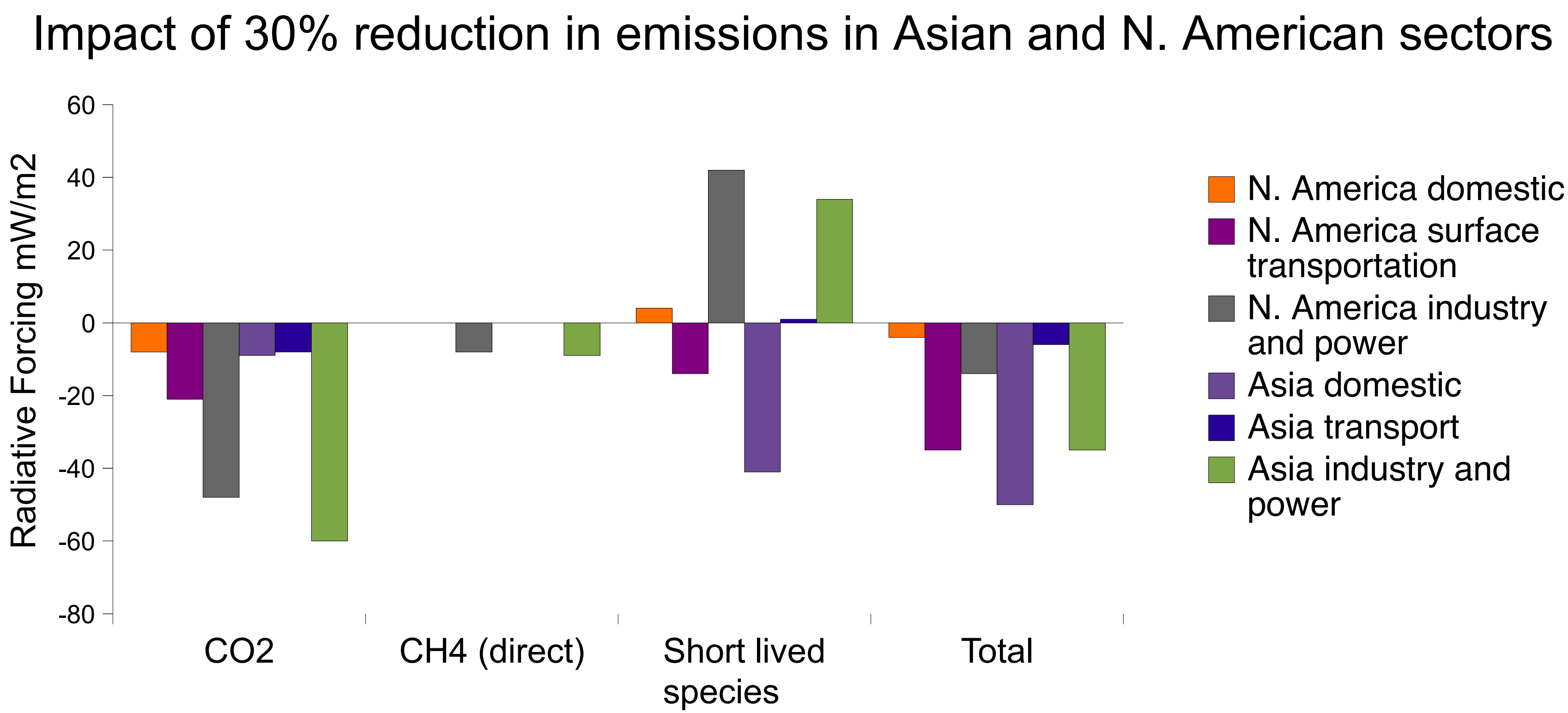
Reductions in emissions from surface transportation (US or Global) good for:

- Unambiguous reductions in climate forcing:
    - Regardless of replacement power source!
- Reductions in temperatures across NH
- Reductions in Ozone and PM (via BC) (less certain)

Impact on sulphates, acid rain, etc. dependent on replacement power source emissions profile

Many questions have robust answers even with complexities or uncertainties in details

Climate forcings by sector (Policy viewpoint)

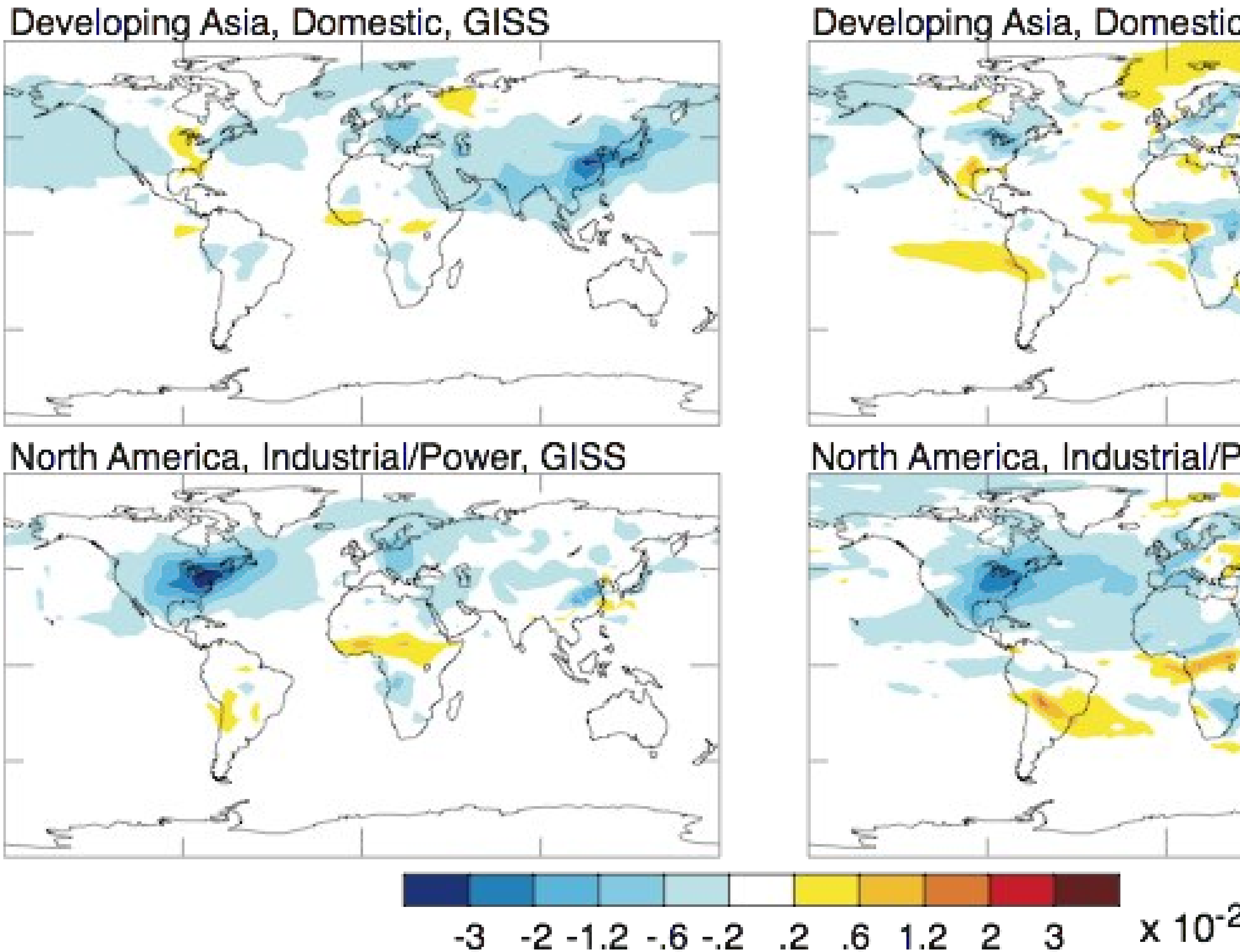


On 20-yr timescale, short-lived species (ozone, black carbon, sulphates) change *relative* importance of sectors

N. Amer. transportation/Asian domestic better targets for reducing climate *and* air pollution effects

Shindell et al (2008)

Regional impacts of sector-specific reductions



Can we identify win-win scenarios?

Yes!

1) Domestic use of coal and biomass in Asia

CO_2, CO, SO_2, soot => ozone, smog, health issues

Electrification (even using modern coal plants)

reduced CO_2, reduced air pollution, reduced climate forcing, better health outcomes

2) Surface transportation in US/Europe

CO_2, soot from diesel, NO_x => ozone

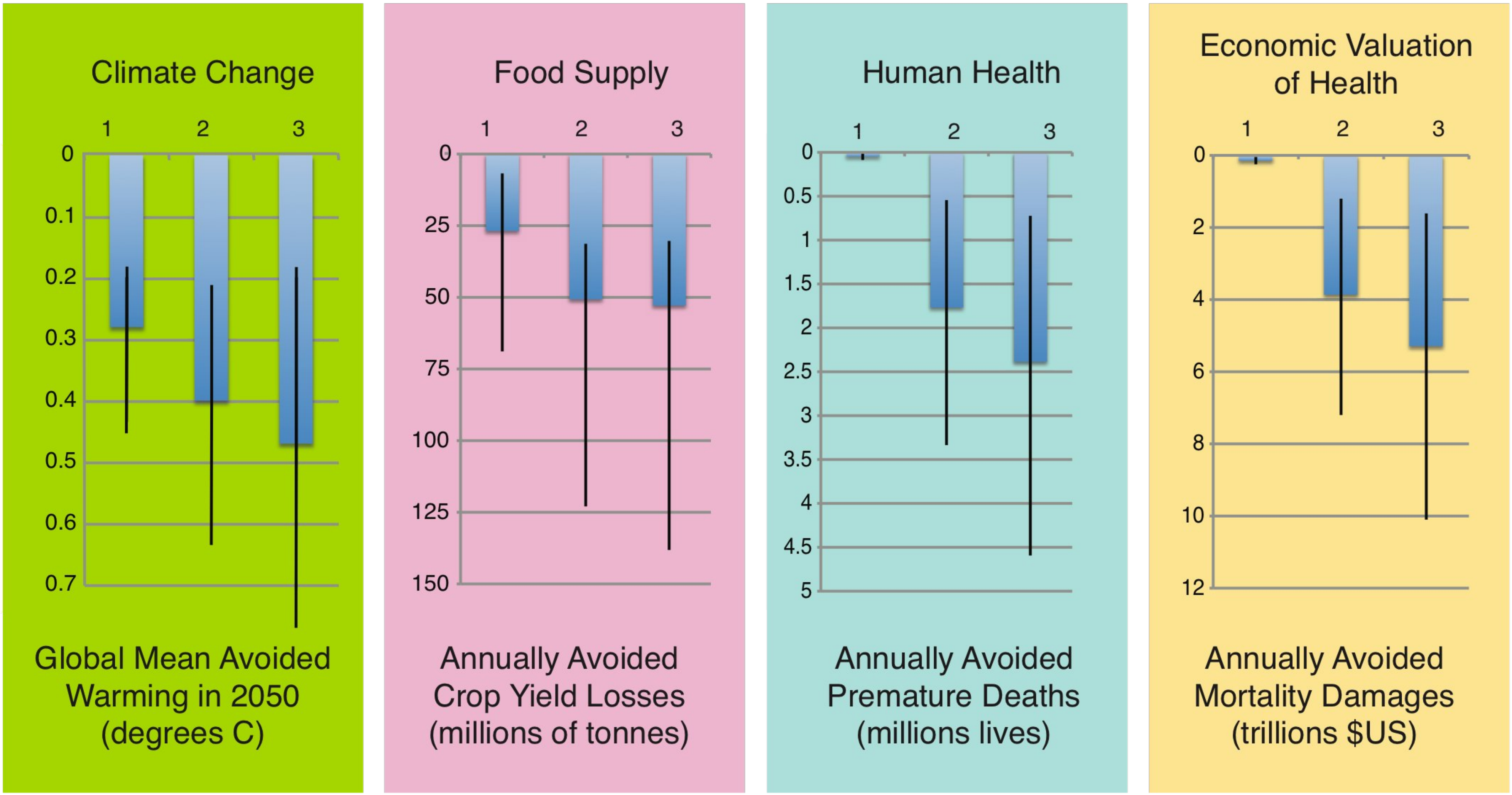
Move to less driving/plug-in hybrids

reduce CO_2, reduced air pollution

UNEP Assessment on BC/ozone

Global Impacts of Additional Emissions Controls on Methane and Products of Incomplete Combustion

1: CH_4 measures, 2: CH_4+BC Group 1 measures, 3: CH_4+ all BC measures



Climate given at 2050, air quality benefits for 2030 and beyond

So how can we proceed?

All sides need to listen as well as talk

What questions are stakeholders and policy-makers actually asking? What can be answered by scientists?

We can't avoid complexity

Need to embrace it

Climate is on top of other problems, not separate

Need holistic assessment of vulnerabilities/actions

Policy-specific science can stay policy-neutral

Science can determine whether policies are likely to effective, not whether they should be enacted.

Conclusions

Earth System Models can provide key input to policy choices:

- Sector/policy specific simulations
- *Coherent* response for air quality/climate/...
- Can build wider coalitions for specific actions

More work needed on appropriate diagnostics, quantifying uncertainties, more accessible/flexible analysis

Outside of current IPCC framework – but perhaps part of new 'Climate Services'?

IPCC can help assessing model credibility:

- Comparisons to historical/paleo-climate change

But basically...

Scientists

Stakeholders

We need to talk….