Update of the EMF-22 Black Carbon Subgroup

Benjamin DeAngelo
presented by Steven Rose
U.S. EPA

EMF-22 Meeting, Tsukaba, Japan
13 December 2006

Current Participants

- Facilitator
  - Benjamin DeAngelo, US EPA
- Inventory development, bottom-up projections
  - Tami Bond, Univ of Illinois
- Climate-economic, integrated assessment modelers
  - Junichi Fujino, NIES w/ AIM
  - Atsushi Kurosawa, IAE w/ GRAPE
  - Shilpa Rao & Keywan Riahi, IIASA w/ MESSAGE
  - Steve Smith, PNNL w/ MiniCAM
- Climate, atmospheric modelers
  - Dorothy Koch, Columbia Univ/NASA GISS, w/ GISS GCM
  - Surabi Menon, LBNL w/ GISS GCM
  - Michael Schlesinger, Univ of Illinois w/ SCM
  - Michael Schultz, LSCE w/ AEROCOM

Does Black Carbon belong in climate mitigation strategies? *Remains a central question*

Are the climate effects of BC "large enough" to warrant consideration for climate mitigation strategies?

NO → **Traditional air quality policy mechanisms**

YES ↓

Do air quality policies already adequately address BC & OC emissions?

YES → **Traditional air quality policy mechanisms**

NO ↓

Would climate change objectives and strategies bring about greater BC & OC reductions than air quality strategies?

NO → **Traditional air quality policy mechanisms**

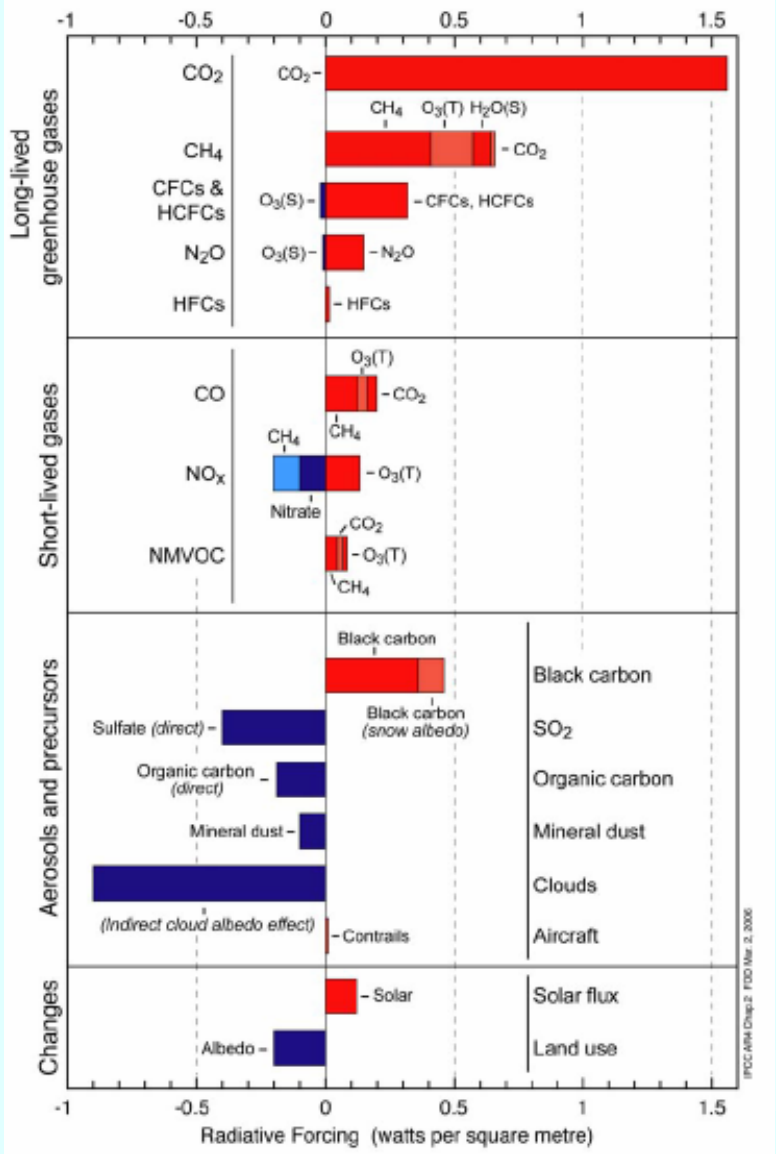
YES ↓

Climate change mitigation arena → **Allow tradeoffs with GHGs?**

YES → **Metrics that allow CO2 'equivalence'**

NO → **NO metric necessary**

Black carbon & organic carbon present-day forcing estimates in draft IPCC AR4



Fossil fuel BC direct effect	+0.2 +/- 0.1
Snow & ice BC albedo effect	+0.1 +/- 0.3
Fossil fuel OC direct effect	-0.1 +/- 0.1
Biomass burning net direct effect (combines BC, OC, sulphates, nitrates)	0.0 +/- 0.1
Total net aerosol direct effect	-0.5 +/- 0.4
Total indirect cloud albedo effect	-0.9 +/- 0.5

Values are W/m2 in 2004 for emissions and changes since 1750.

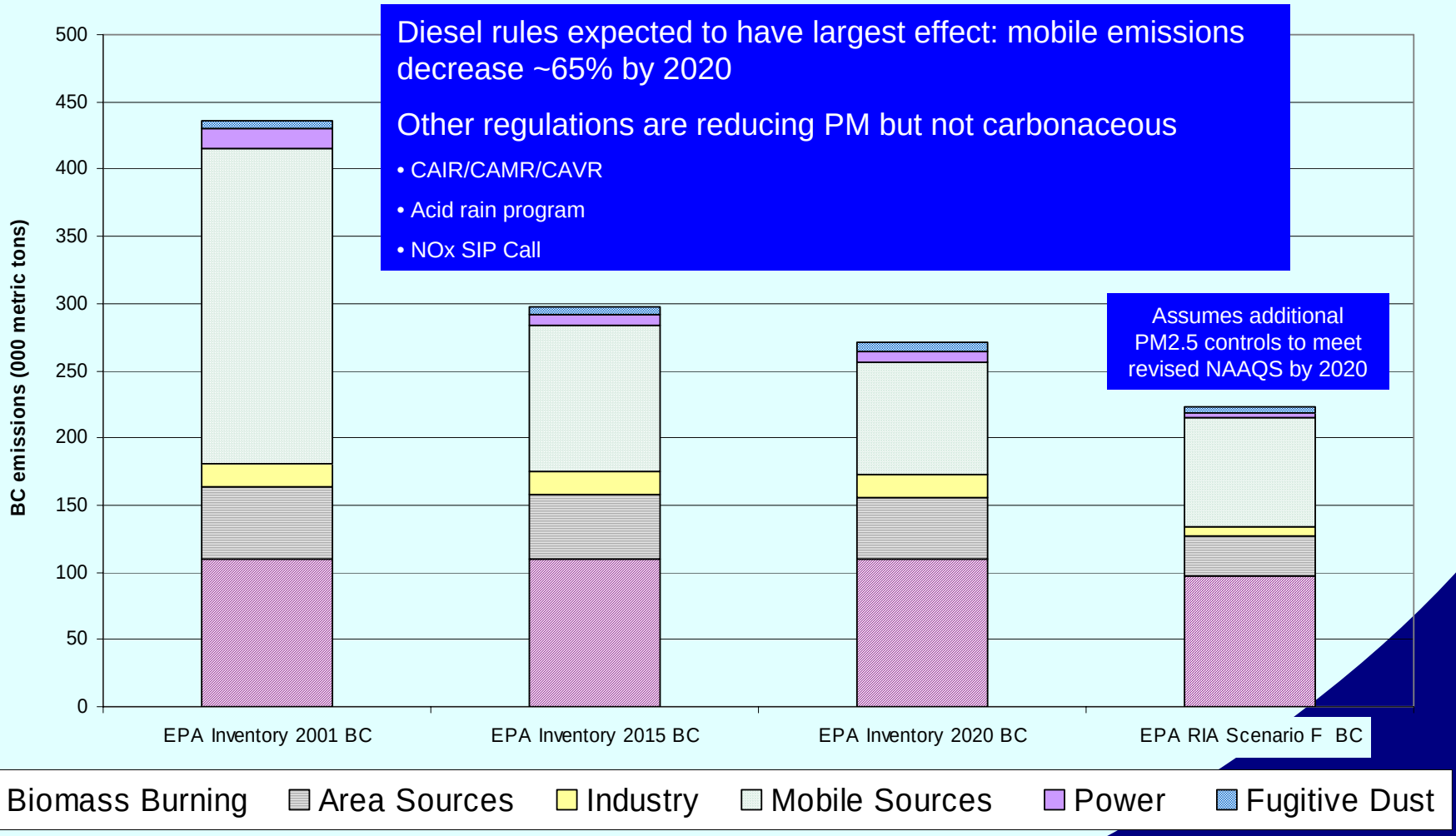
BC & OC information reflected in draft AR4 related to EMF Subgroup

- WG1
  - For present-day forcing, AeroCom ensemble modeling where Bond et al. (2004) global BC & OC inventory used
  - For climate projections, continued reliance on SRES where BC was scaled with CO, i.e., new projections from EMF participants not yet incorporated
- WG3
  - Bond et al. (2004) global BC & OC inventory
  - Streets et al. (2004) bottom-up BC & OC projections
  - Rao et al. (2005) projections and mitigation scenarios with MESSAGE
  - Smith et al. (2006) projections and mitigation scenarios with MiniCAM

What's new since subgroup last met in Washington?

- Updated U.S. emission projections to 2020 taking into account most recent air quality regulations
- U.S. BC mitigation cost estimates using U.S. $PM_{2.5}$ data
- Updated global projections and mitigation scenarios
  - IIASA MESSAGE
  - PNNL MiniCAM
- Relationship with AeroCom
  - international forum of atmospheric modelers running inter-model comparison forcing experiments

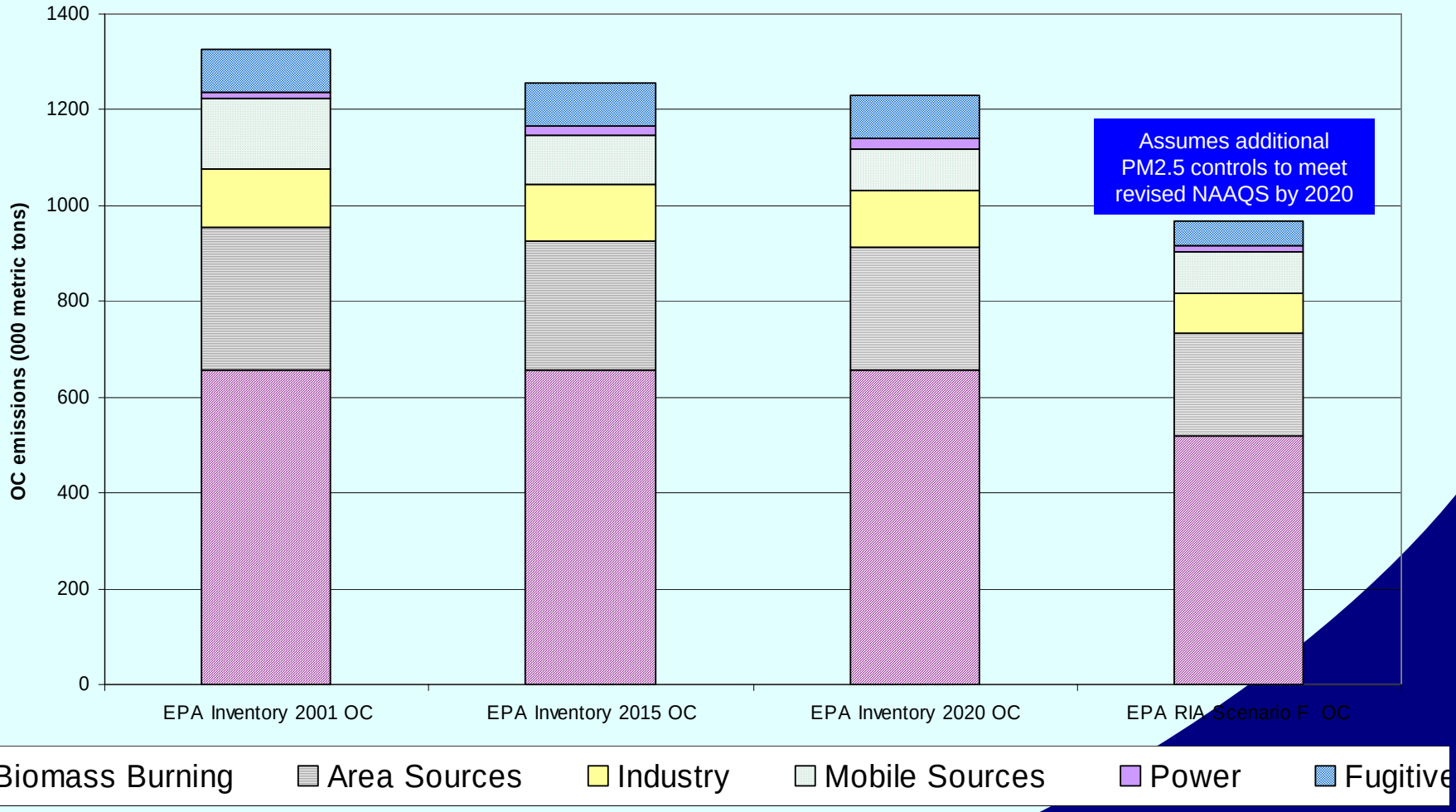
Projected U.S. BC emissions with full implementation of recent U.S. air quality policies: 2001, 2015, 2020



Based on EPA Regulatory Impact Analysis, http://www.epa.gov/ttn/ecas/ria.html

Speciation of PM2.5 into carbonaceous particles, http://www.epa.gov/ttn/chief/emch/speciation

Projected U.S. OC emissions with full implementation of recent U.S. air quality policies: 2001, 2015, 2020



Based on EPA Regulatory Impact Analysis, http://www.epa.gov/ttn/ecas/ria.html

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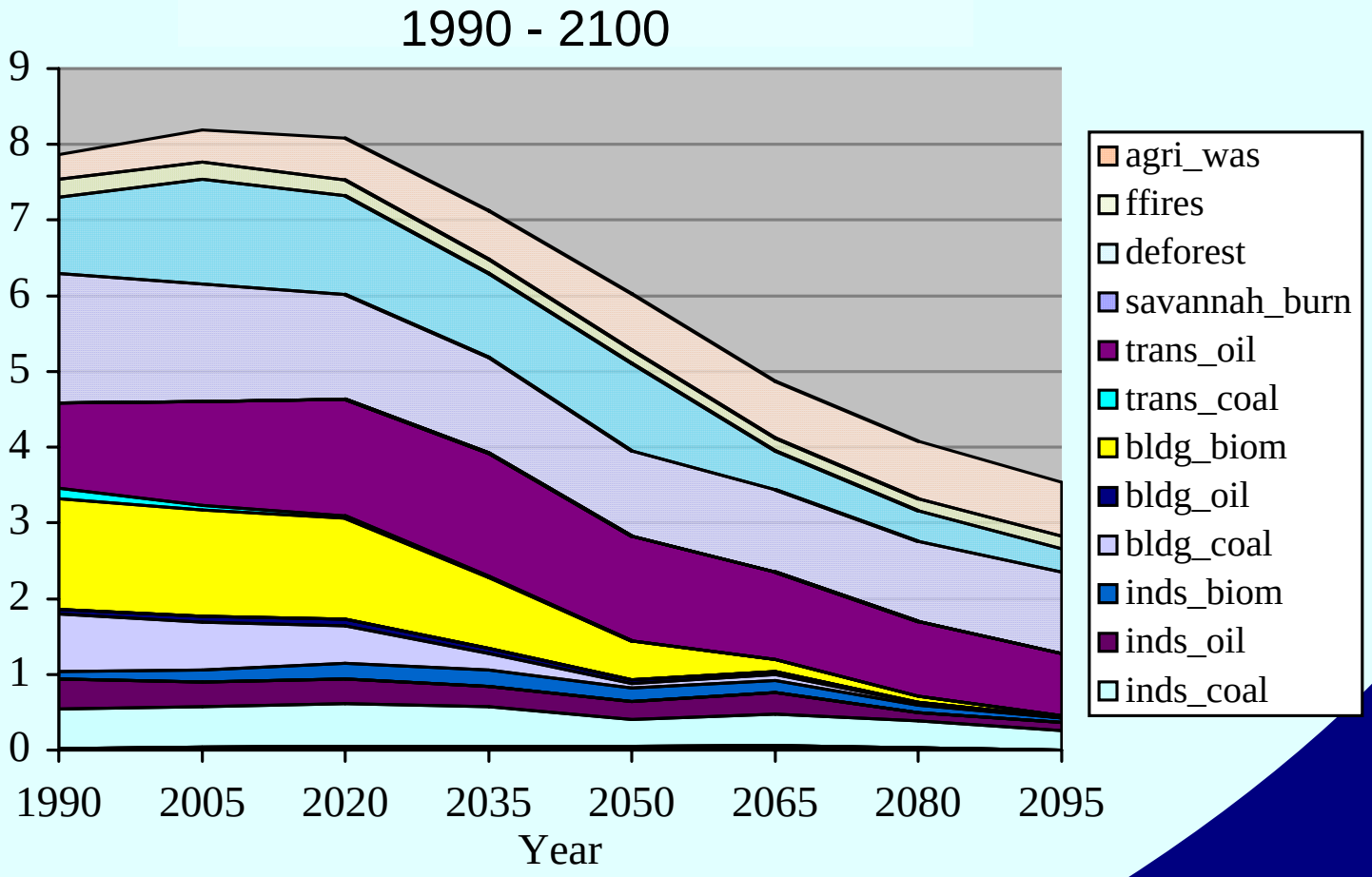
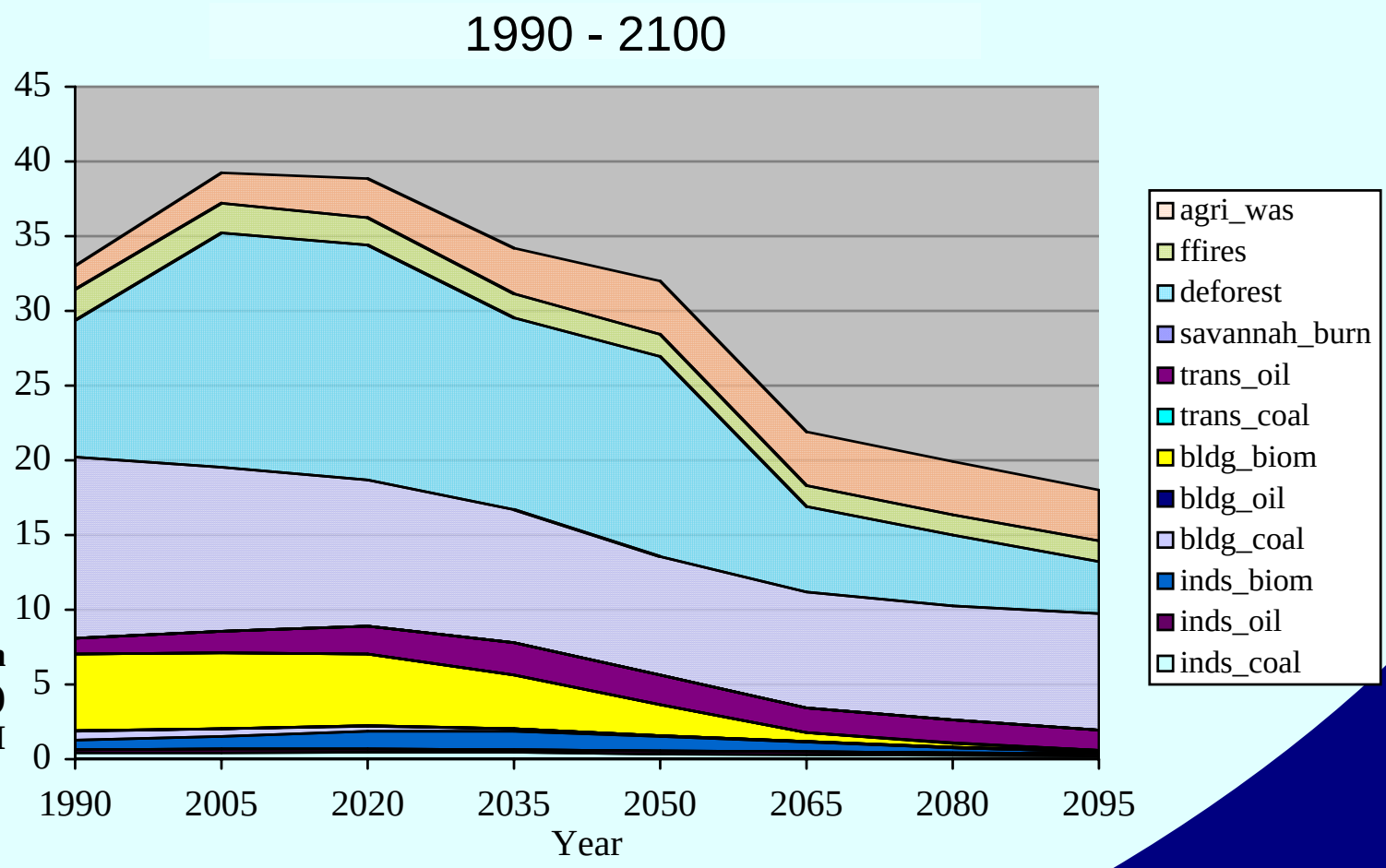
Global projections of Black Carbon emissions under B2 in MiniCAM



Source: Steven Smith (JGCRI) with MiniCAM

Land-use and transportation emissions dominate by the end of the century

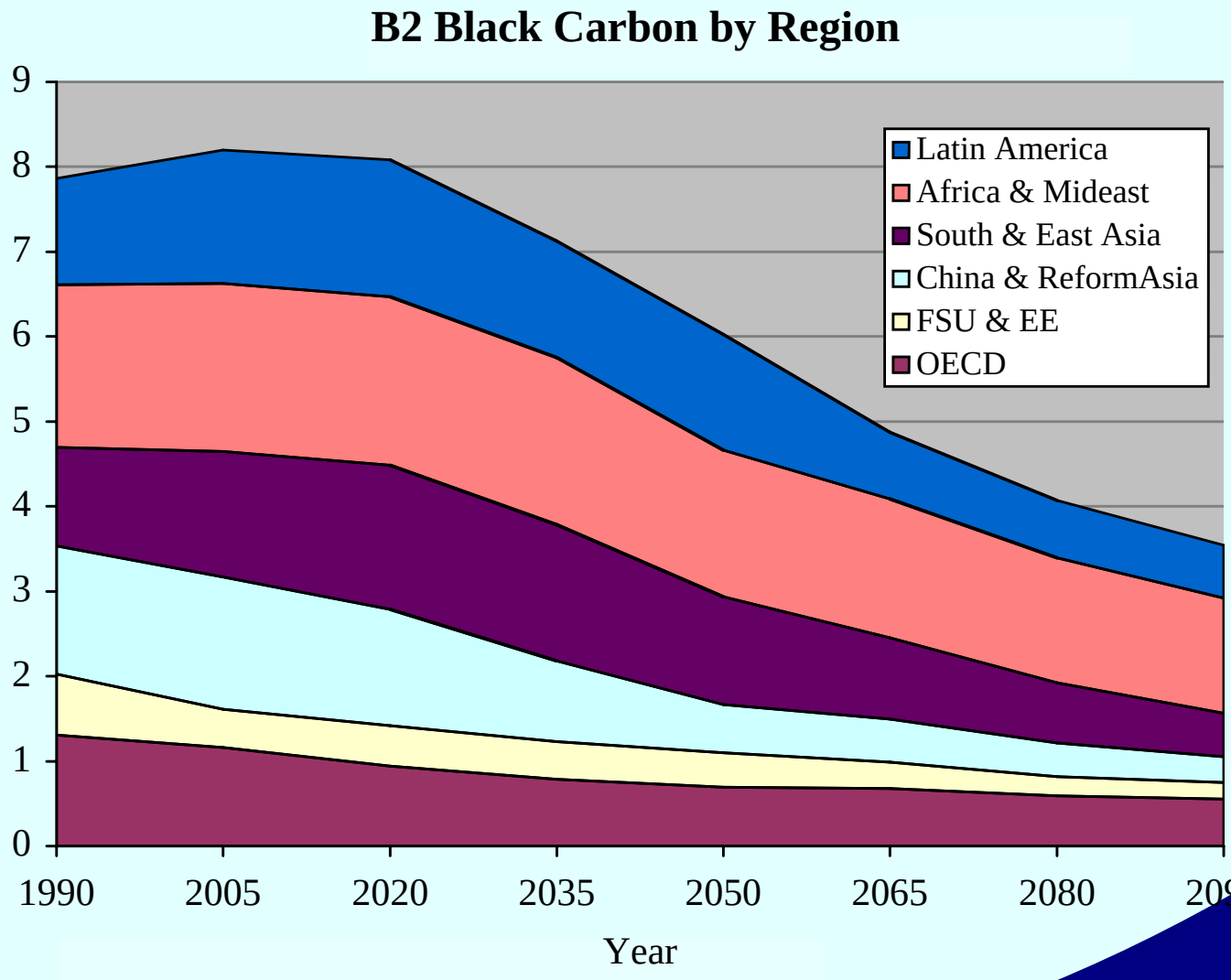
Global projections of Organic Carbon emissions under B2 in MiniCAM



Source: Steven Smith (JGCRI) with MiniCAM

Land-use emissions dominate at all times

Global projections of BC emissions by region under B2 in MiniCAM



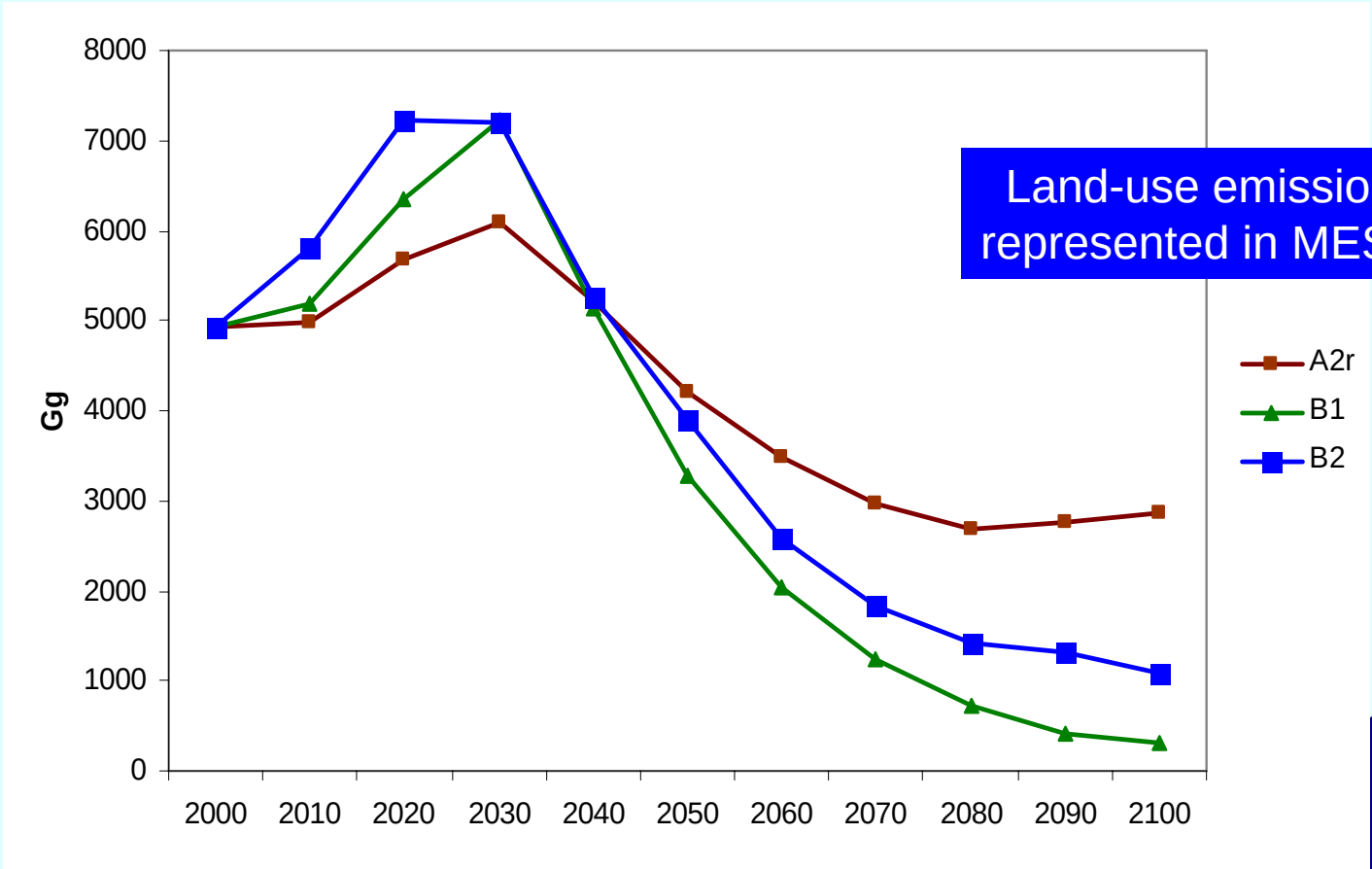
Emissions from Latin America and Africa dominate the end of the century

This assumes current land use patterns (savannah and ag-waste burning) continue!

Source: Steven Smith (JGCRI) with MiniCAM

Global projections of BC emissions under A2r, B1 & B2 in MESSAGE

2000 - 2100

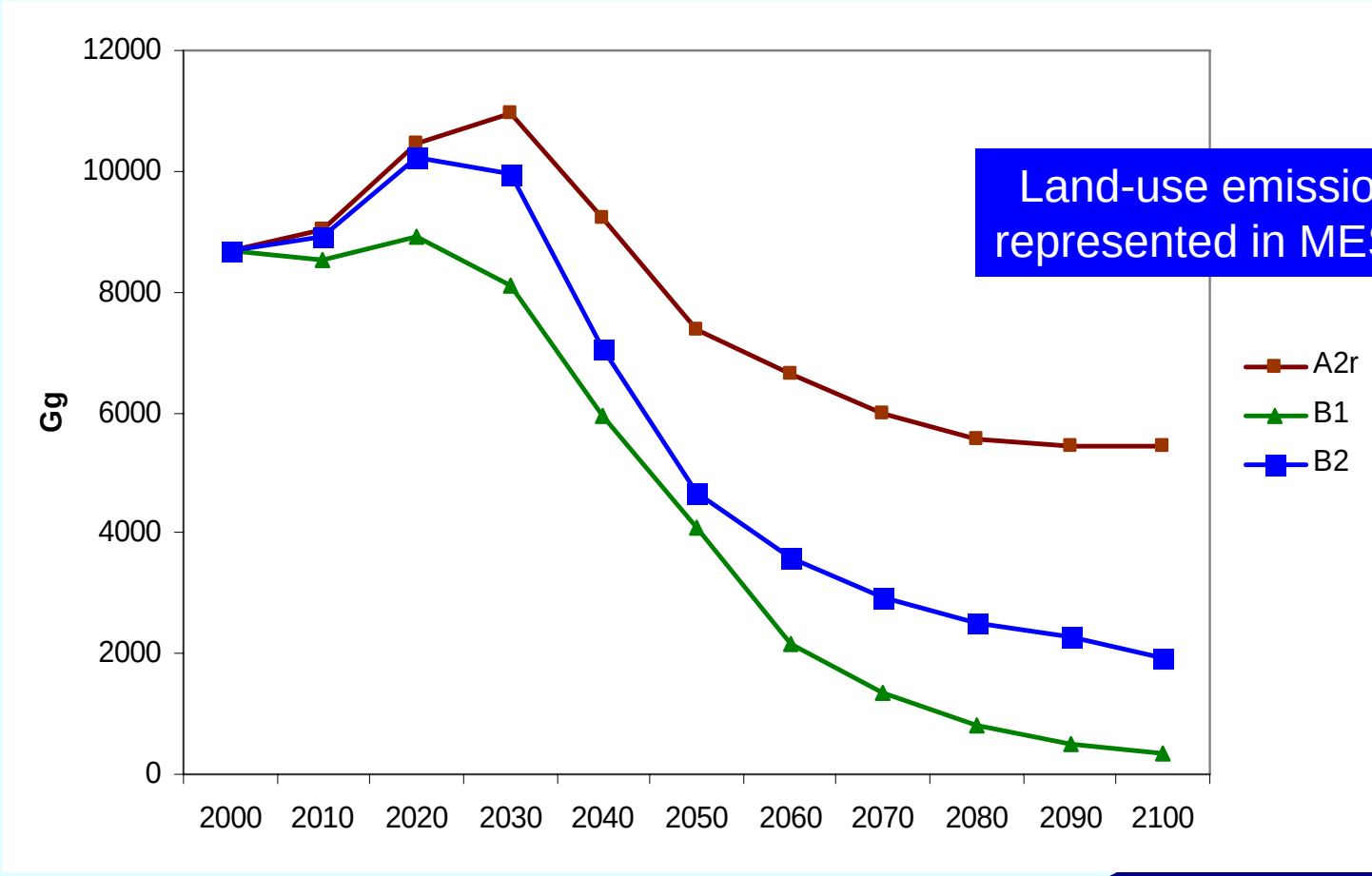


Land-use emissions not represented in MESSAGE

Source: Shilpa Rao, IIASA's MESSAGE model

Global projections of OC emissions under A2r, B1 & B2 in MESSAGE

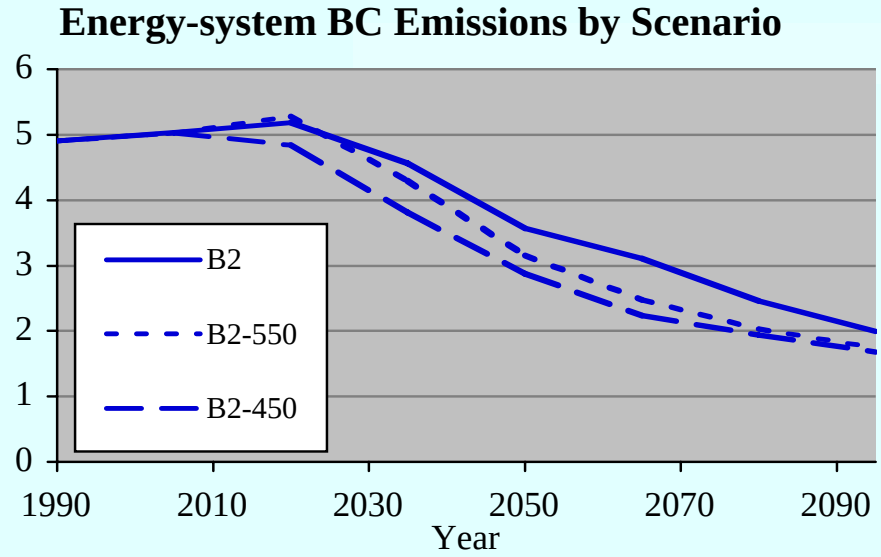
2000 - 2100



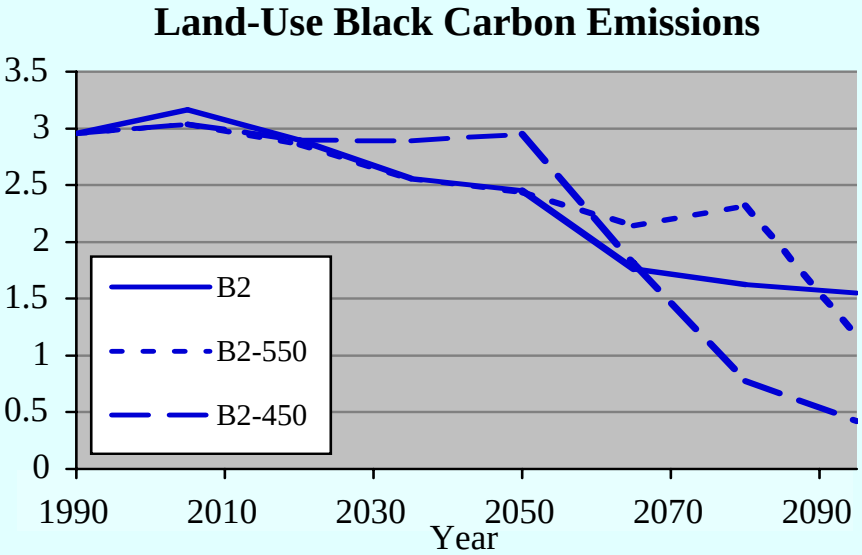
Land-use emissions not represented in MESSAGE

Source: Shilpa Rao, IIASA's MESSAGE model

What kind of synergies or tradeoffs exist between GHG mitigation and BC?



Energy-related BC emissions consistently decrease under CO_2 mitigation scenarios.

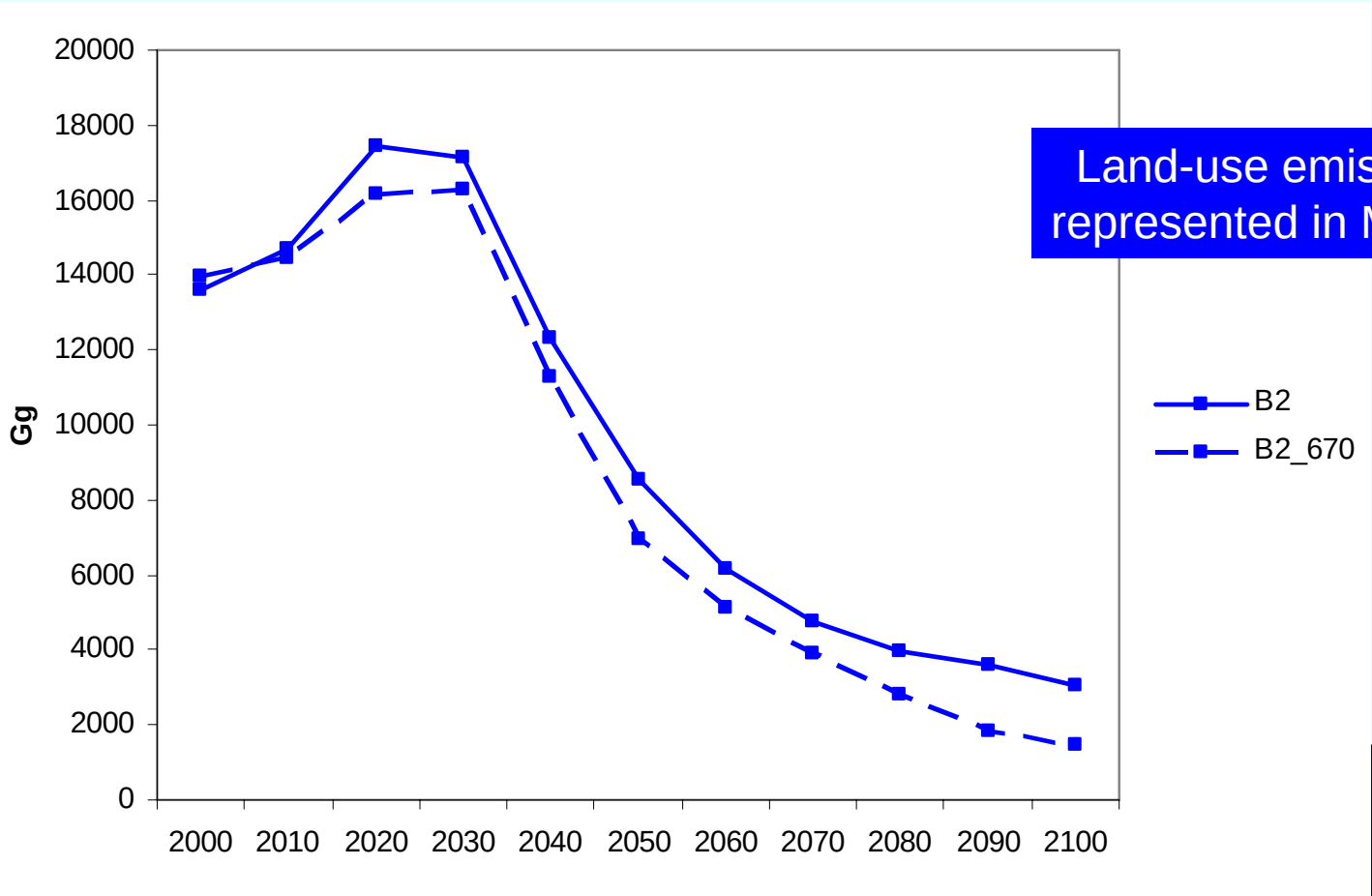


Land-use BC emissions can move in either direction under CO2 mitigation scenarios.

***Source*: Steven Smith (JGCRI) with MiniCAM**

What kind of synergies or tradeoffs exist between GHG mitigation and BC/OC?

BC and OC Emissions: B2 vs. B2 with 670 CO2 eq. Stabilization



Land-use emissions not represented in MESSAGE

Source: Shilpa Rao, IIASA's MESSAGE model

Statements on current knowledge

- To a large degree, BC is already being addressed by air quality policies in the U.S., and many industrialized countries, particularly from transportation, where BC dominates over OC
- Biomass burning remains a difficult source to control, but from a warming mitigation perspective may be less important, as OC is more dominant in terms of emissions and negative forcing
- Near-term trends in BC and OC in developing countries point towards increases, with expected reductions over long timeframes
- BC mitigation options can be readily identified and characterized due to work on PM
- Costs of BC mitigation options can be difficult to compare with GHG mitigation options without appropriate CO_2-equivalent metric
- Initial mitigation scenarios point to modest BC co-benefits when CO_2 from energy is targeted, but synergy in land-use sector is not clear
- BC & OC reductions should have clear health benefits, but role in climate change mitigation remains unclear

Next steps for EMF Black Carbon Subgroup and interaction with AeroCom

- Goal is to work towards a joint publication that:
  - Tells the story about BC and OC trends
    - By region
    - By sector
    - Over time
    - Role of air quality policies vs. other drivers
  - Compares different approaches for projecting future BC & OC which are very specific to fuel type, technology and combustion efficiency
  - Illustrates co-effects with GHG mitigation
  - Discusses importance of BC & OC forcing over time
    - AeroCom is interested in using 3-4 future EMF scenarios
    - AeroCom may also help inform direct & indirect forcing estimates for BC & OC by the simple climate models used in EMF
  - And finally makes some judgments about appropriate role for BC & OC in climate mitigation strategies

Thank you!

- For thoughts regarding participation in and publication(s) of the EMF Black Carbon Subgroup, please contact

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