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Recent trends and mid-term projections of air pollutants emissions in Asia

Oslo, October 26-28, 2009



Background – Motivation (1)



- GAINS-*Asia* project completed in 2008 (collaboration between IIASA, ERI, Tsinghua, TERI, JRC - *Amann et al., 2008; Klimont et al., 2009*)
- Following remote sensing work on NO₂, emission inventory community updated several inventories, also for other pollutants (SO₂, CO, BC, OC, CO₂, CH₄, NMVOC)
- Remote sensing community provides first assessments of SO₂ change over Asia
- IPCC SRES scenarios are still used in modelling work but contain dated projections
- Several new projections available at regional (e.g, REAS) and global (e.g, RCP) level

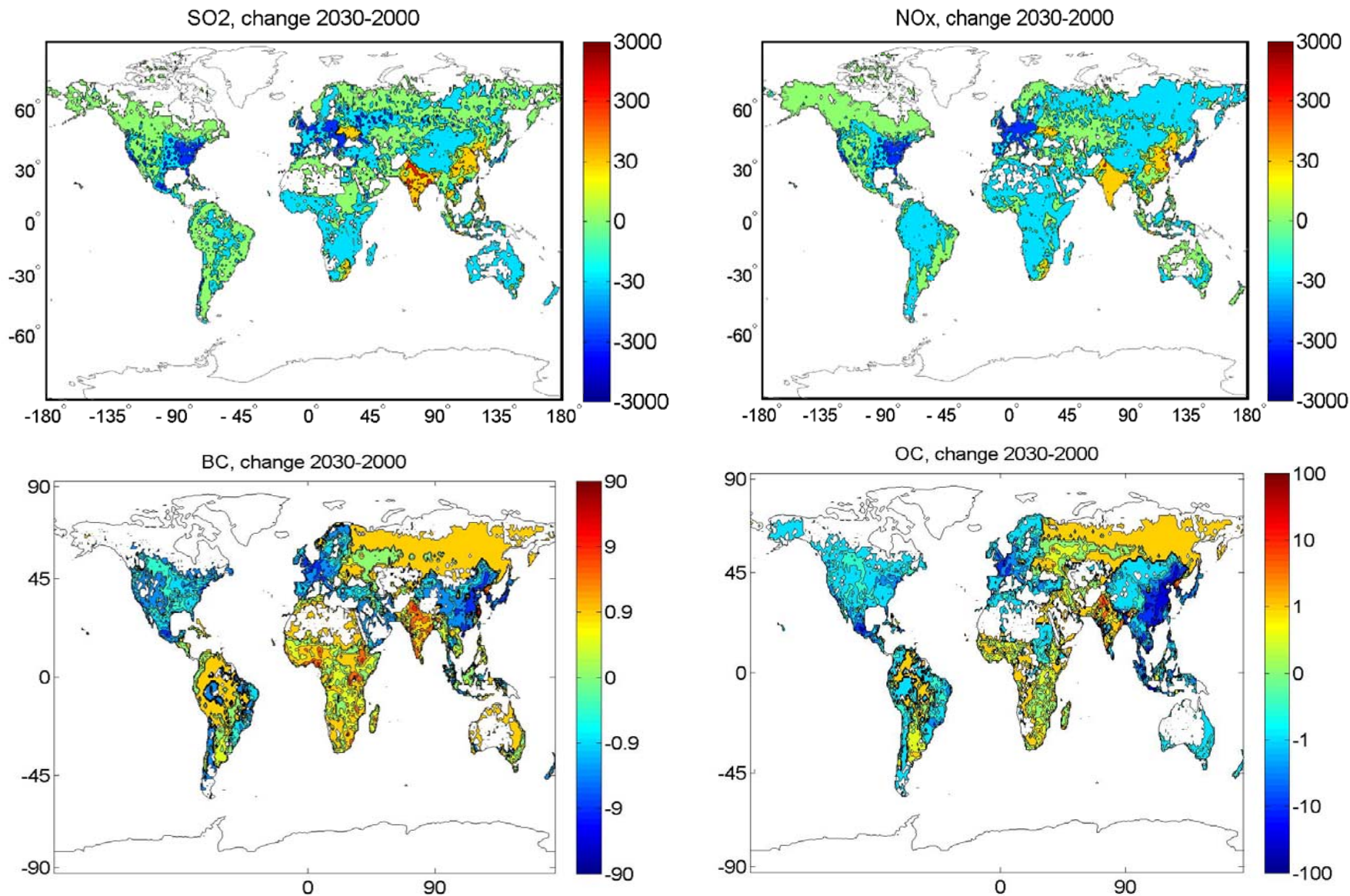
Background – Motivation (2)



- Although GAINS is not an emission tool...
 - We do not develop emission inventories but rather try to reproduce/understand them using the model by explicitly considering “technology” in calculating emissions and reduction potential
- ...it calculates fairly detailed annual emissions of several species at a national/regional level (including mid-term projections)
- GAINS does also a couple of other things, check: <http://gains.iiasa.ac.at>
- Why Asia?

Change in spatial distribution, *GAINS'08 CLE scenario*

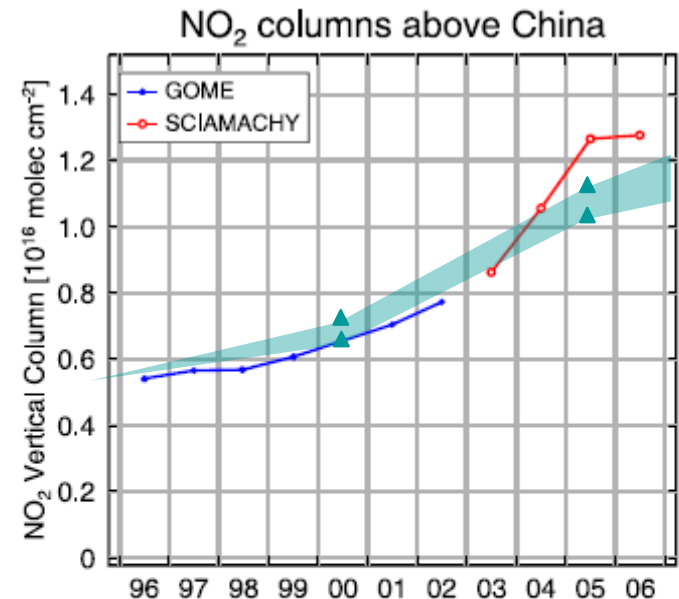
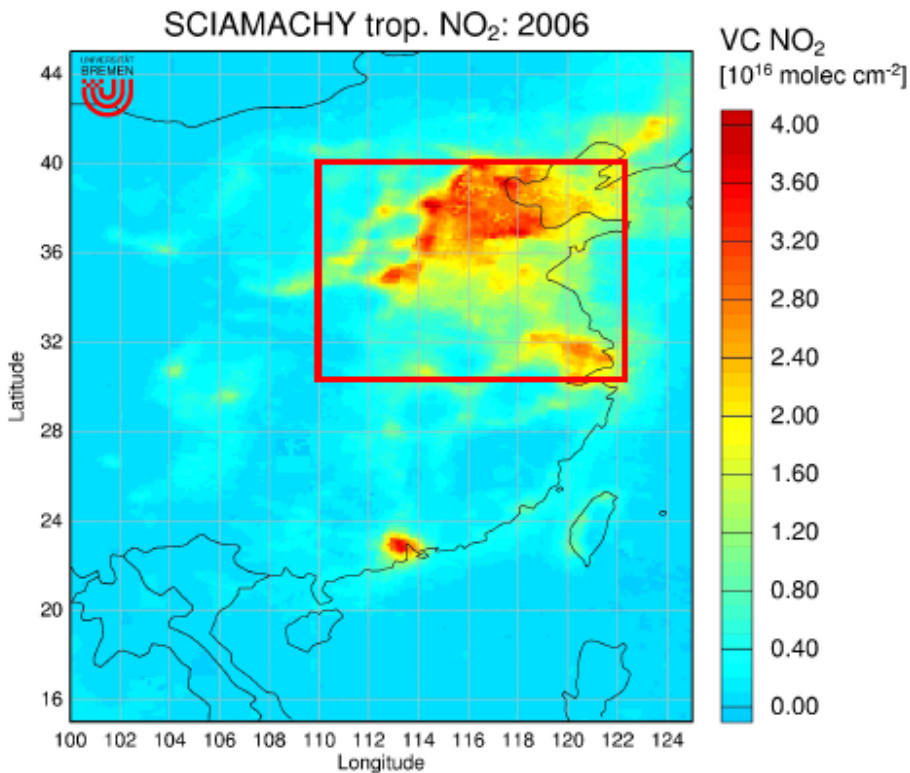
Gridding of GAINS results and difference maps by T. Bond



Comparison of remote sensing data on NO₂ changes over China (Richter et al., 2007) with GAINS emission changes

NO₂ increase above China

Richter et al. (2007)



Annual averages of tropospheric NO₂ above the indicated region in China as seen by GOME and SCIAMACHY. Data for 2006 are still preliminary.

▲ GAINS-NO₂ emission change relative to 1995 for the selected area

Preliminary comparison of remote sensing data on SO₂ changes over China (Richter et al., 2007) with GAINS emission changes



Richter et al. (2007) Tropospheric composition change observed from space. 2nd ACCENT symposium, Urbino, Italy

SO₂ Increase above China

▲ GAINS-China;
SO₂ emission change relative to 1995 for the selected area

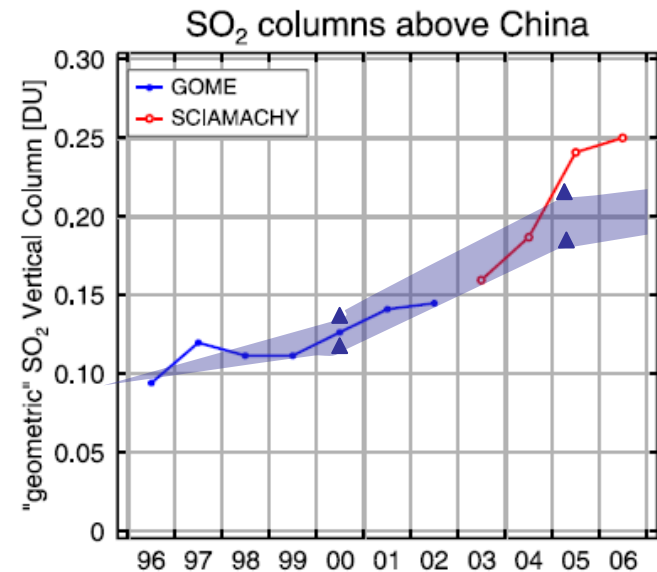
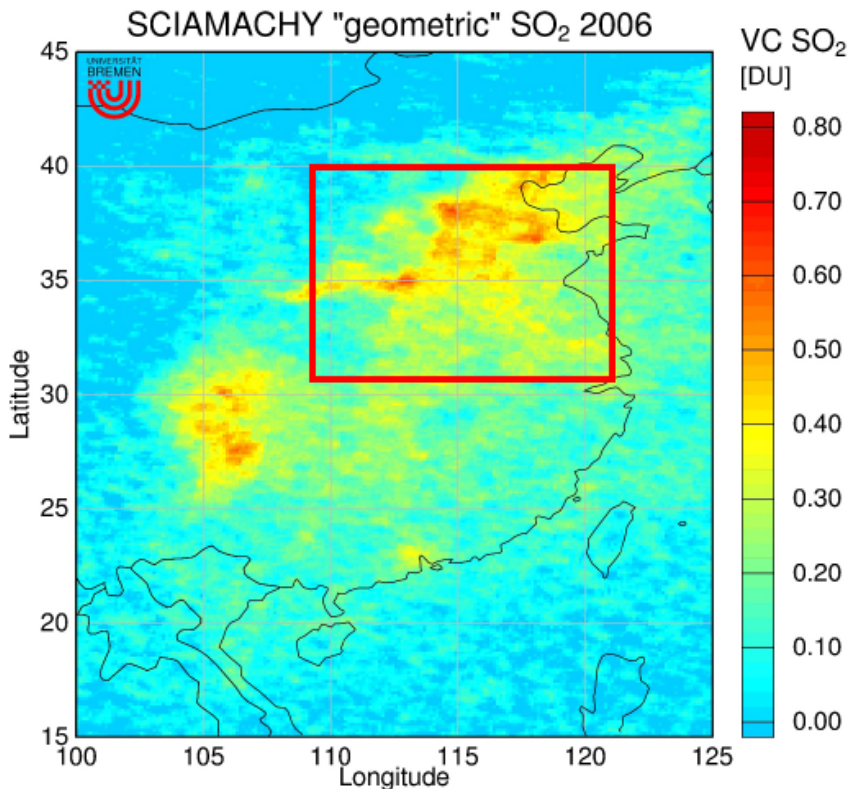
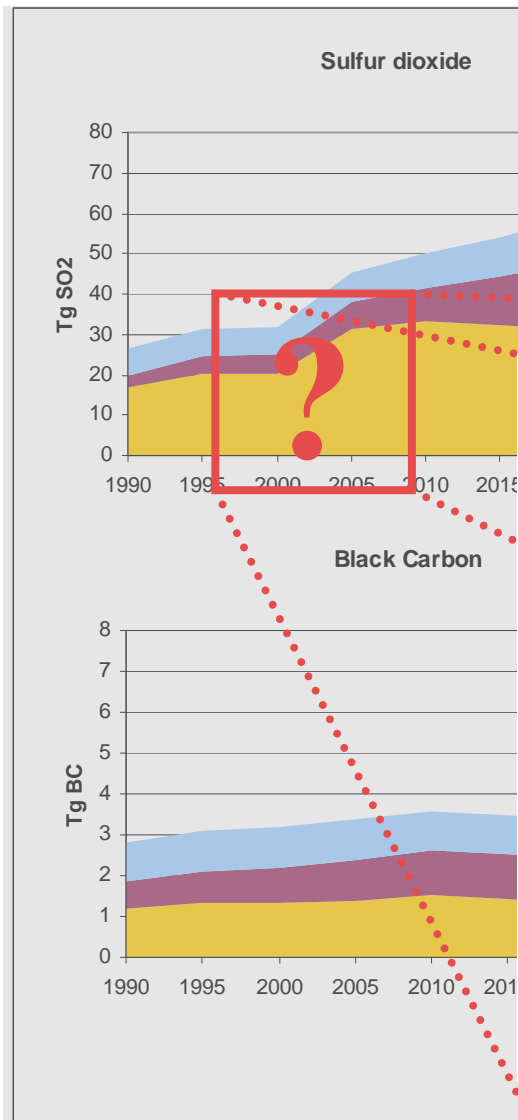


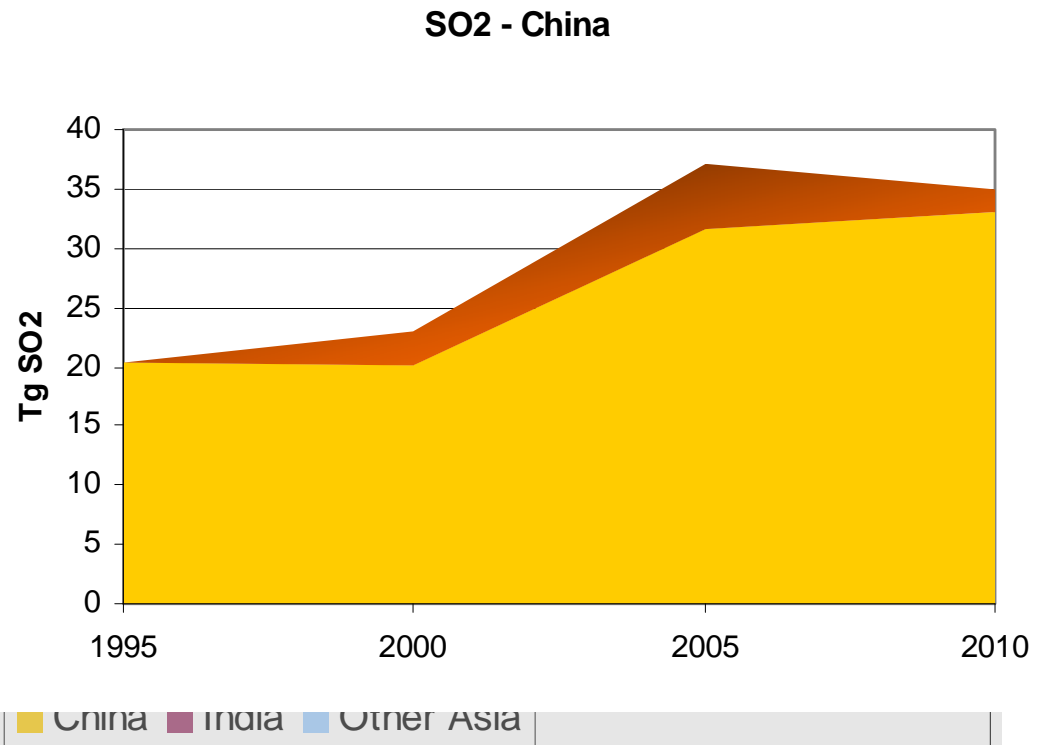
Fig. 3: Annual averages of tropospheric SO₂ above the indicated region in China as seen by GOME and SCIAMACHY. Data have not yet been fully corrected for light path effects. 2006 point is still preliminary.

Emissions of air pollutants in Asia

GAINS-Asia baseline (2008) *Source: Klimont et al., 2009*



- Fuel consumption estimates for 2005 vary up to 10% between Chinese sources;
- Some uncertainty with respect to S content of coal actually used in power sector and industry
- Strong increase in FGD penetration after 2003;
- By 2008 >60% of coal power plant capacity with FGD but unclear what is their operating time (Xu et al., 2009; IEA, 2008)

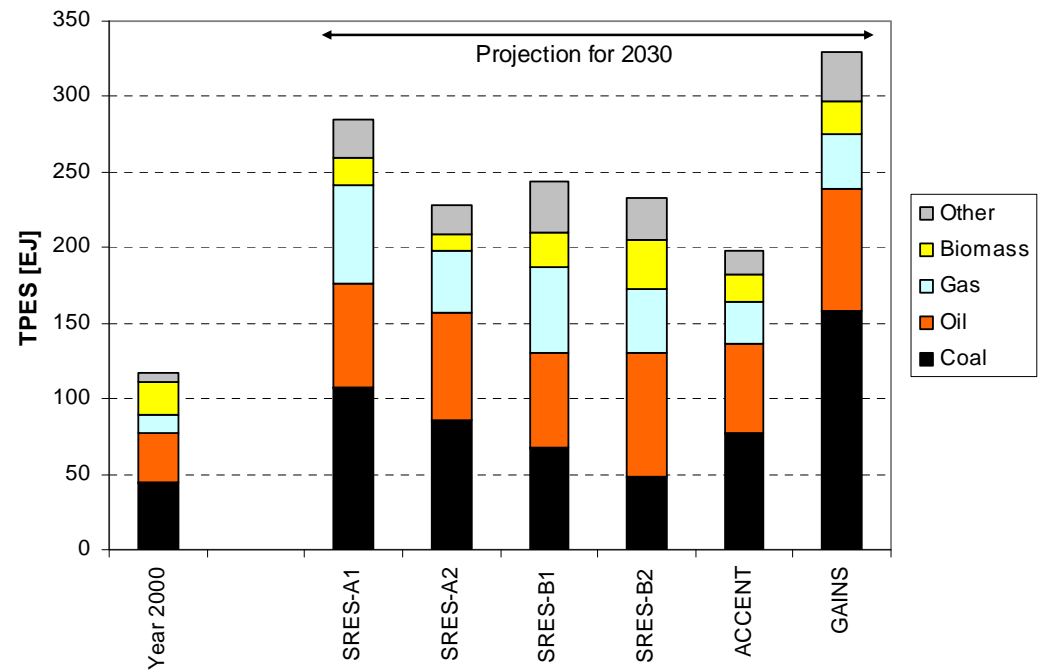
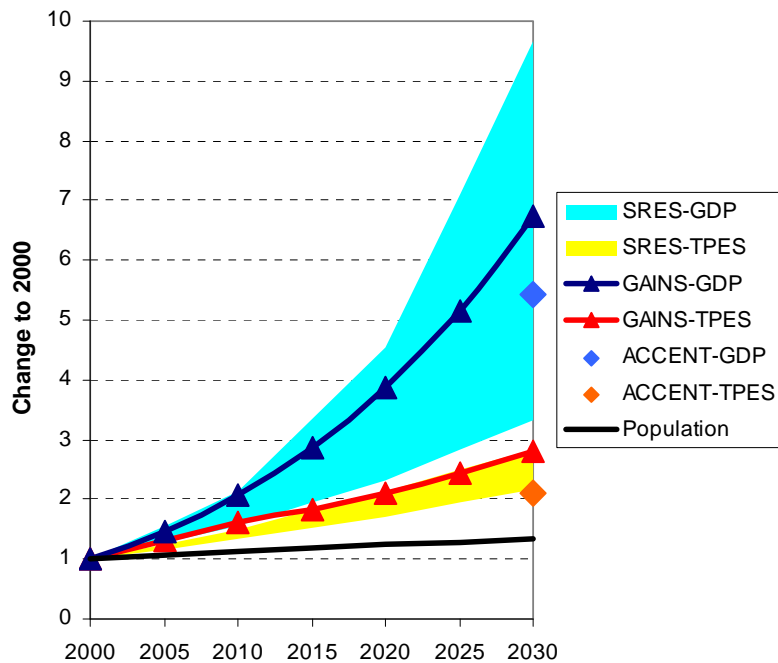


Comparison of macroeconomic assumptions in selected Asian projections

Source: Klimont et al., 2009

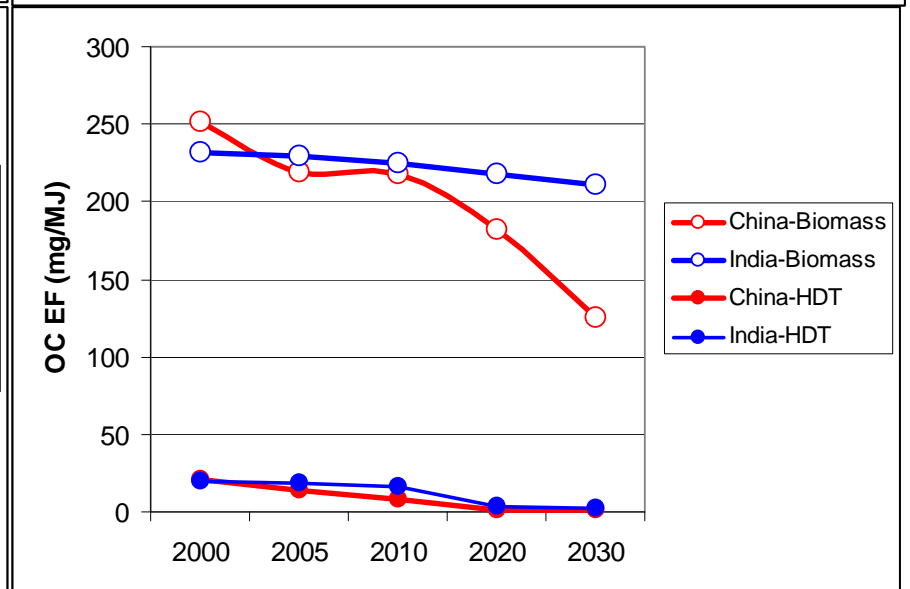
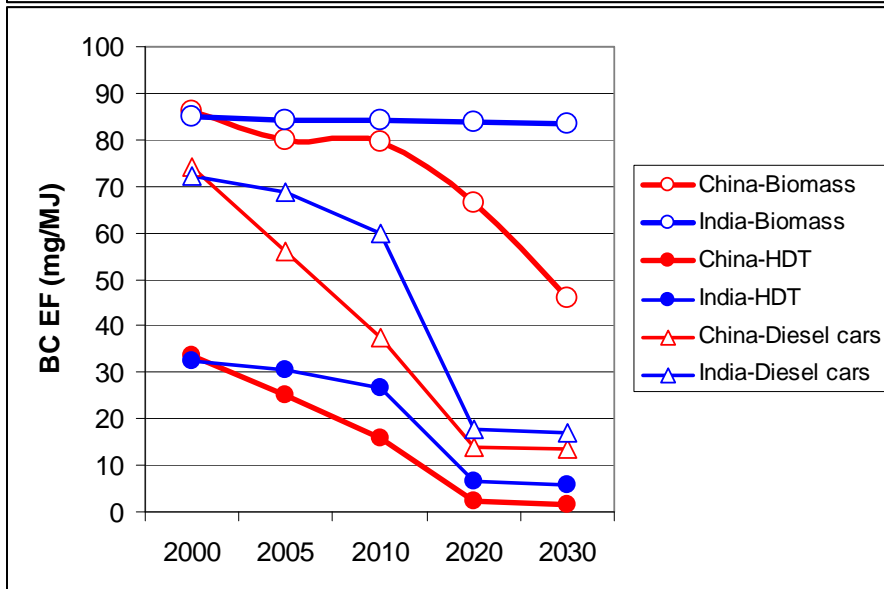
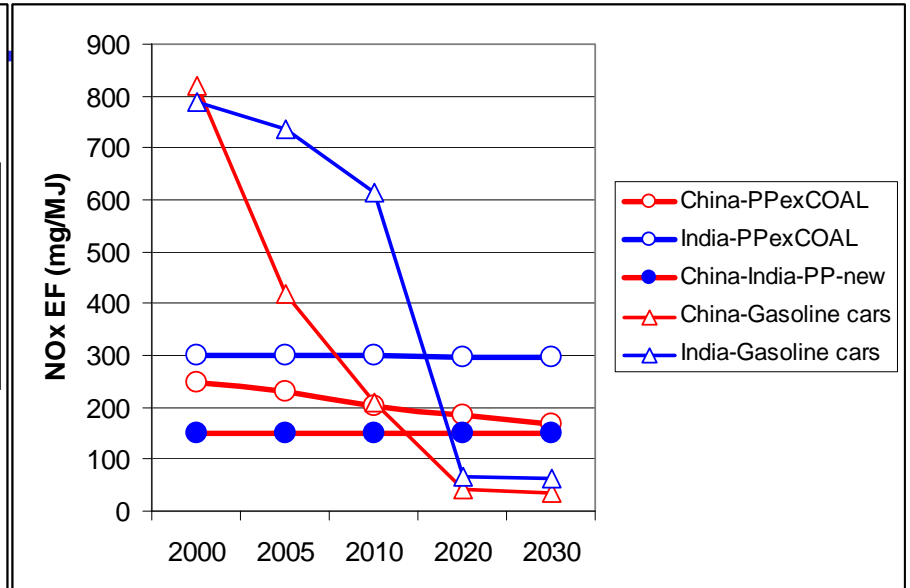
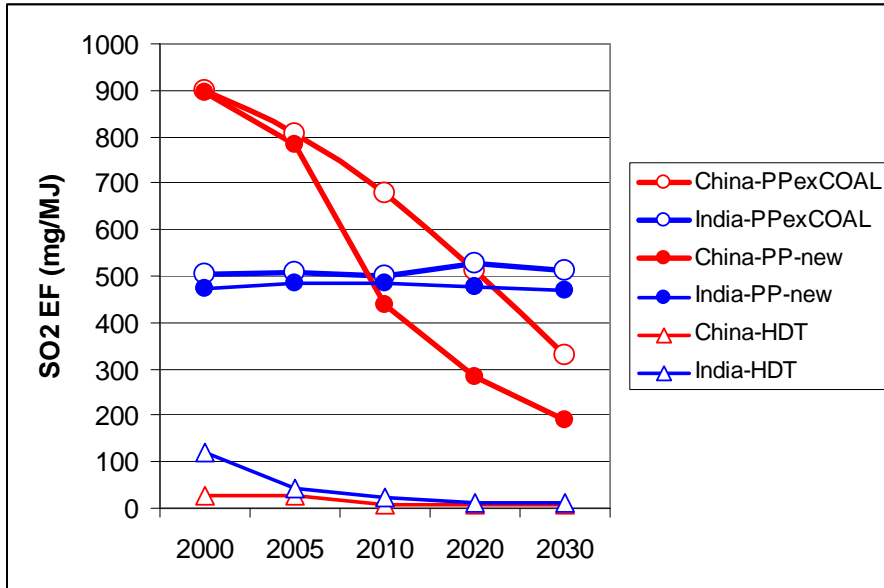


Assumptions on the growth of population, GDP, and total primary energy supply (TPES) in Asia (**LEFT**) and TPES in 2030 by fuel (**RIGHT**) for the compared scenarios

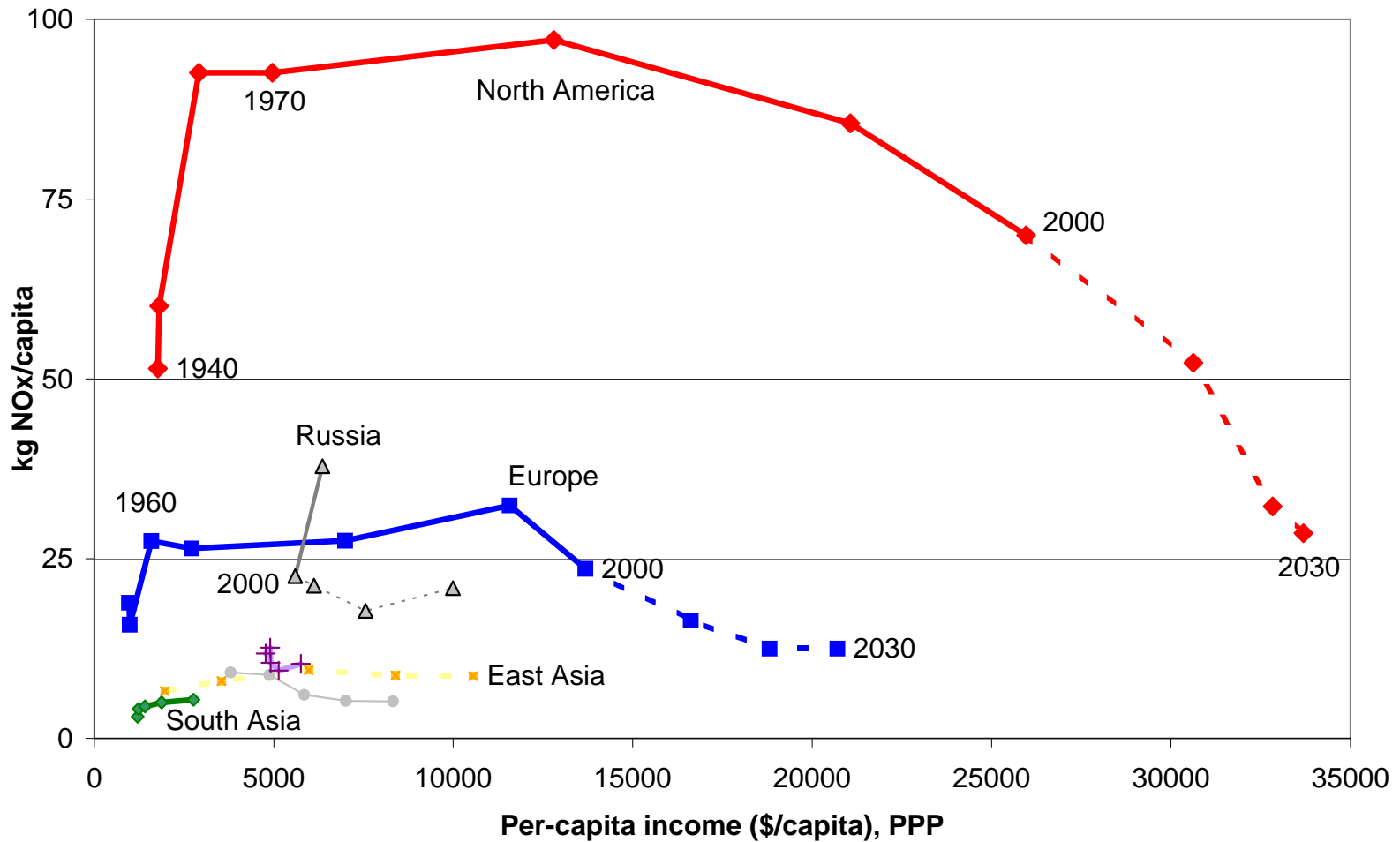


Technology impact on EF in GAINS-Asia

Source: Klimont et al., 2009



Per-capita NO_x emissions 1940-2030

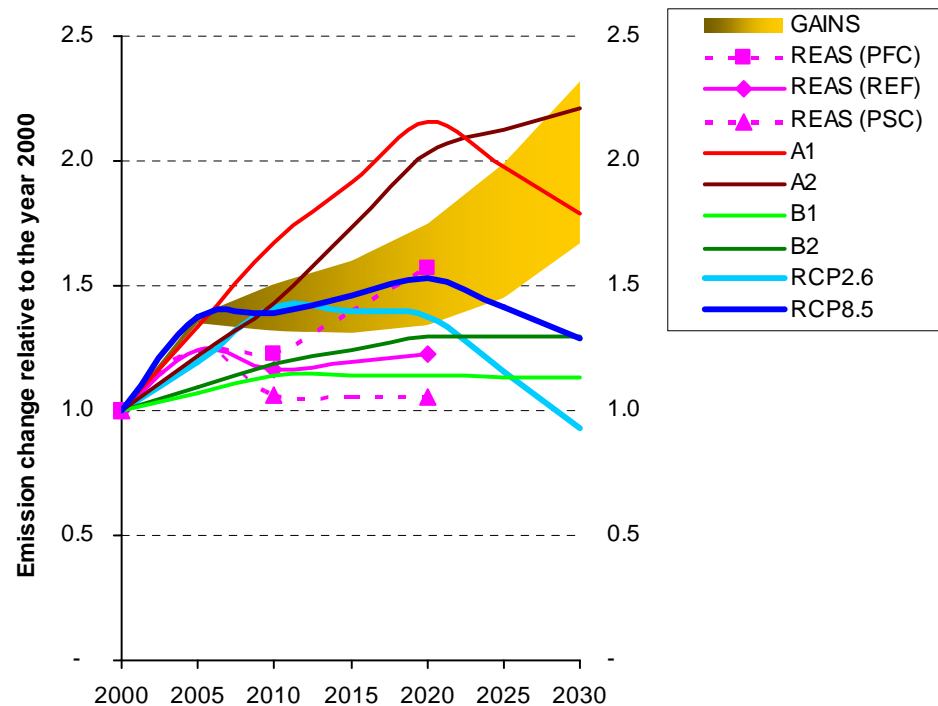
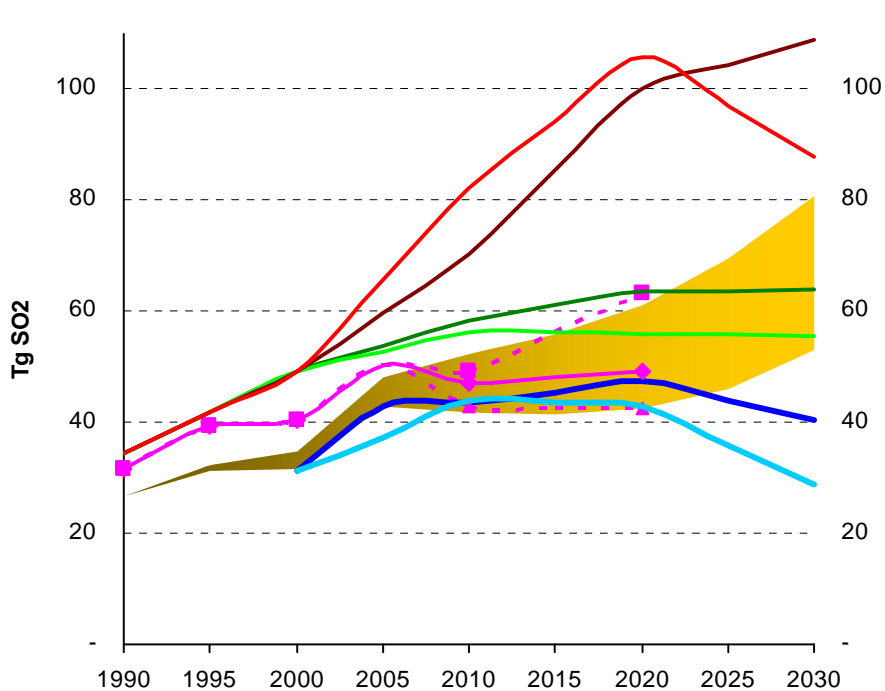


Comparison of SO₂ emissions

Source: Klimont et al., 2009; Ohara et al., 2007; Nakicenovic et al., 2000; RCP database



SO₂ emission estimates for Asia (**LEFT**)
and their growth rates from the year 2000 (**RIGHT**) for the compared scenarios

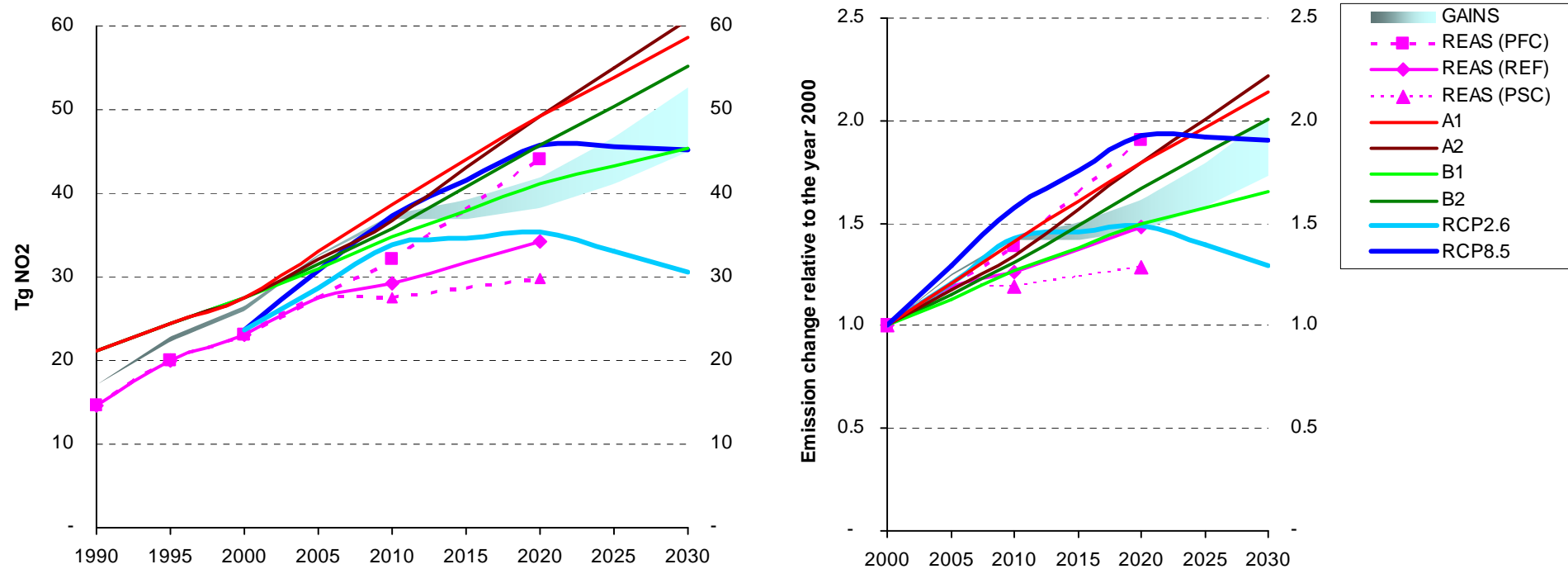


Comparison of NO₂ emissions

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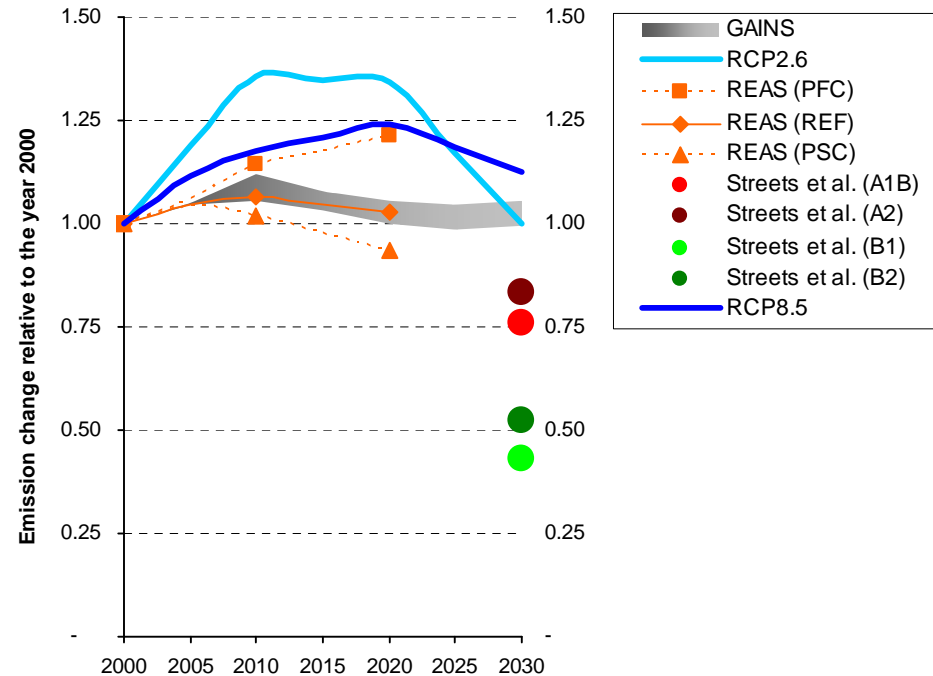
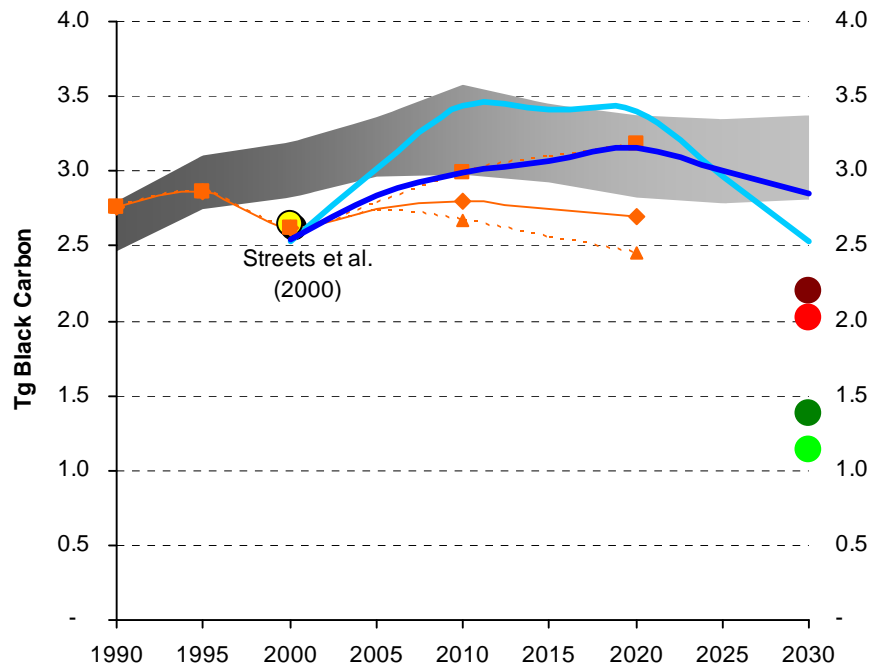


Comparison of BC emissions

Source: Klimont et al., 2009; Ohara et al., 2007; Streets et al., 2004; RCP database



BC emission estimates for Asia (**LEFT**)
and their growth rates from the year 2000 (**RIGHT**) for the compared scenarios

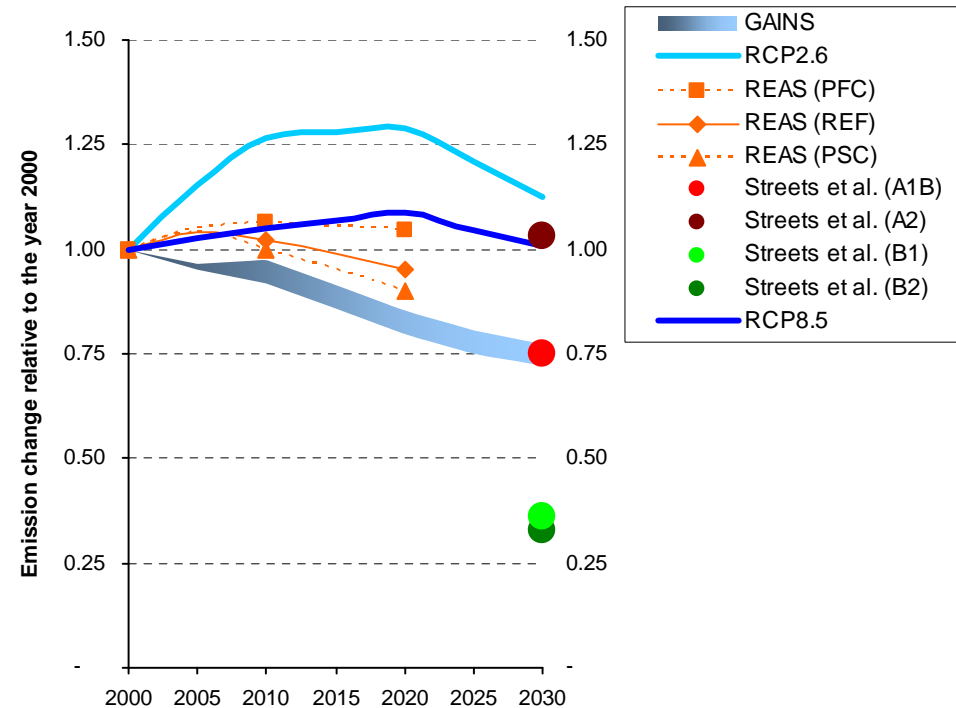
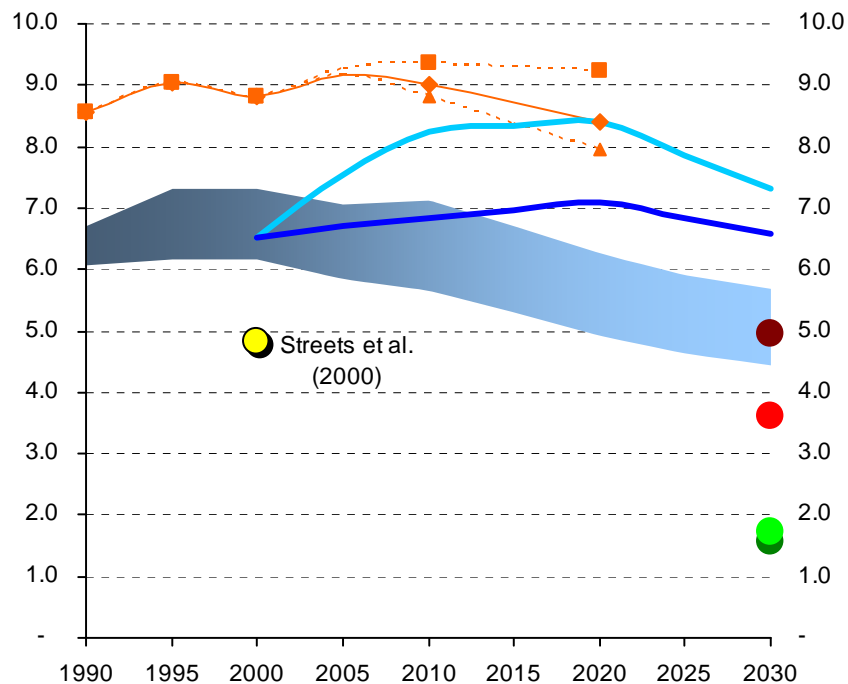


Comparison of OC emissions

Source: Klimont et al., 2009; Ohara et al., 2007; Streets et al., 2004; RCP database



OC emission estimates for Asia (**LEFT**)
and their growth rates from the year 2000 (**RIGHT**) for the compared scenarios



Conclusions – Summary



- Recent inventories and modelling studies confirm the findings of the remote sensing community about high growth of NO_x and SO_2 over East Asia in the last decade, although estimating slightly smaller increases.
- There are still significant uncertainties in the historical estimates
- For the future, the recent studies show comparable trends of Asian emissions
- The impact of legislation has been underestimated in SRES scenarios
- The importance of better quantification of BC and OC emissions has been highlighted recently by various scientific communities; a lot more needs to be done to reduce uncertainty in historical estimates and assessment of reduction potential in Asia
- **This work did not consider any potential impact of the current global economic crisis**

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