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science for global insight

ECLIPSE emission scenarios;
Key characteristics

Klimont, Z.[1)], L. Hoglund, Heyes, Ch., Rafaj, P., Schoepp, W., Cofala, J., Borken-Kleefeld, J., Purohit, P., Kupiainen, K., Winiwarter, W., Amann., M , Zhao, B.[2)] , Wang, S.X.[2)], Bertok, I., Sander, R., G. Kiesewetter

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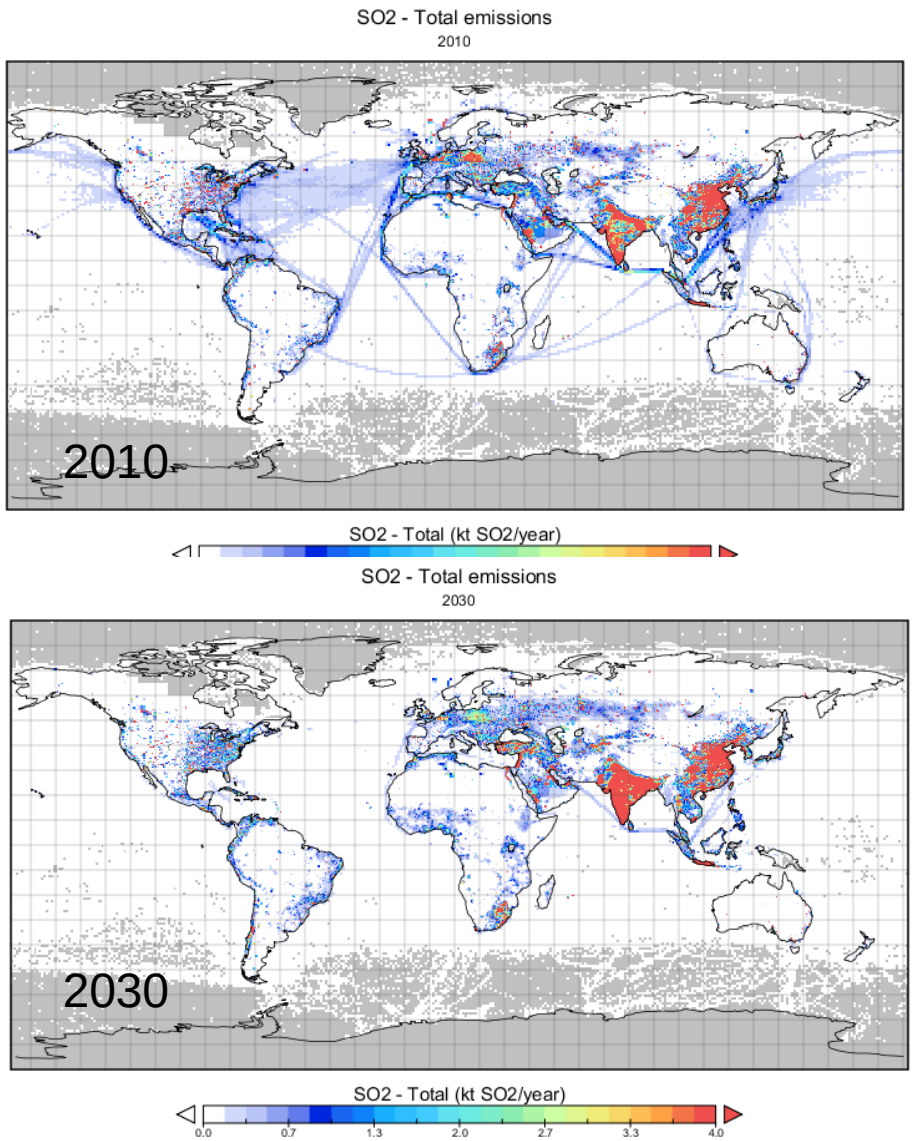
Task Force on Hemispheric Transport of Air Pollution, IIASA, Laxenburg, Austria, 11-13th February 2015

Key features

- Driven by HTAP objectives and the need to improve representation of aerosol emissions in the global long-term IAM (Integrated Assessment Models) scenarios
- Developed with IIASA's GAINS model
  The emissions of all species are estimated using the same primary activity data set within one common framework, which assures internal consistency (also with the CO2 calculation), including multi-pollutant character of several control technologies
- 165 regions, period 1990-2050
- Considered pollutants: SO_2, NO_x, PM (PM1, PM2.5, PM10, BC, OC, OM), NMVOC, CO, NH_3, CH_4
- Improved spatial (0.5^ox0.5^o) distribution – updated proxies
- Annual and monthly distribution of emissions
- A number of 'new' sources included:
  shale gas, gas flaring, wick lamps, diesel generators, superemitters
- Several scenarios:
  CLE, NFC, MTFR, Climate mitigation, SLCP mitigation

Gridded emissions: SO_2



- For China:
  MEIC spatial distribution for power stations 2000/2005/2010

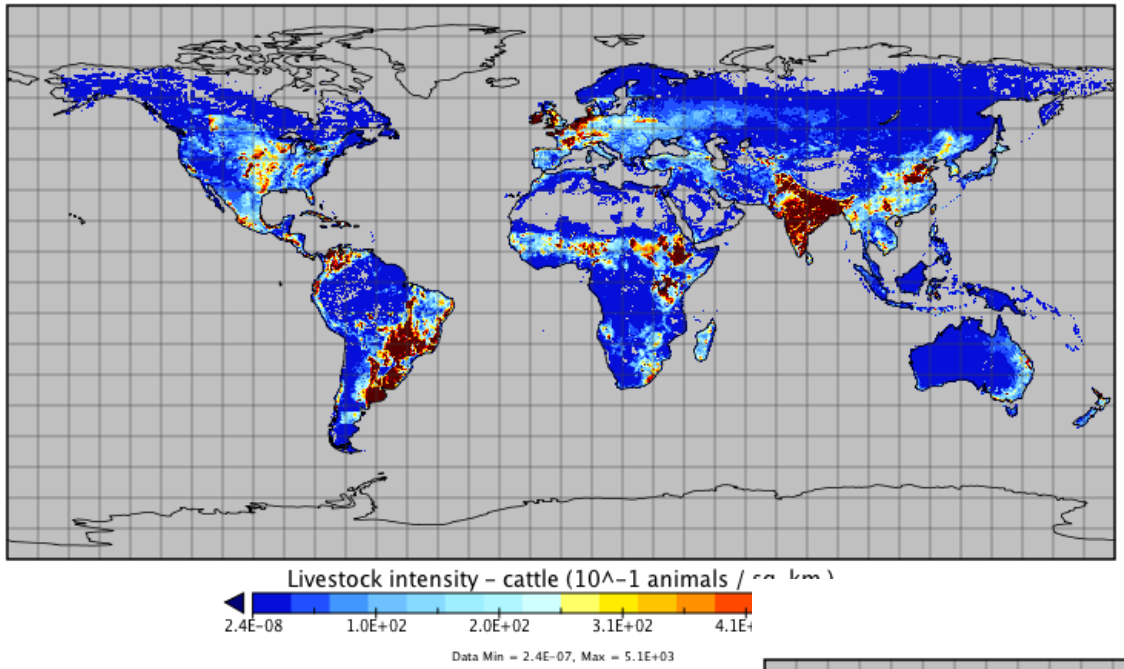
- For international shipping:
  IMO agreement assumed

Source: GAINS model; ECLIPSE V5 scenario

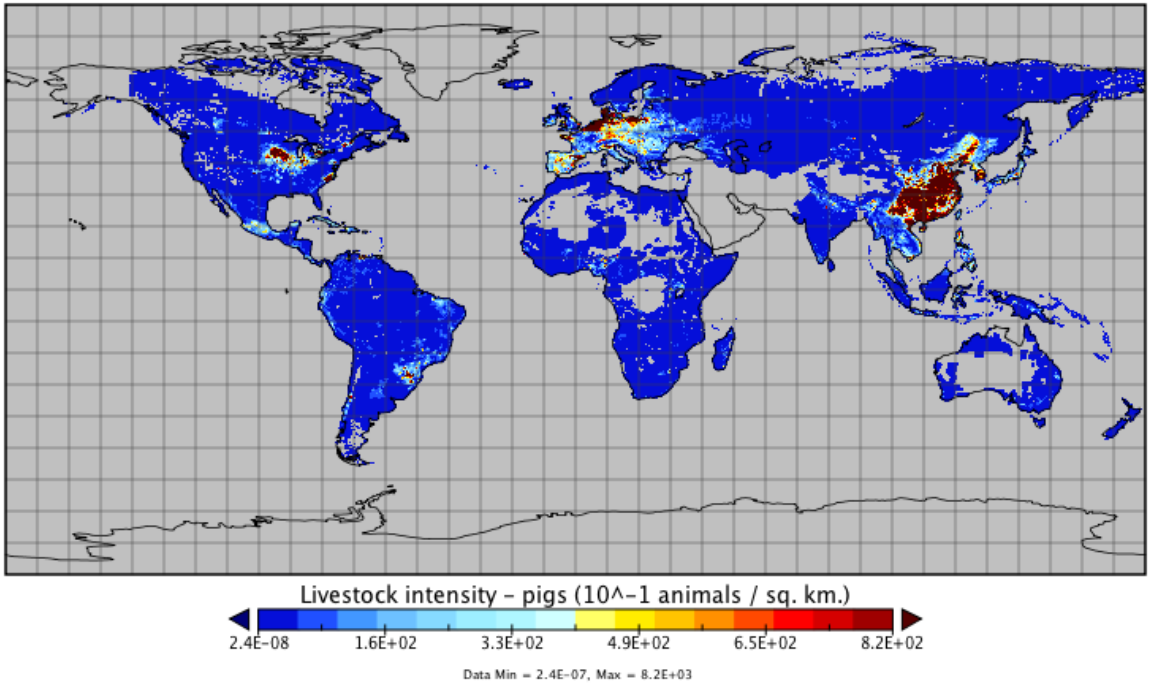
Example of new gridding proxies:

Livestock intensity maps for cattle and pigs

Livestock intensity – cattle

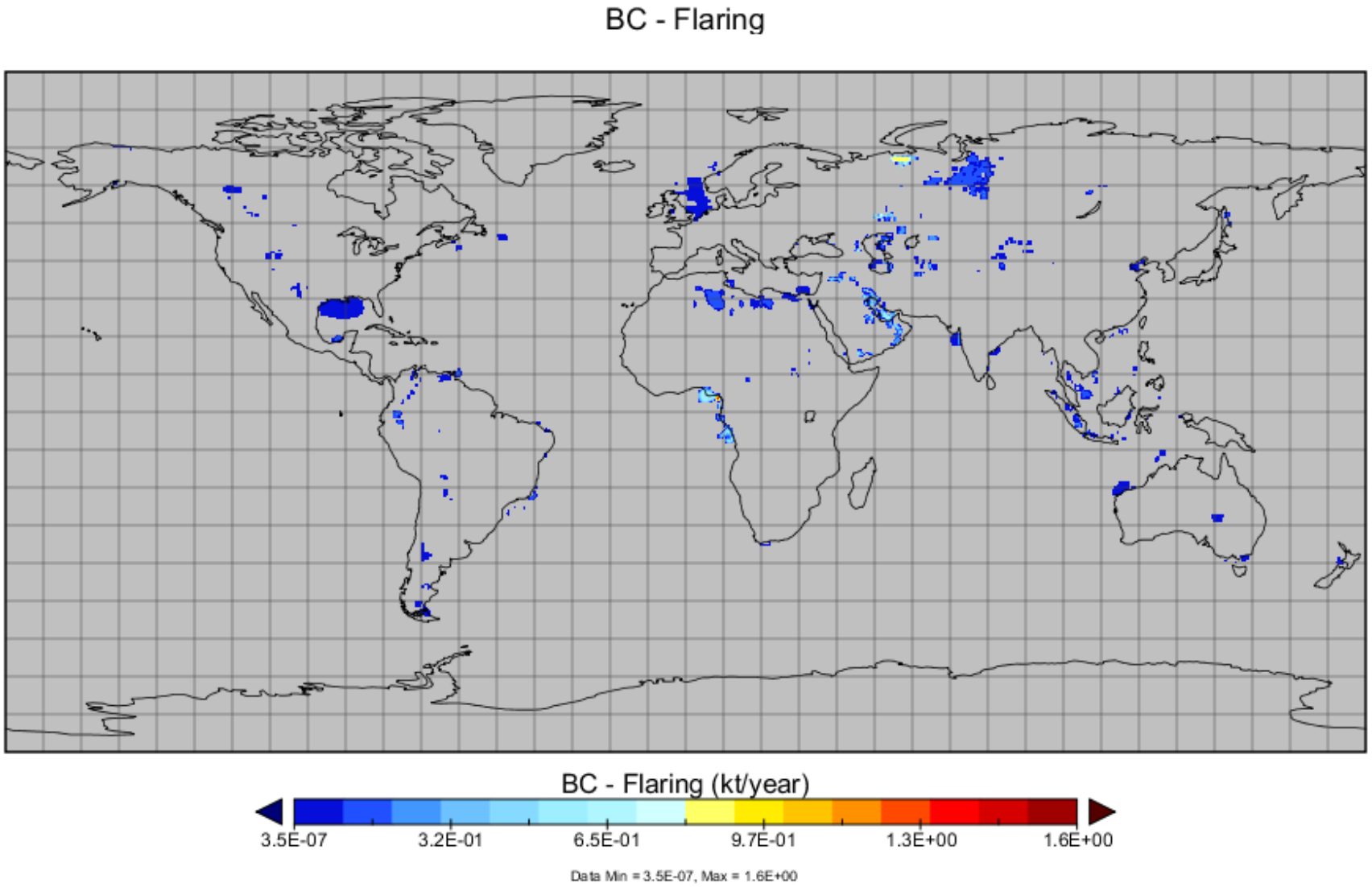


Livestock intensity – pigs



Spatial distribution of emissions from gas flaring in GAINS

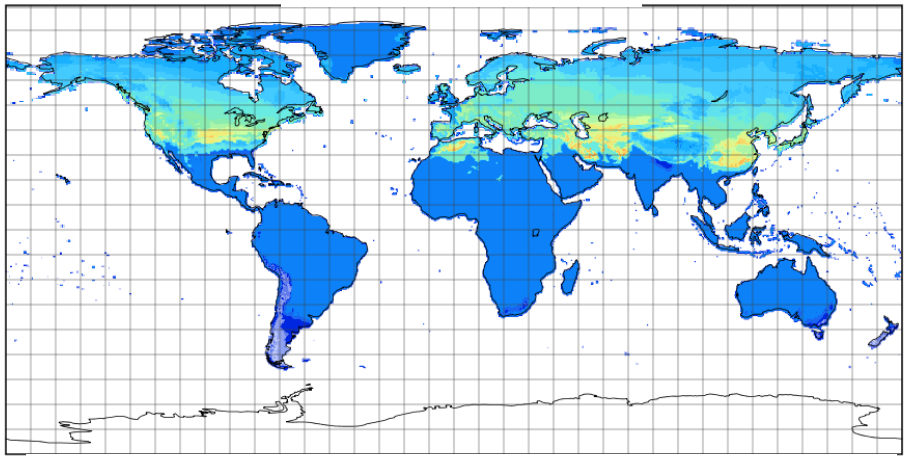
Location of flares: Source: *NASA, World Bank, GAINS model*



Residential combustion

Example maps illustrating temporal distribution

January 2005



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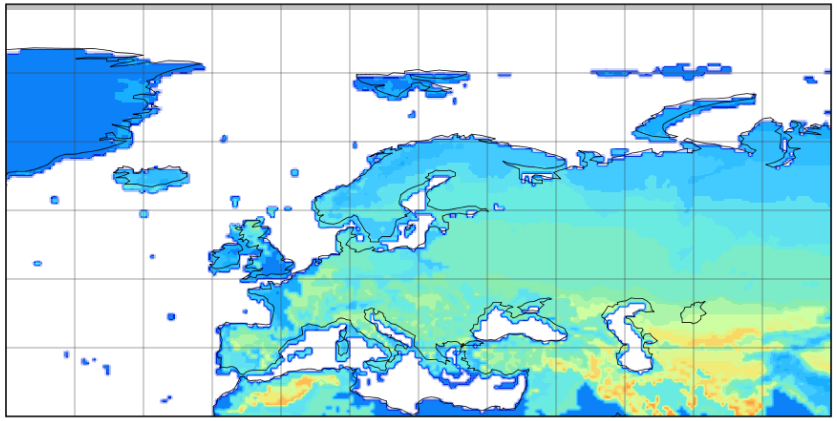
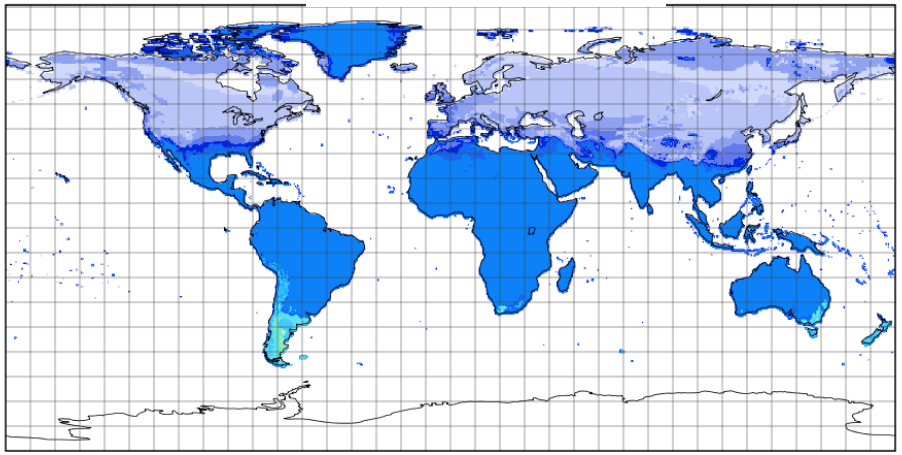


August 2005



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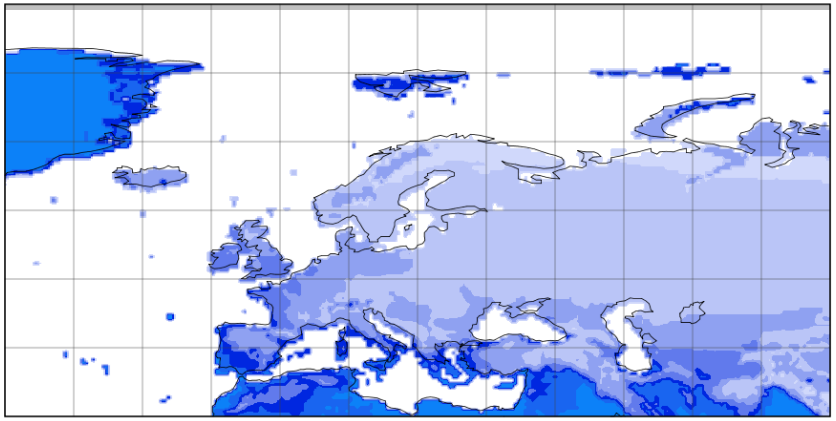
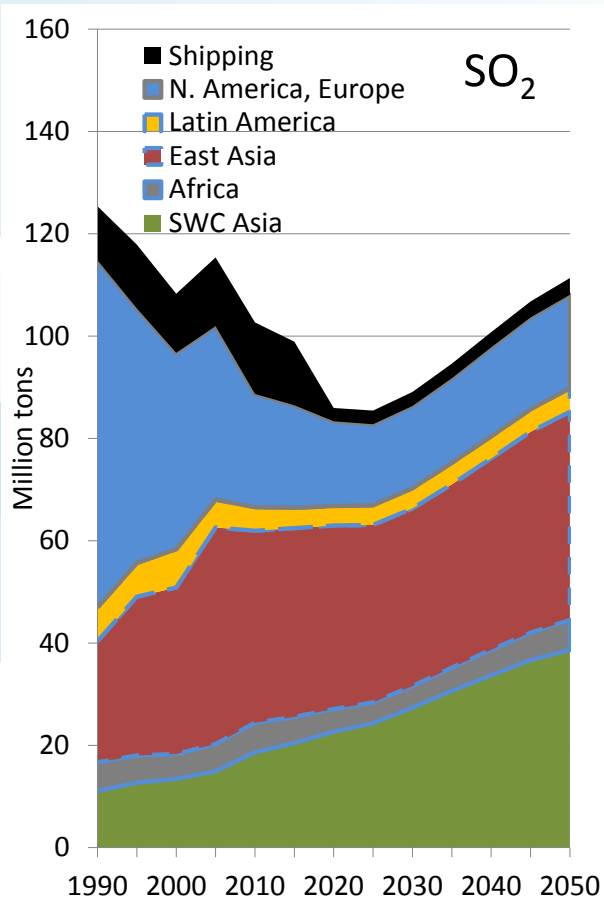
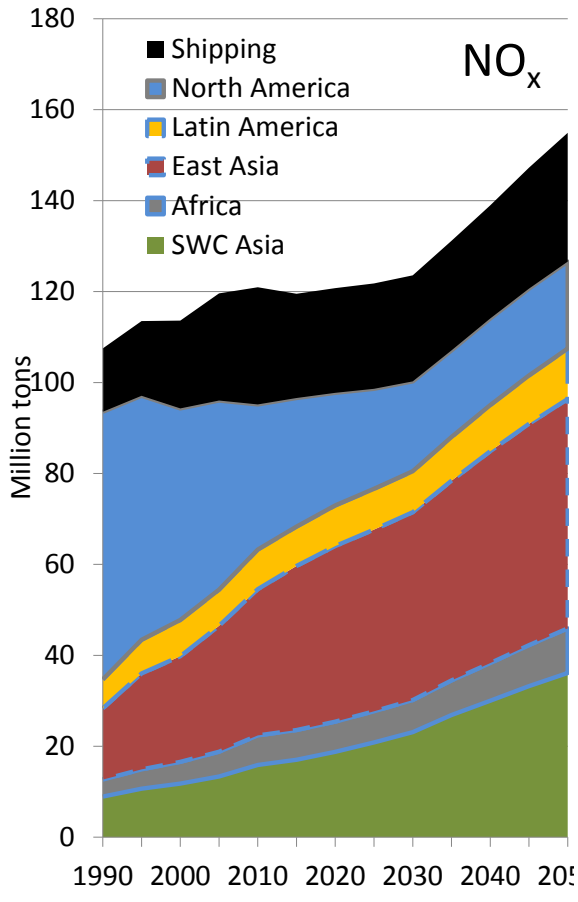
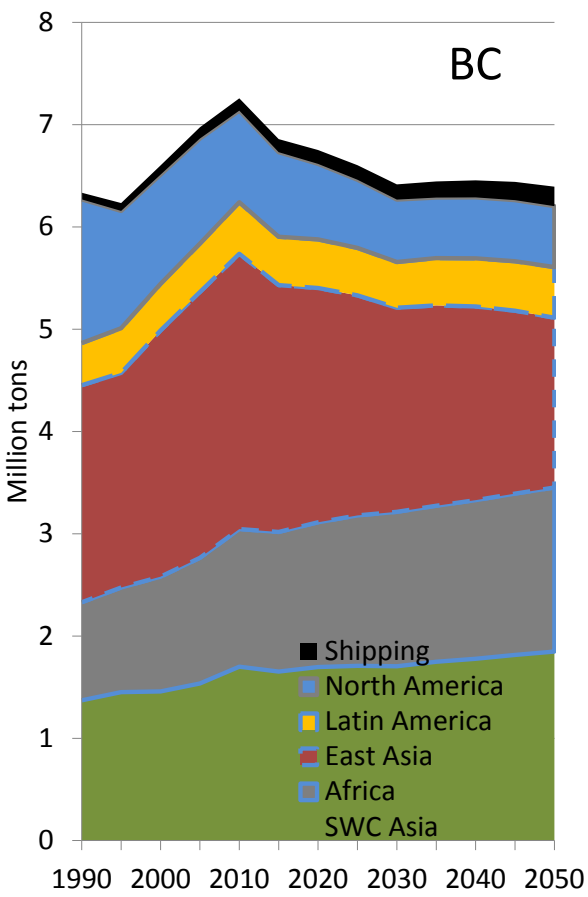


‘Current legislation’ emissions by UNEP world region [million tons]

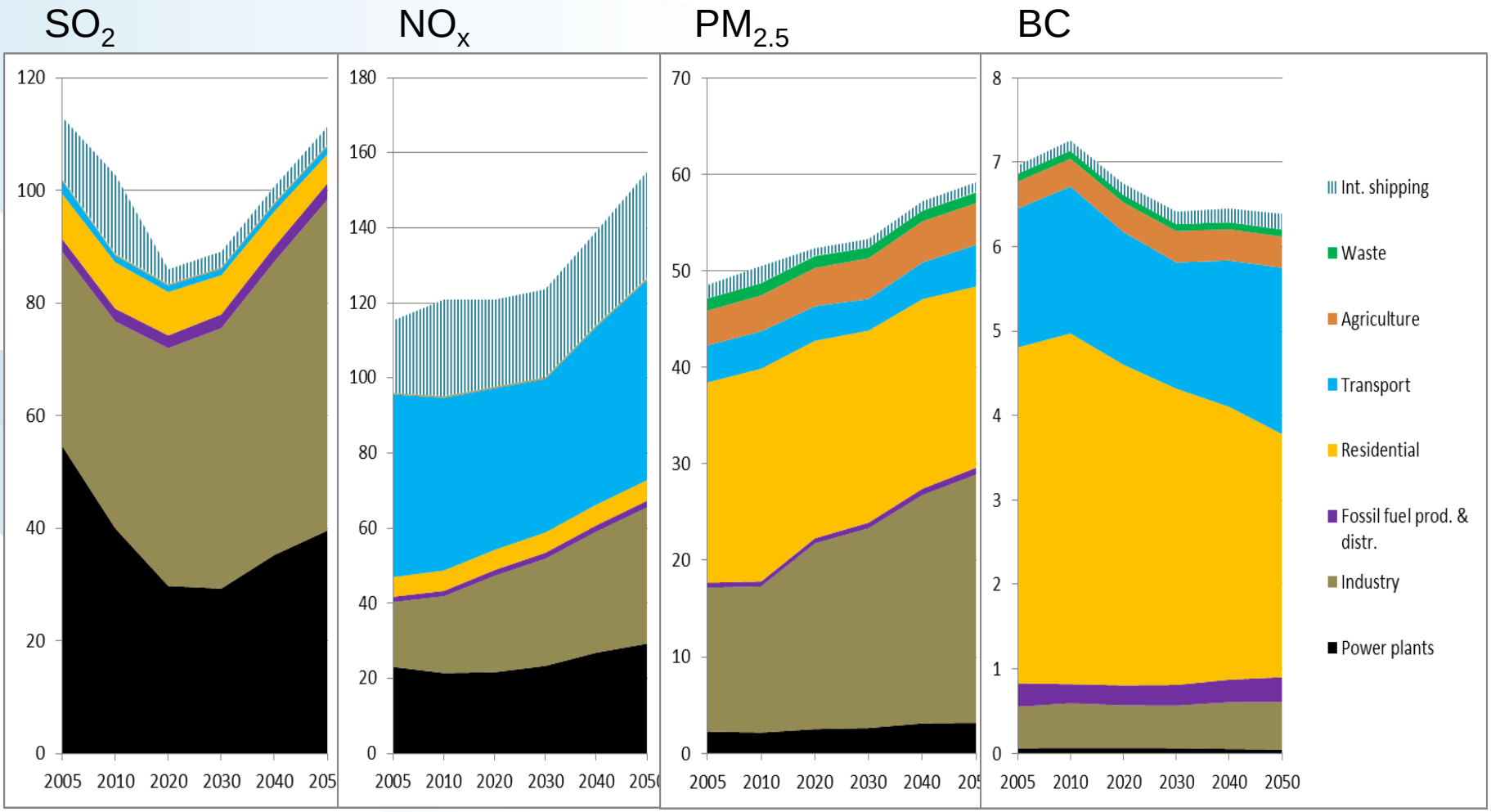






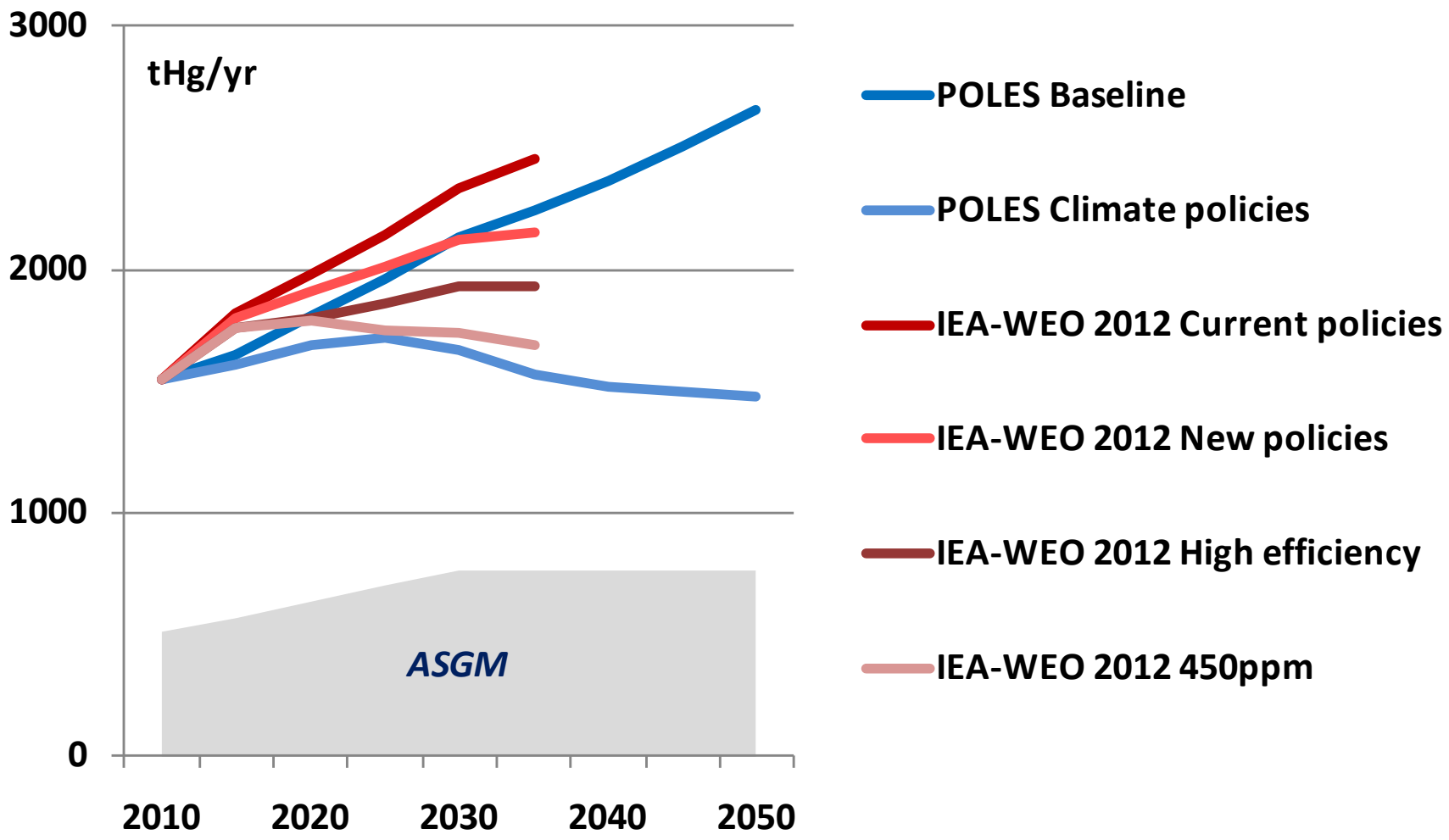
Source: GAINS model; ECLIPSE V5 scenario

‘Current legislation’ emissions by key sectors [million tons]

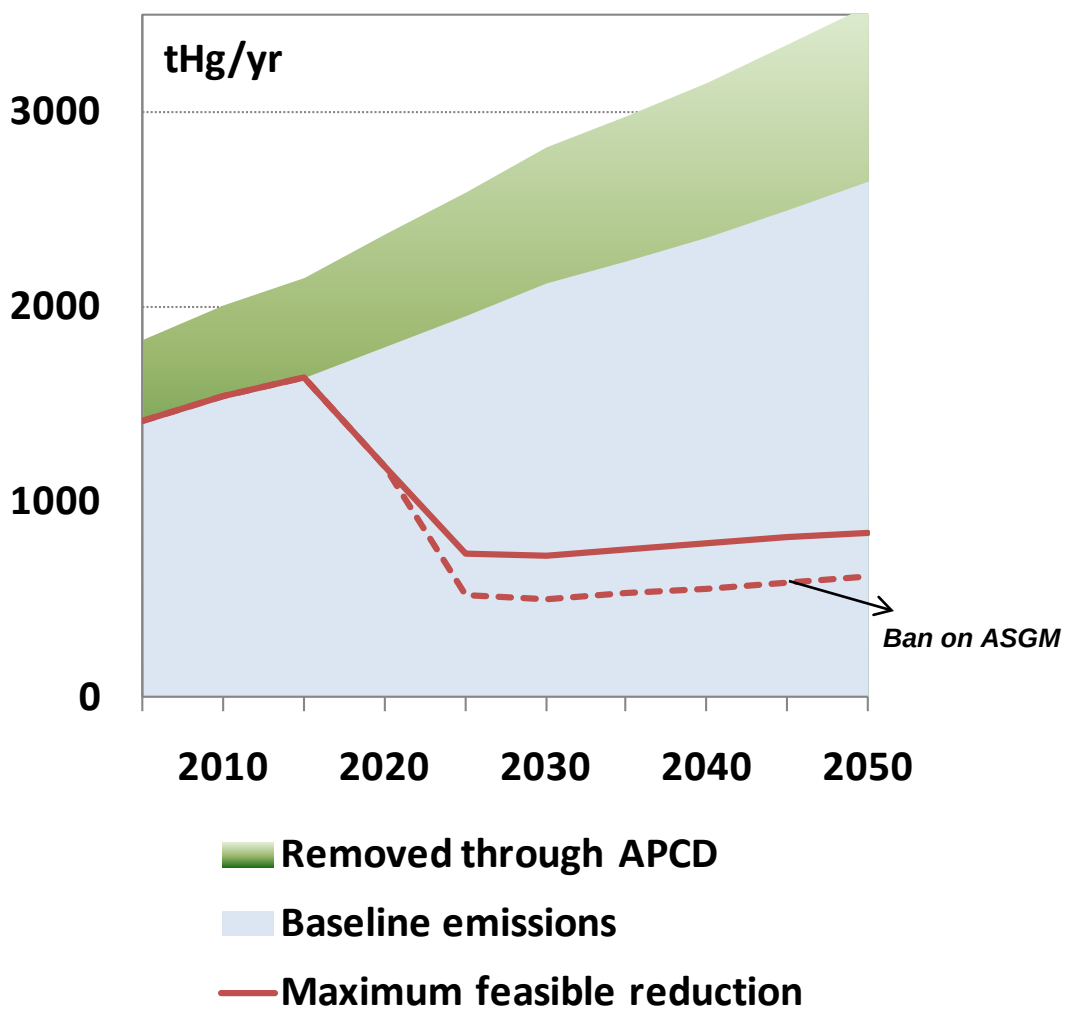


Source: GAINS model; ECLIPSE V5 scenario

Evolution of the future global Hg-emissions from anthropogenic sources



Co-benefits from air pollution control for global Hg-emissions

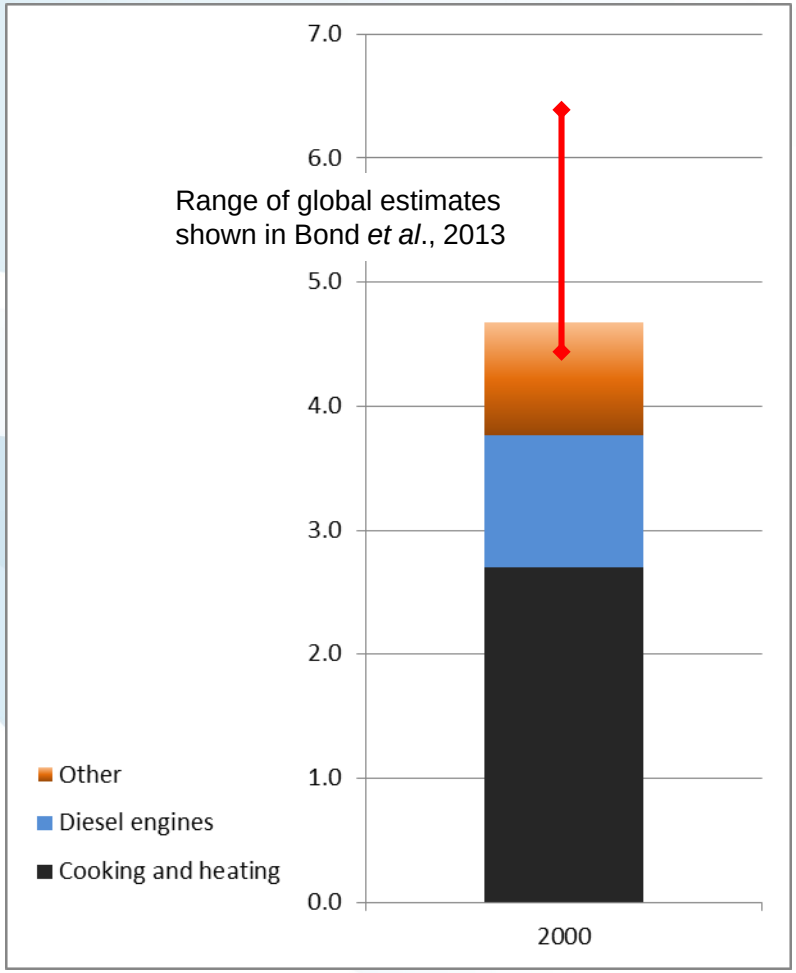


- Air Pollution Control Measures reduce current Hg-emissions by 20%
- Co-benefits expected to grow till 2050 (25%)
- MFR strategy might bring future Hg emissions below today's levels (-40% in 2050)

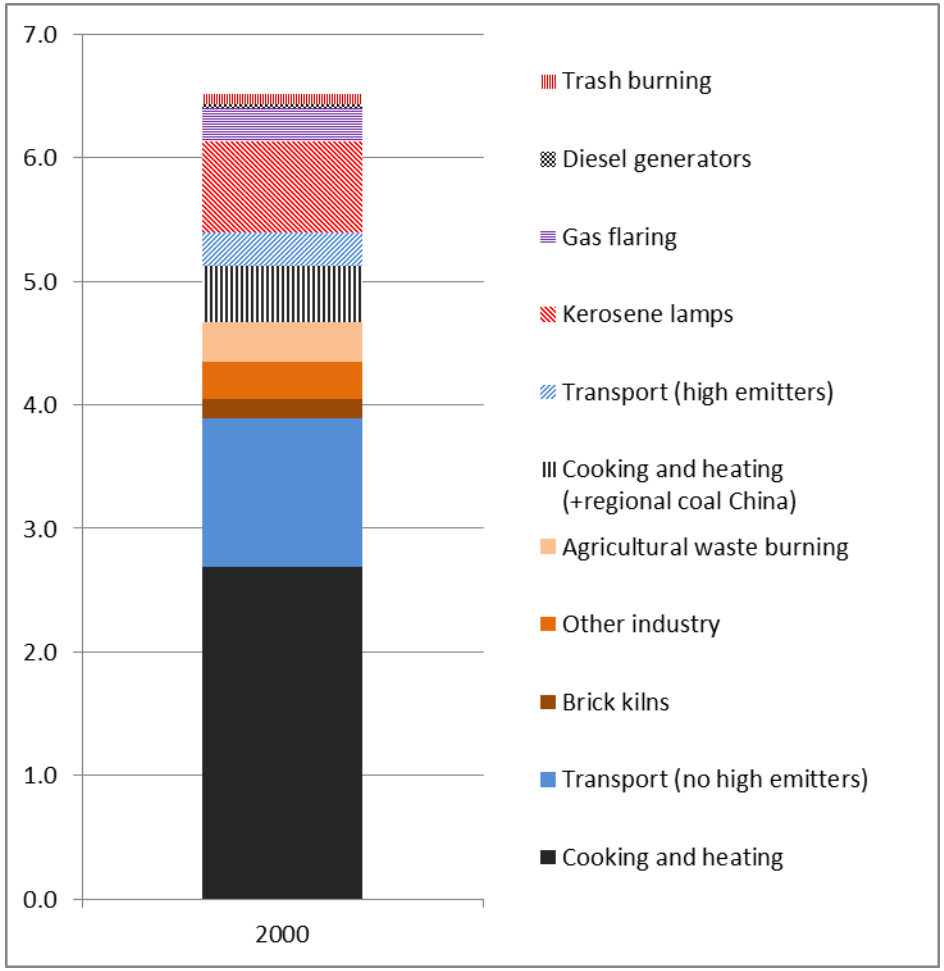
Global BC emissions in 2000, Tg BC

(excluding forest and grassland fires)

Source: GAINS model – ECLIPSE results (Klimont *et al.*, in preparation)



GAINS; <u>excluding</u> 'new/re-estimated' sources

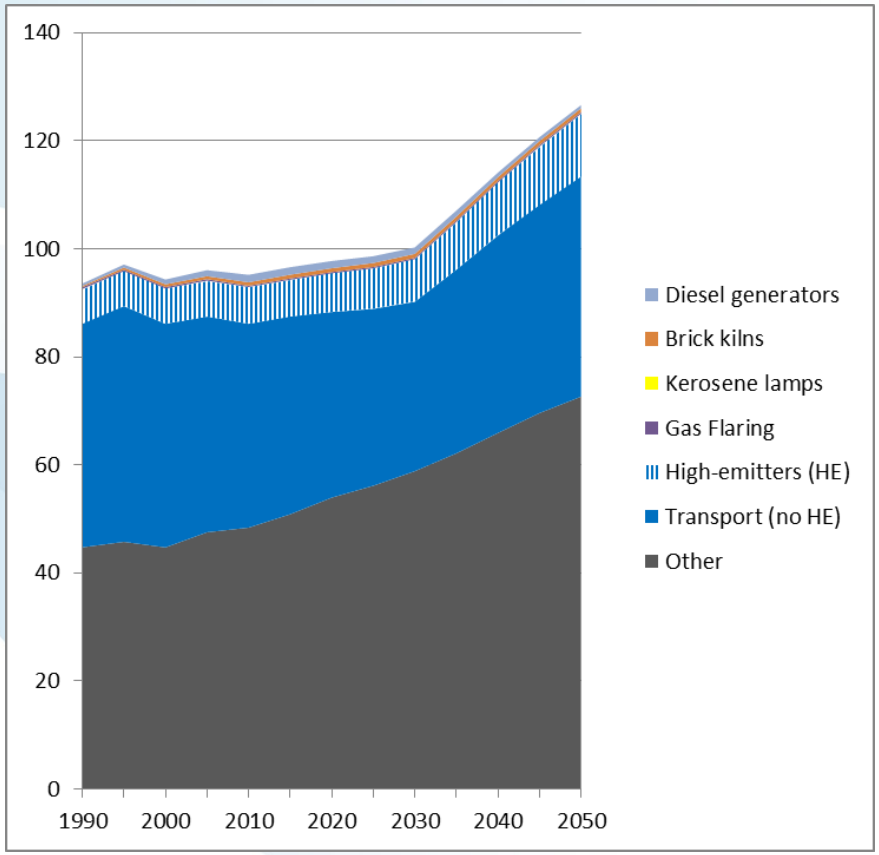


GAINS; all sources

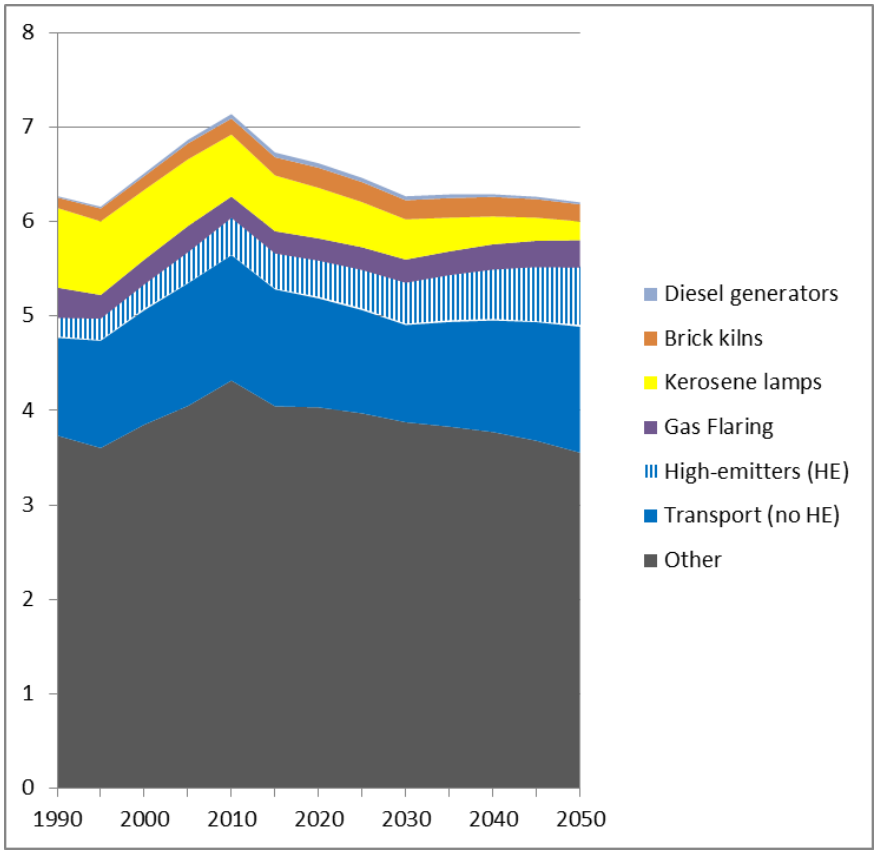
Role of ‘new’ sources in global emissions

GAINS Baseline, ECLISPE V5 (excl int shipping, savannah & forest fires)

NO_x, Mt NO_2

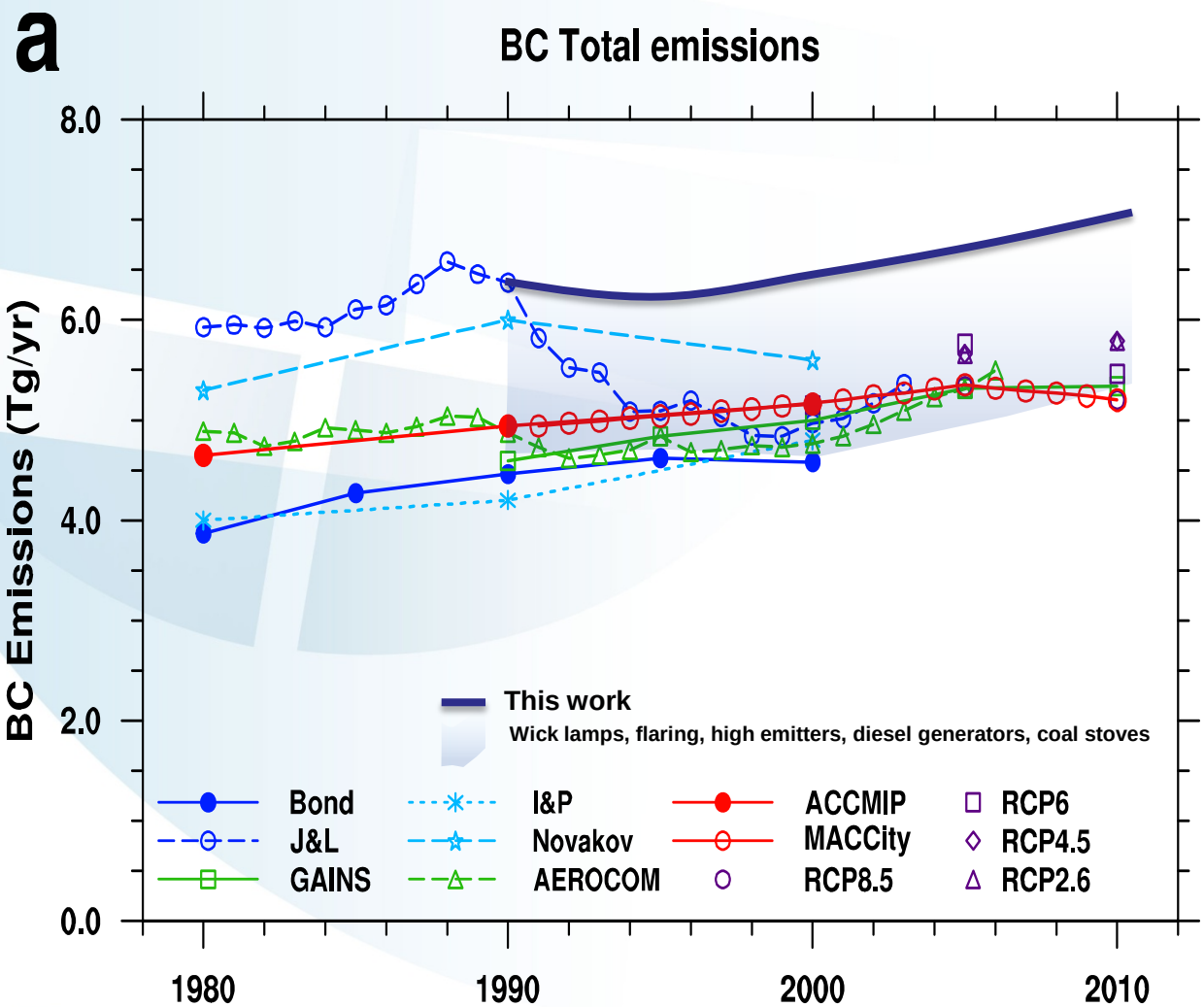


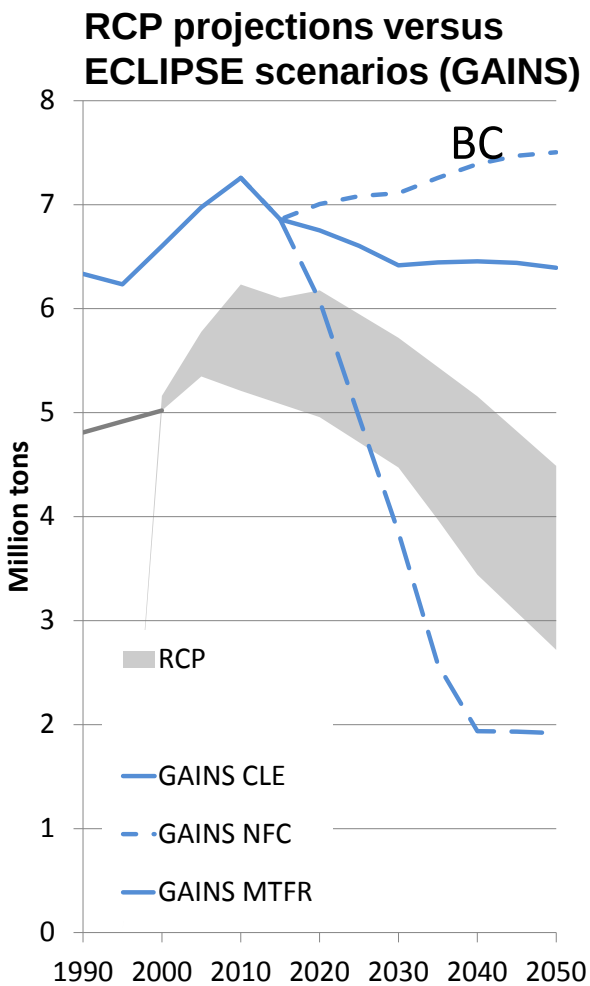
BC, Mt



Global BC emission estimates

Source: Granier *et al.*, 2011 (Climatic Change); This work (Klimont *et al.*, in preparation)

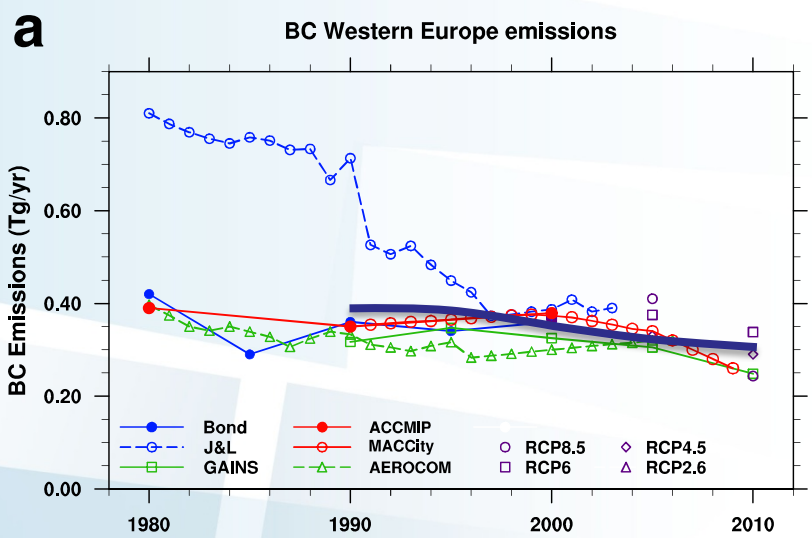


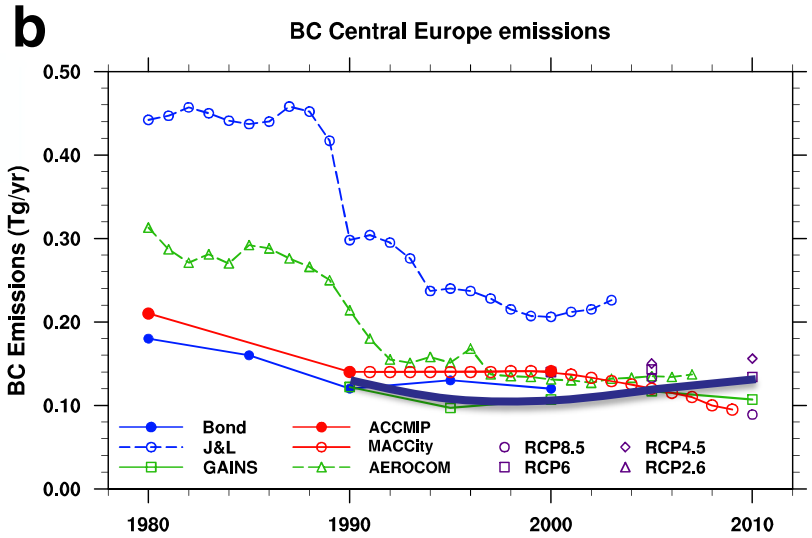


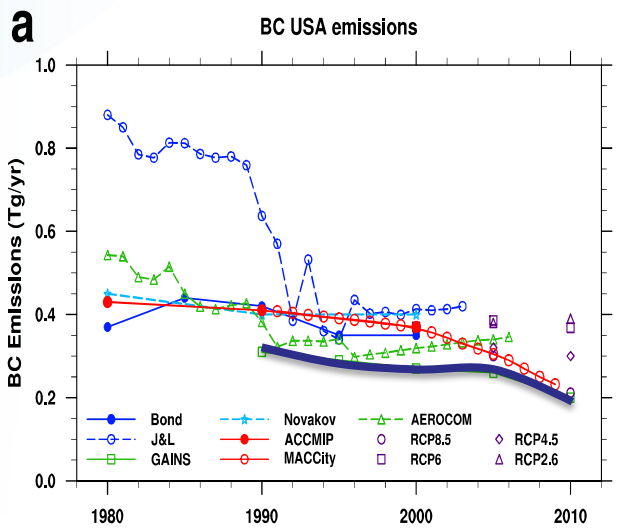
Regional BC emission estimates

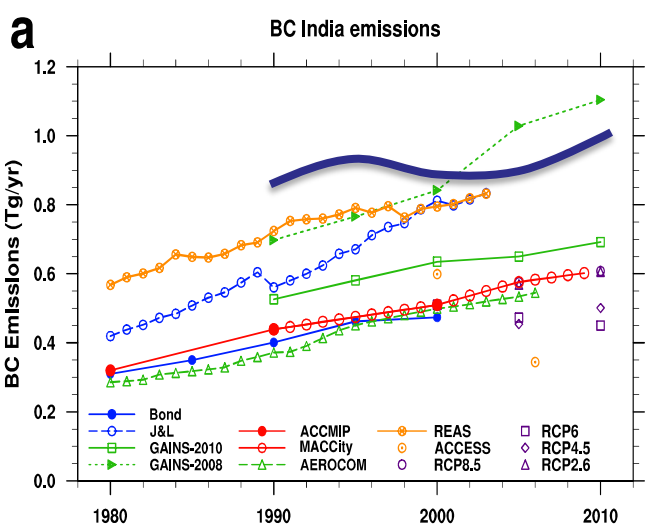
Source: Granier *et al.*, 2011 (Climatic Change), This work (Klimont *et al.*, in preparation)

This work



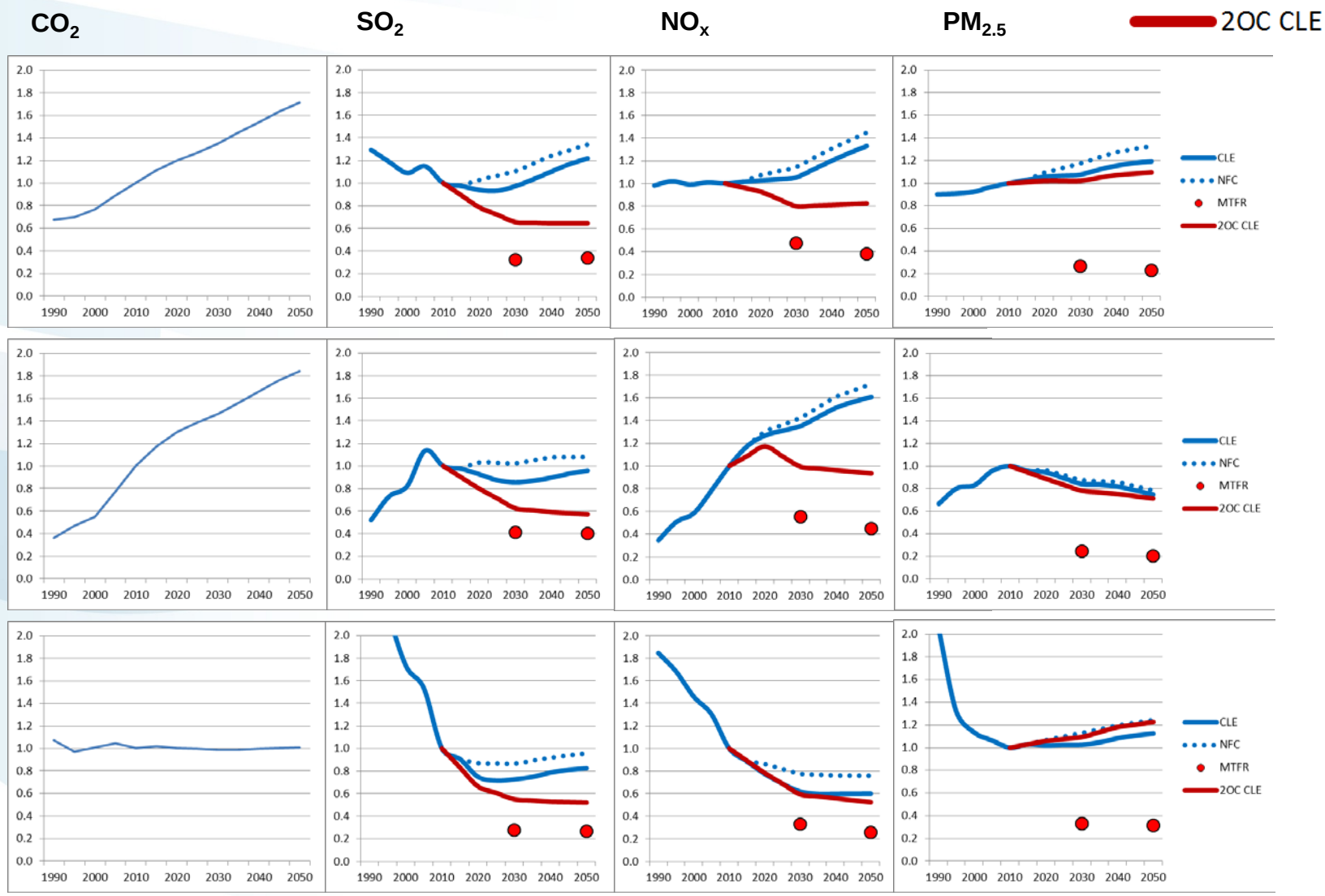






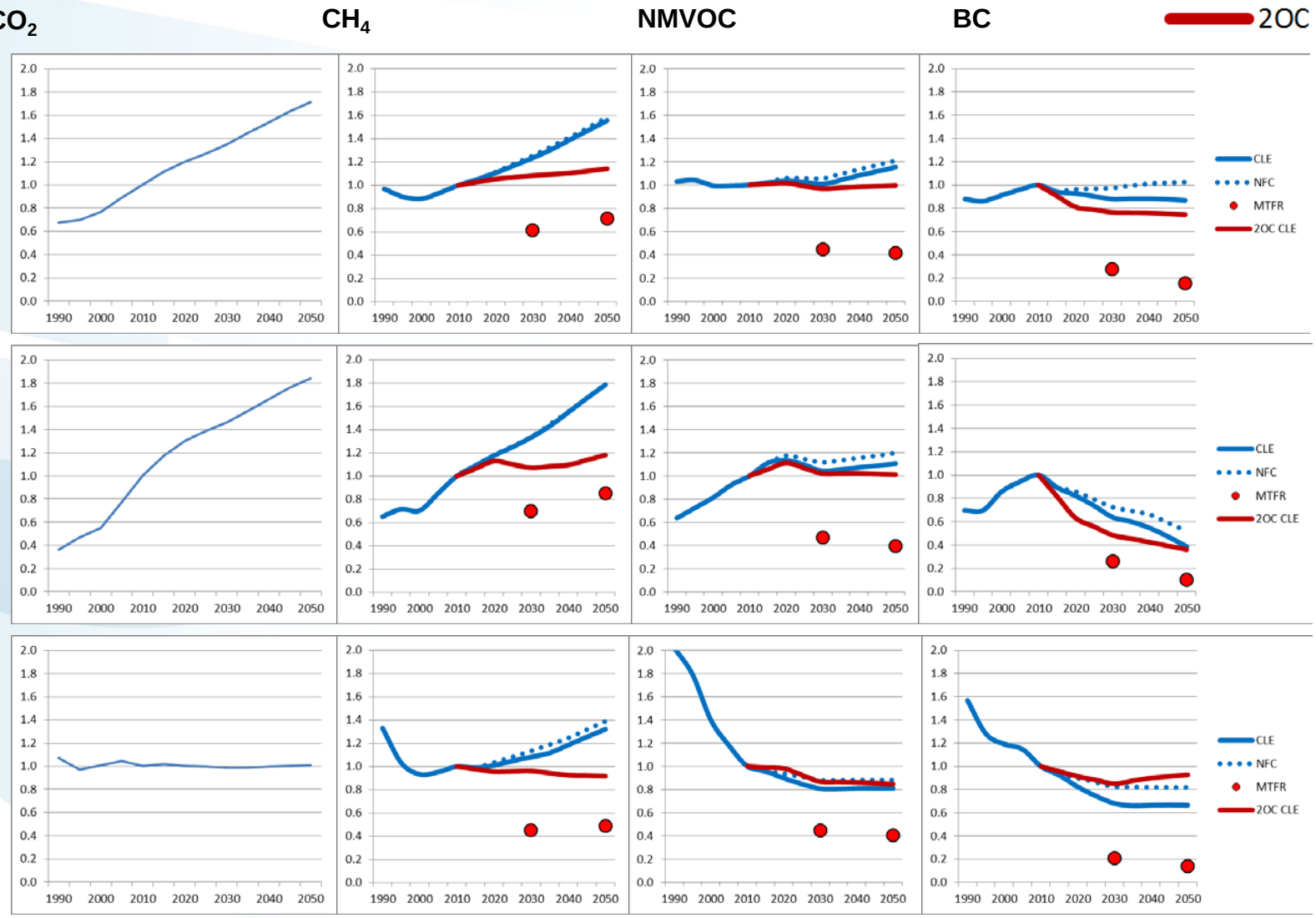
CLE vs mitigation scenarios (1)

Relative changes to 2010, GAINS ECLIPSE V5

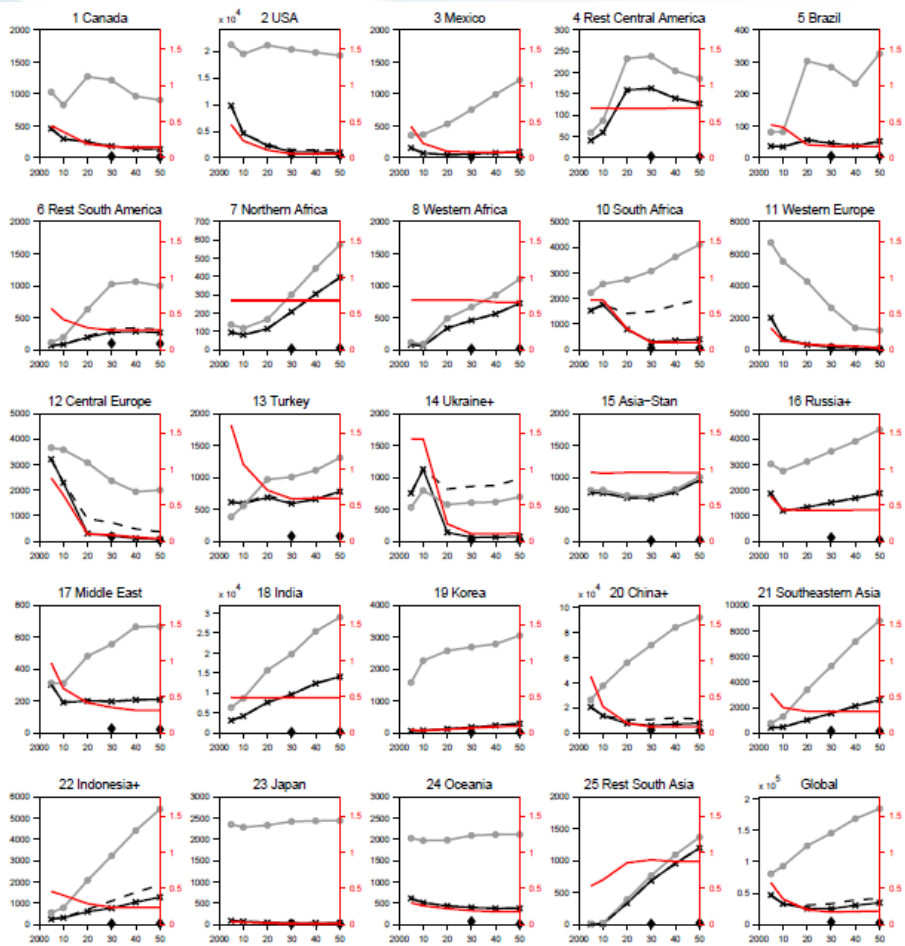


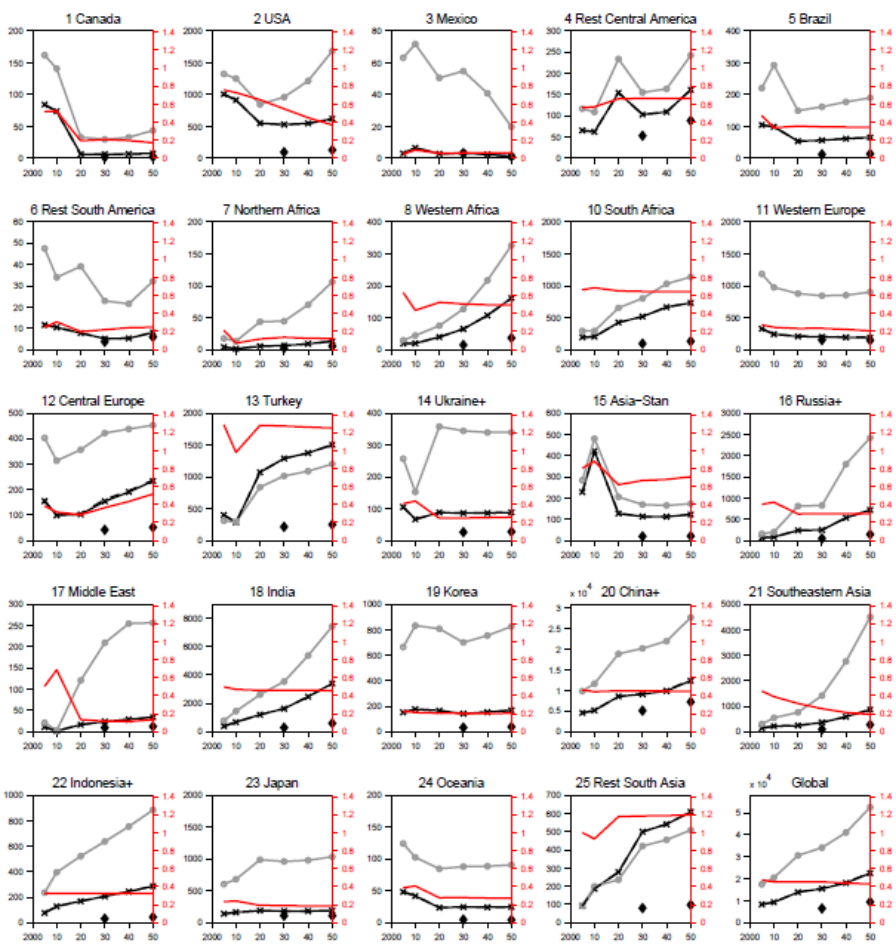
CLE vs mitigation scenarios (2)

Relative changes to 2010, GAINS ECLIPSE V5



A closer look...





SO2 emissions: Coal Power Plants

- SO2 emissions: Current Legislation – CLE [kt] (left axis)
- SO2 emissions: No Further Control – NFC [kt] (left axis)
- SO2 emissions: Maximum Reduction – MFR [kt] (left axis)
- Activity: Coal consumption [PJ] (left axis)
- Implied emission factor [g/MJ] (right axis)

SO2 emissions: Industrial coal boilers

- SO2 emissions: Current Legislation – CLE [kt] (left axis)
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Data source: IIASA GAINS model, scenario: ECLIPSE, version: V5 – April 2014

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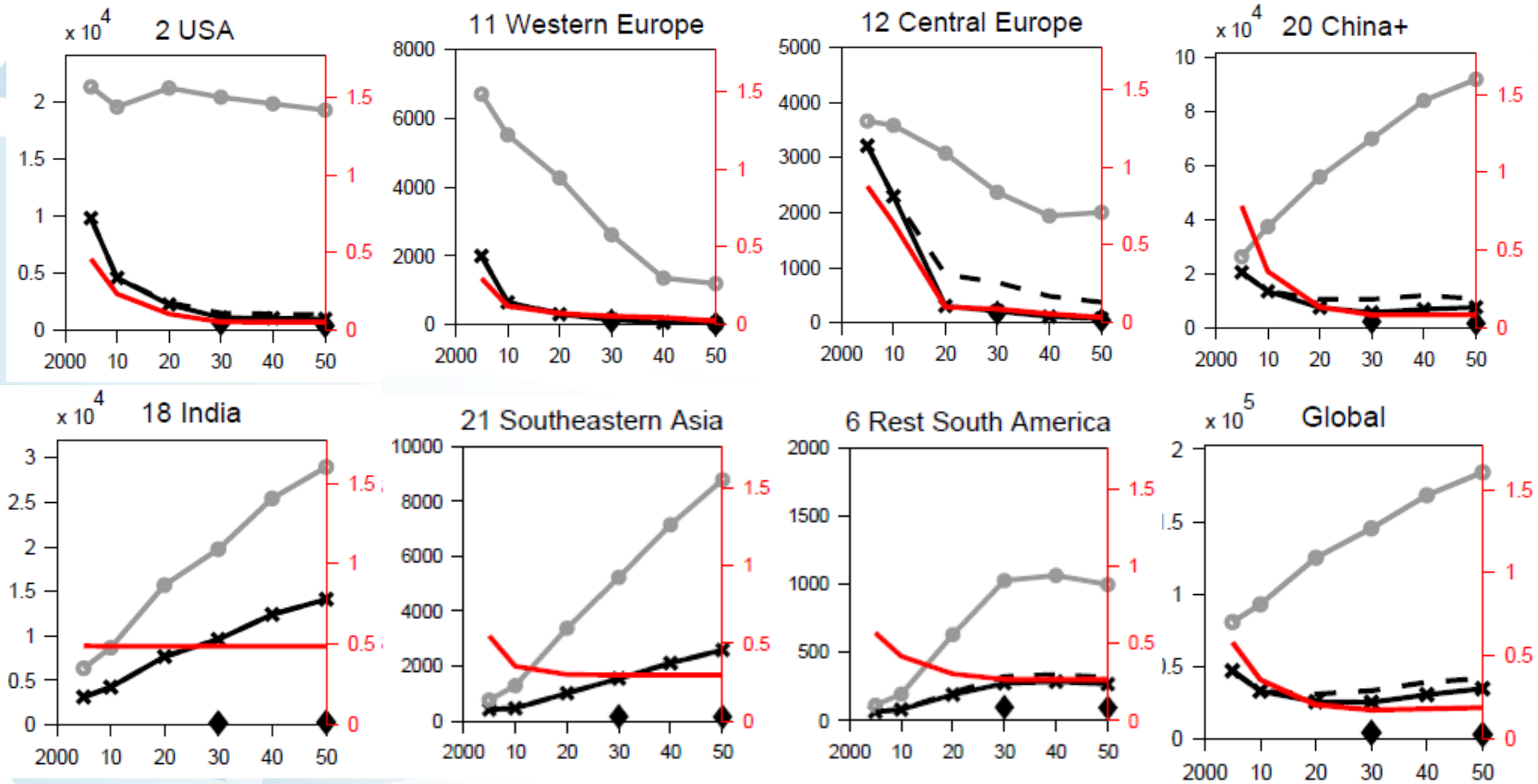

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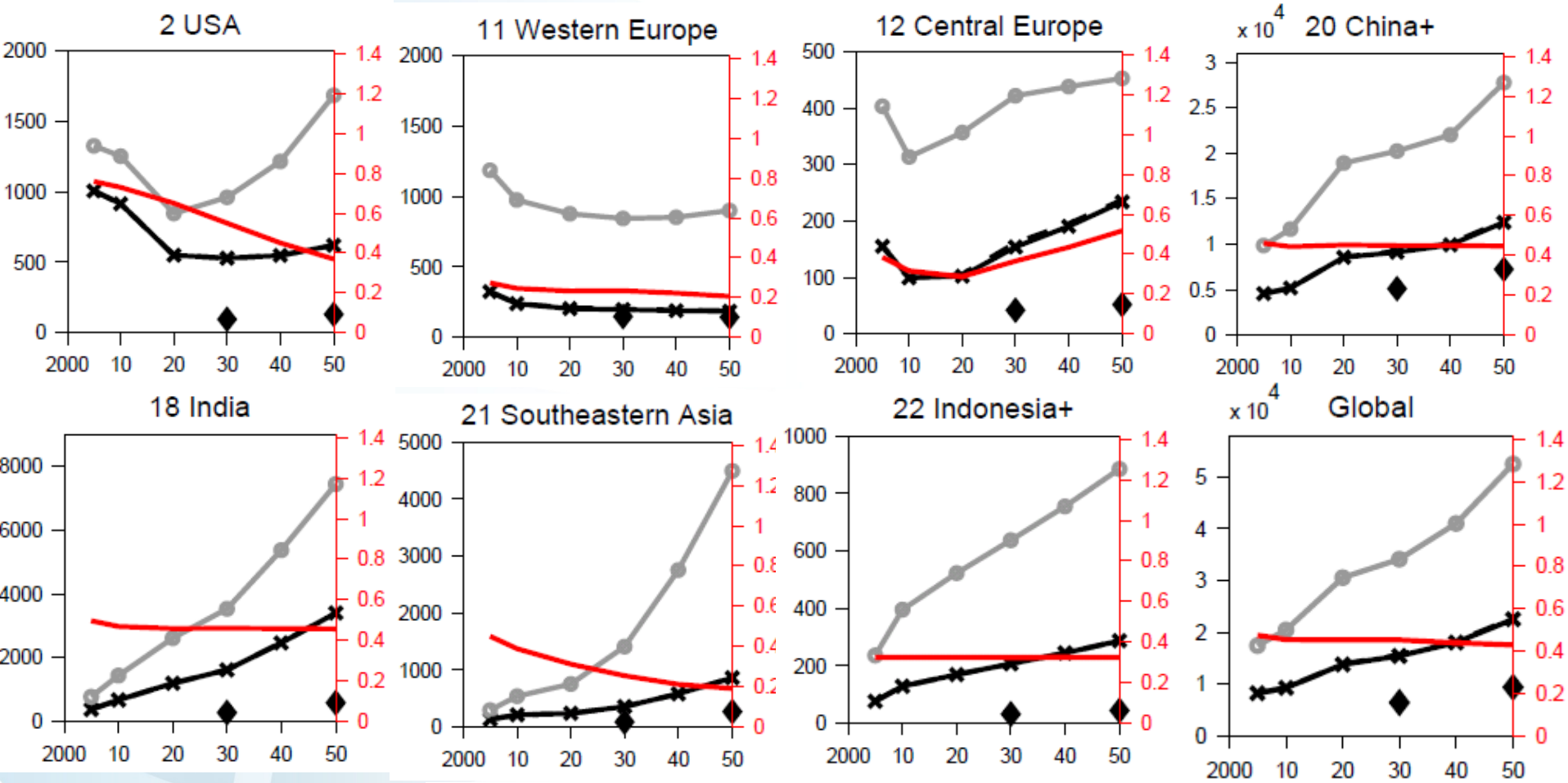

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- Activity: Coal consumption [PJ] (left axis)
- Implied emission factor [g/MJ] (right axis)

Highlights (1)

- Emissions of all species are estimated using the same primary activity data set within one common framework, which assures internal consistency (also with the CO_2 calculation), including multi-pollutant character of several control technologies
- For some regions, emission estimates evaluated with local experts
- The scenarios maintain relatively high regional and source sector resolution through the whole modelling horizon
- Still large uncertainties with respect to enforcement of policies and so exploring ‘failure/delayed implementation’ scenarios remain relevant
- Agriculture emissions are seldom addressed in current policies and expect to continue strong growth possibly hampering achieving PM concentration goals set in the legislation

Highlights (2)

- The ECLIPSE scenarios show a wider range of potential outcomes for aerosol emissions than projected in the RCP (Regional Concentration Pathway) scenarios
  - The scenarios highlight the importance of enforcement of existing policies in the mid-term as they can contribute to significant reductions or at least stabilization of aerosol emissions, especially in Europe, North America and East Asia
  - In the long term, however, current policies do not guarantee that emissions would not be raising again and therefore call for more action, even in the developed world.

Data sources and references

- Activity data, drivers:
  - Energy use: IEA and EUROSTAT statistics; IEA/OECD projections until 2050 (Energy Technology Perspectives, 2012; PRIMES, 2013):
    - 6°C scenario – consistent (until 2035) with the WEO 2011
    - 2°C mitigation scenario – comparable to the WEO 450ppm
  - Agriculture: Eurostat, FAO (2012)
  - Shipping: QUANTIFY (EU FP6; Endresen et al., 2007; IMO, 2011)
  - Gas flaring: Elvidge et al. (2009)
  - Industrial production, waste, other: IEA, UN, national stats, …
- Papers:
  - *Published:* Klimont et al (2013; Global SO2), Stohl et al (2013; Arctic BC), Yttri et al. (2014; BC Europe), Lund et al. (2014; transport BC), Safieddine et al. (2014; ozone), Gadahvi et al. (2015; BC India)
  - *Submitted:* Eckhard et al (aerosols, BC Arctic), Huneeus et al (Global SO2, inverse modelling)
  - *In preparation:* Klimont et al. (documentation of ECLIPSE),
- The gridded emission data has been accessible via several portals:
  - ECLIPSE (http://nilu.eclipse.no)
  - GEIA (http://www.geiacenter.org) and directly at ECCAD http://eccad.sedoo.fr
  - IIASA/GAINS (http://gains.iiasa.ac.at)