Zbigniew Klimont, David Streets, Janusz Cofala, et al.

Changes in Asian emission estimates over time

10th MICS meeting
IIASA, Laxenburg, 18-19th February 2008

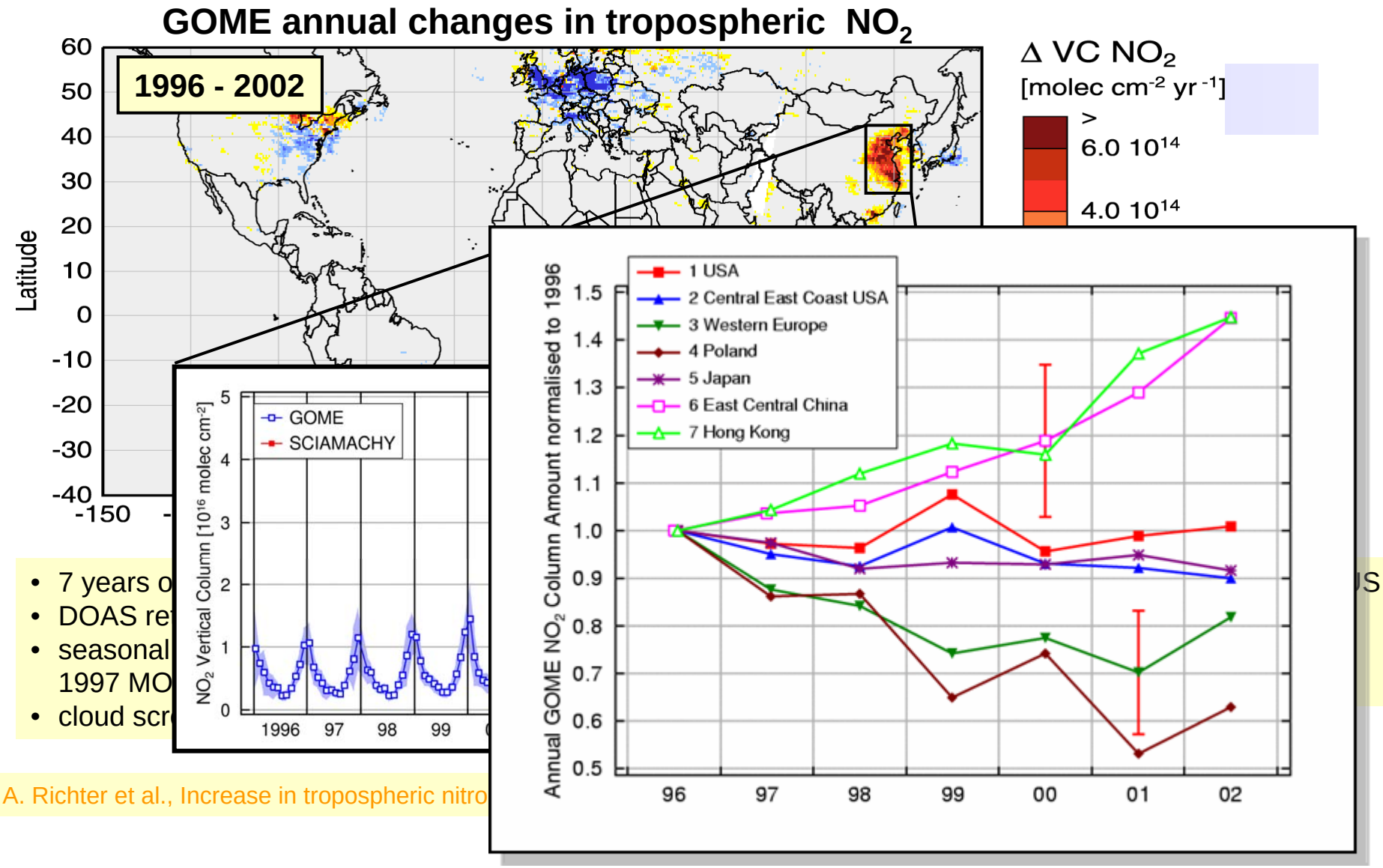
CONTENTS

- ***Joint workshop with ACCENT AT-2 WP on remote sensing (December 2007)***

  – Presentations available from the meeting website: www.iiasa.ac.at/rains/meetings/ACCENT_satellite/accent_satellite.html
  The report is being written and will be available soon.

- **Latest GAINS-Asia scenarios for China and India *(February 2008)***

Example: Detection of NO_2 changes I (Richter et al., 2007)

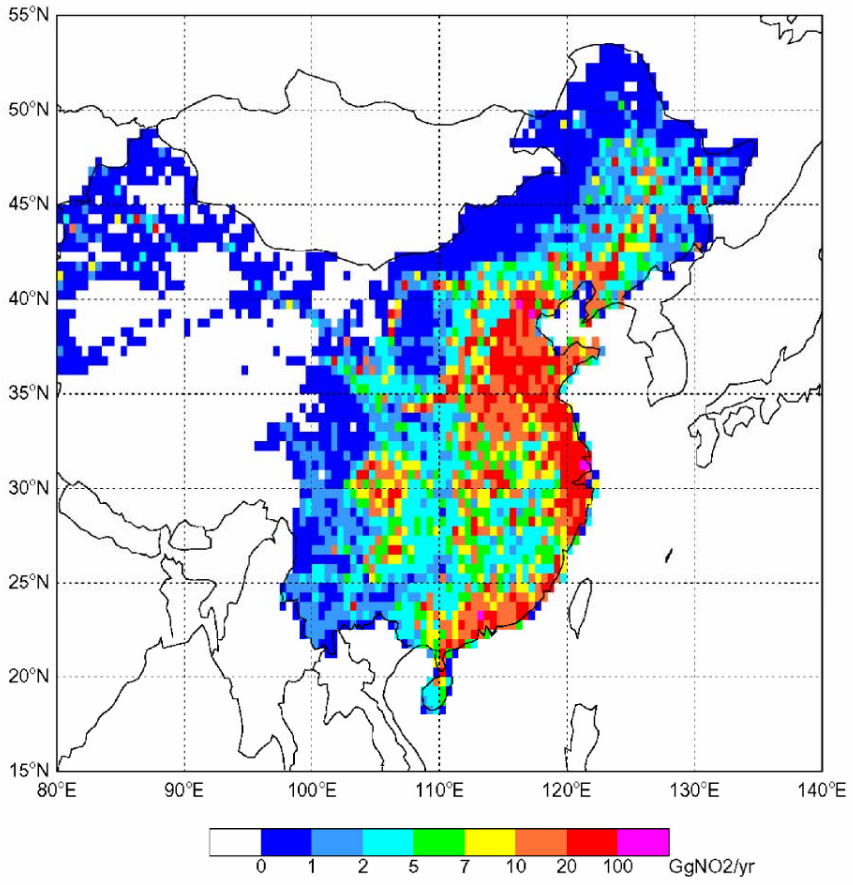


- 7 years o
- DOAS re
- seasonal
  1997 MO
- cloud scr

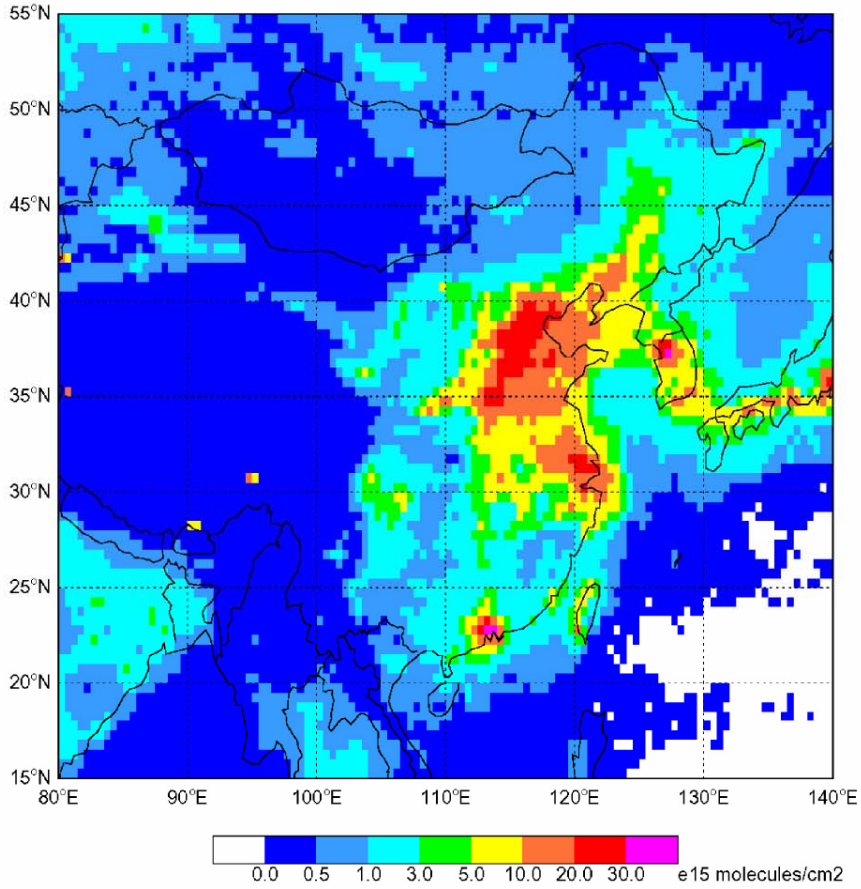
US

A. Richter et al., Increase in tropospheric nitro

The general spatial distributions of NO_x emissions obtained by inventory methods (left) and satellite retrievals (right) are similar (Zhang et al., 2007)



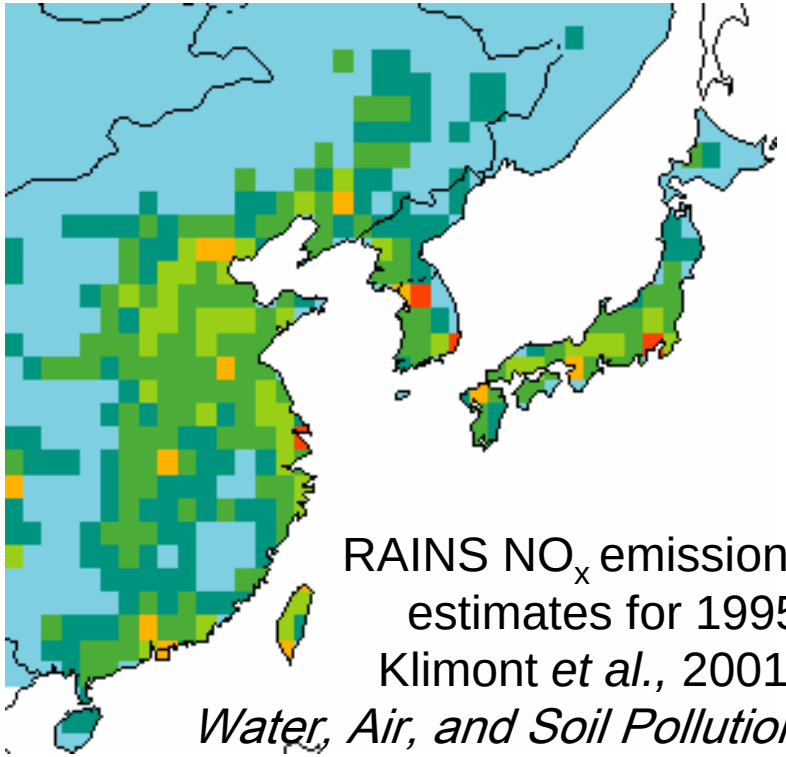
(a)



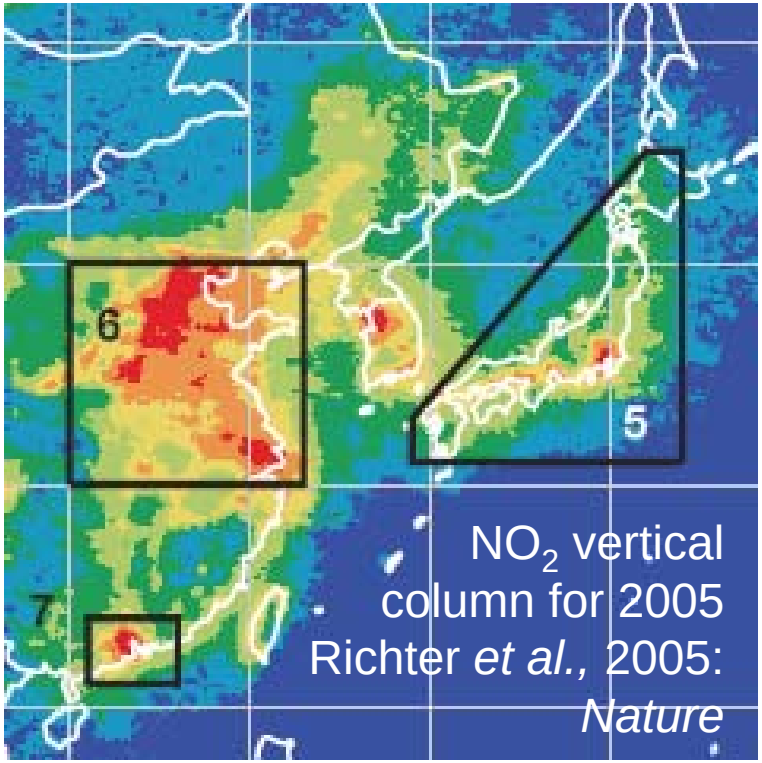
(b)

DS80705

Comparison of emission inventories with satellite information

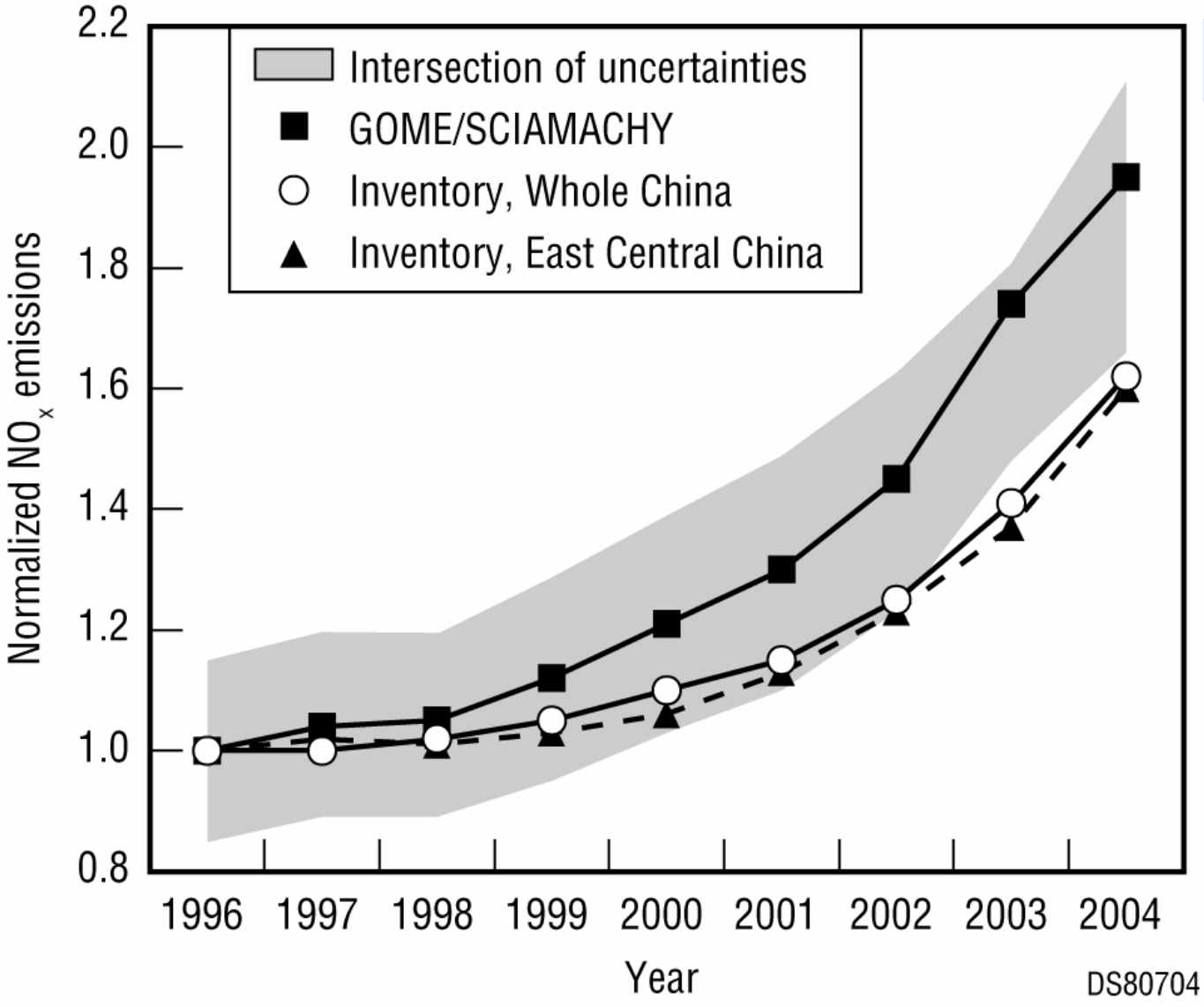


RAINS NO_x emission estimates for 1995
Klimont *et al.*, 2001:
Water, Air, and Soil Pollution

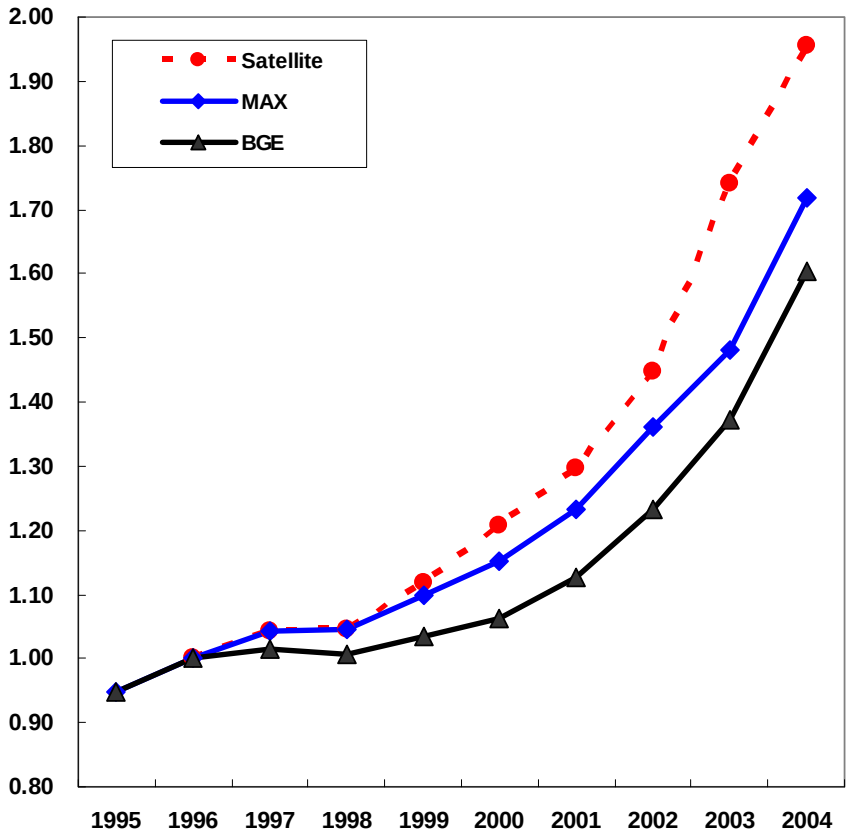


NO_2 vertical column for 2005
Richter *et al.*, 2005:
Nature

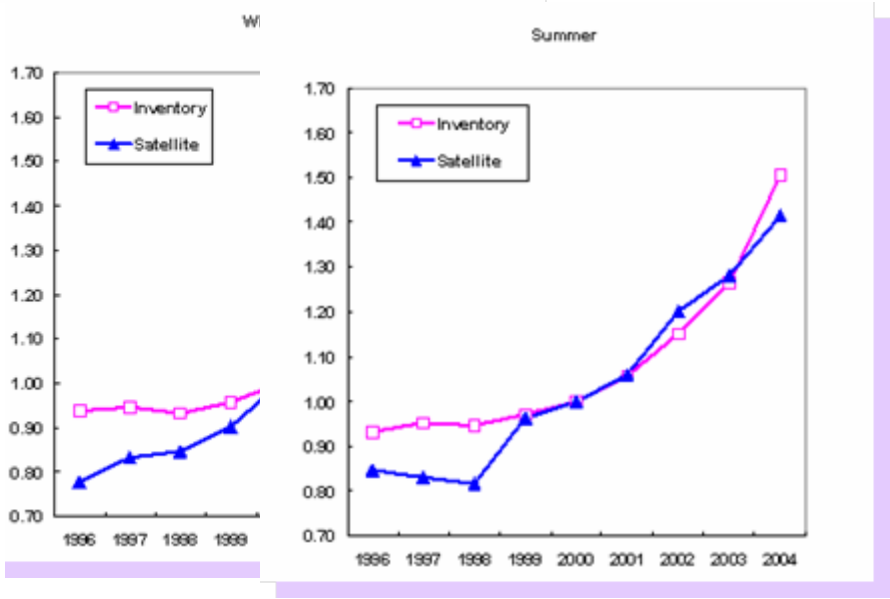
We cannot replicate the exceptionally high growth rates reported by Richter et al. [Nature, 2005] (95%, 1996-2004), but we still get a 61% increase [Streets et al.,2007]



Example: Detection of NO_2 changes II (Richter et al, 2007)



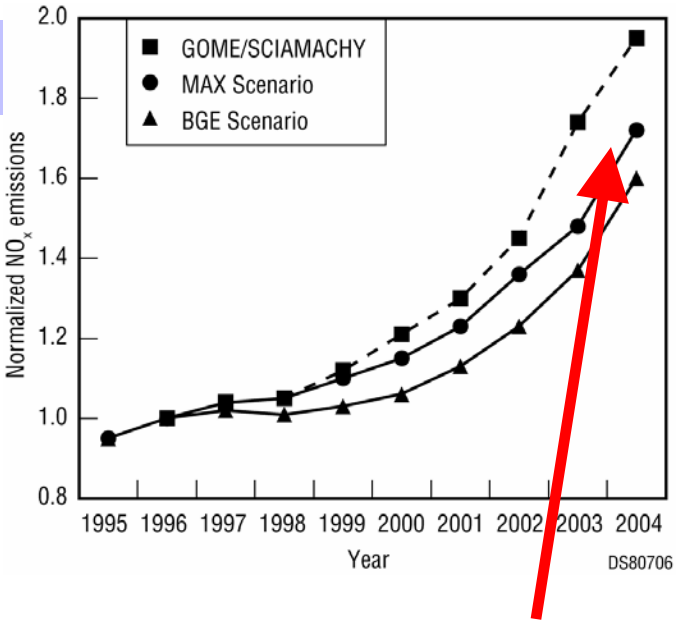
Q. Zhang et al., NOx emission trends for China, 1995–2004: The view from the ground and the view from space, J. Geophys. Res., 112, D22306, doi:10.1029/2007JD008684., 2007



- the latest bottom-up inventories agree qualitatively with satellite data
- summer values agree even quantitatively
- satellite problems in winter?
- strong seasonality in emissions?

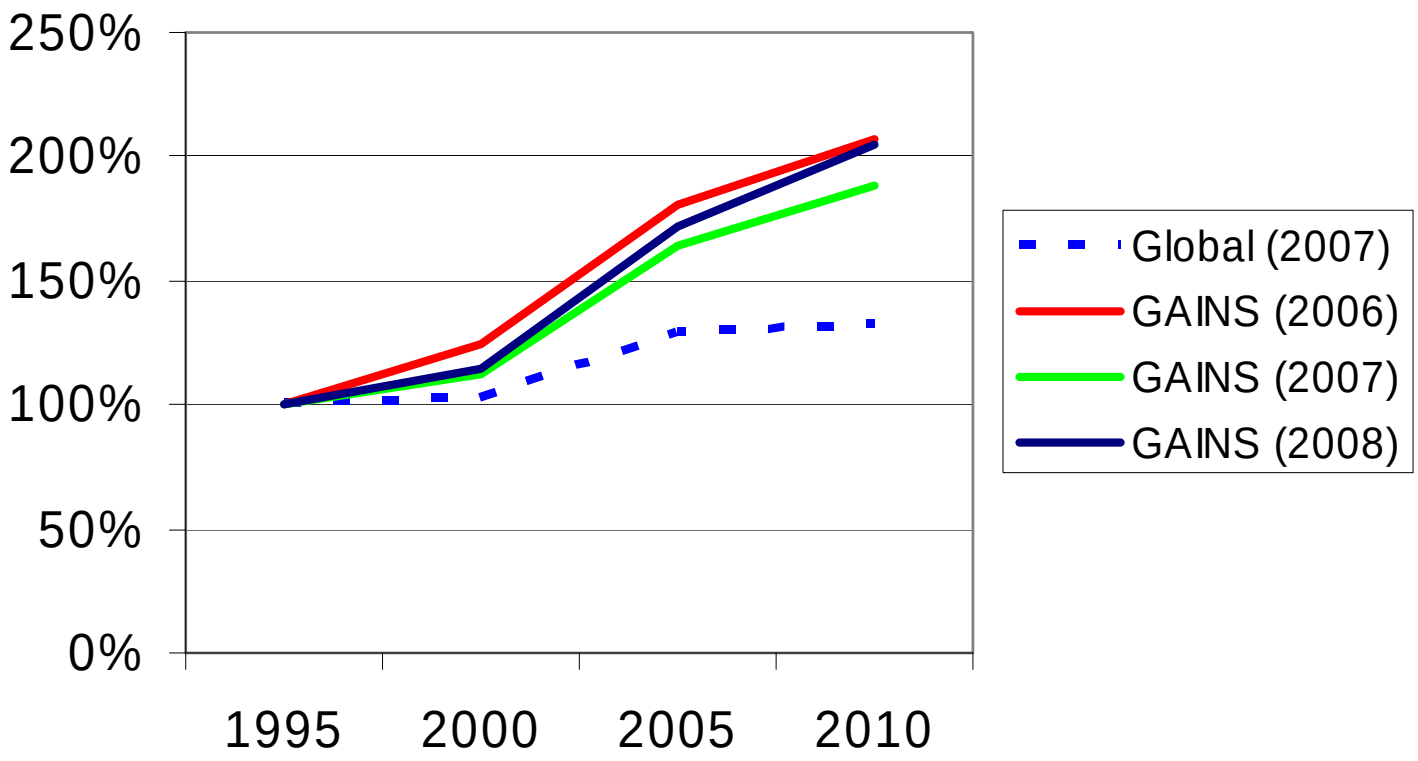
Some possible reasons for differences between satellite retrievals and emission inventories in wintertime (Streets et al., 2007)

- Due to the lack of coal in recent years, power plants sometimes could not get enough high-quality coal in winter
- Vehicles emit more NO_x in winter from cold starts
- Energy use in winter may be underestimated, especially for residential and central heating
- Changing NO_x emissions injection height (getting higher)
- Sulfate concentration in winter has also increased over the years, which may increase the satellite-retrieved NO_2 columns
- Satellites fly over China in the morning; captured trend exaggerated due to dominance of traffic emissions?
- Can NO_x atmospheric lifetime contribute to 'double counting' of some emissions in retrievals?
- Underestimated NO_x emissions from N mineral fertilizers? Their use grew in this period by nearly 70%

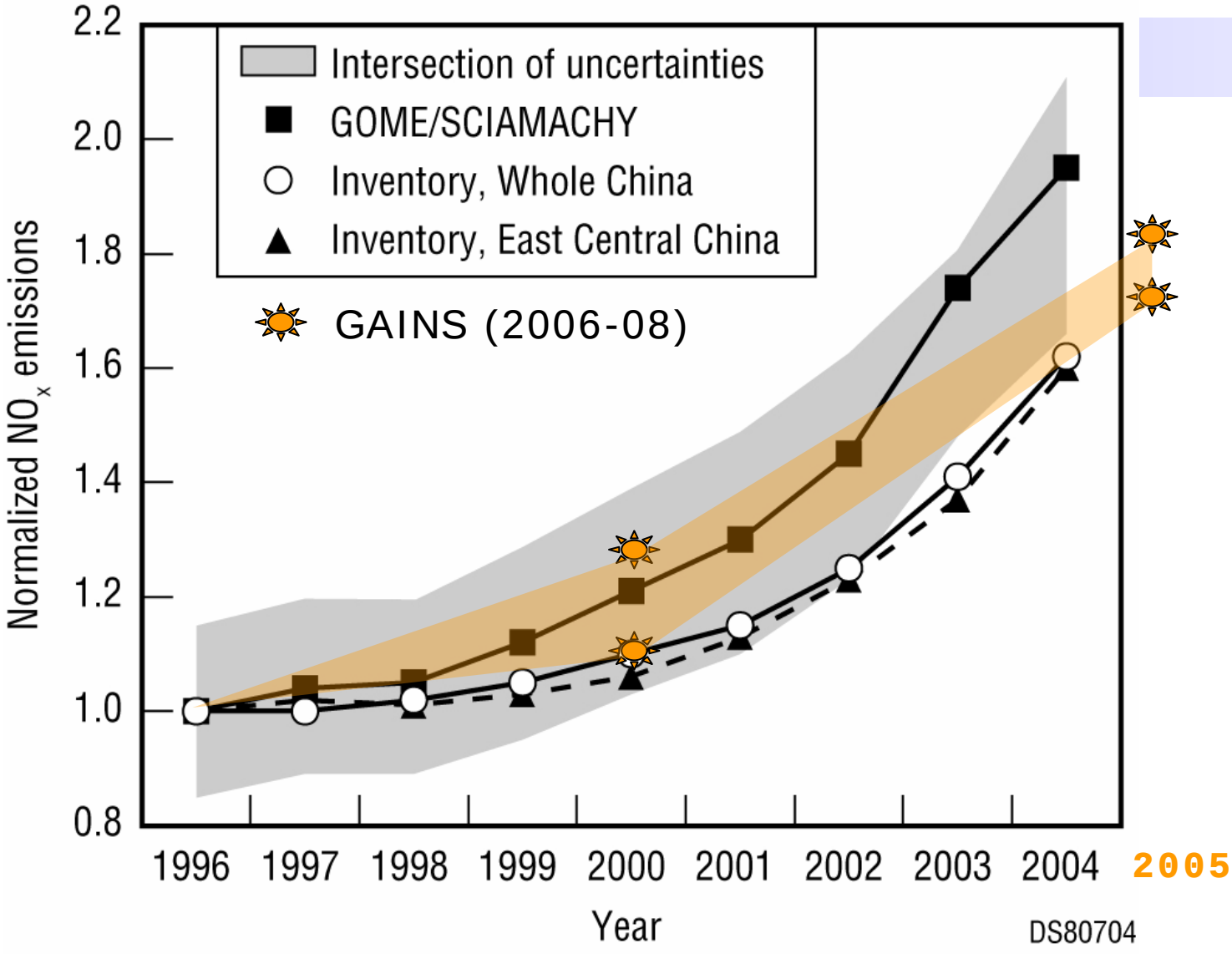


But, even with our highest inventory estimate, which maximizes parameter values, we cannot reproduce the satellite trend.

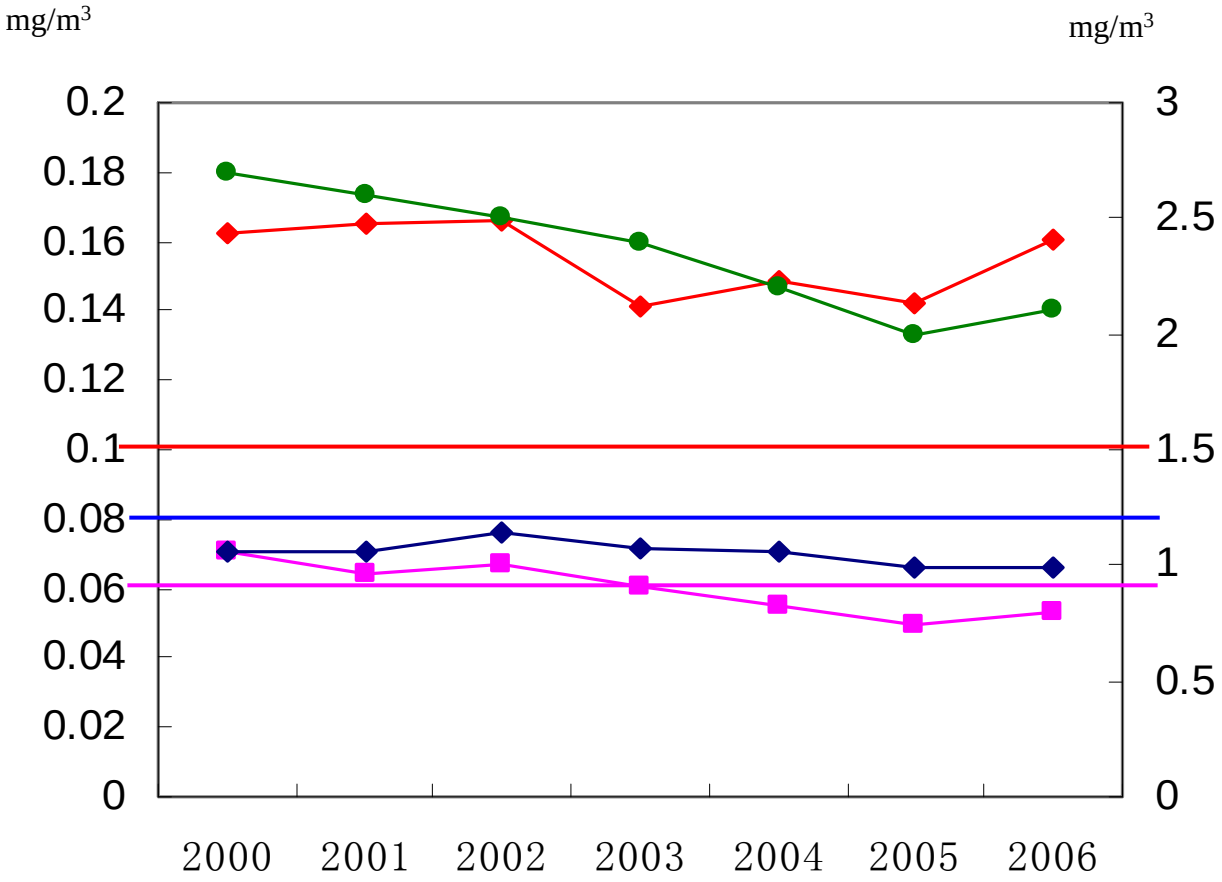
NOx emission estimates for China in GAINS



We cannot replicate the exceptionally high growth rates reported by Richter et al. [Nature, 2005] (95%, 1996-2004), but we still get a 61% increase [Streets et al.,2007]



Trends of Air Quality in Beijing (Wang et al., 2007)



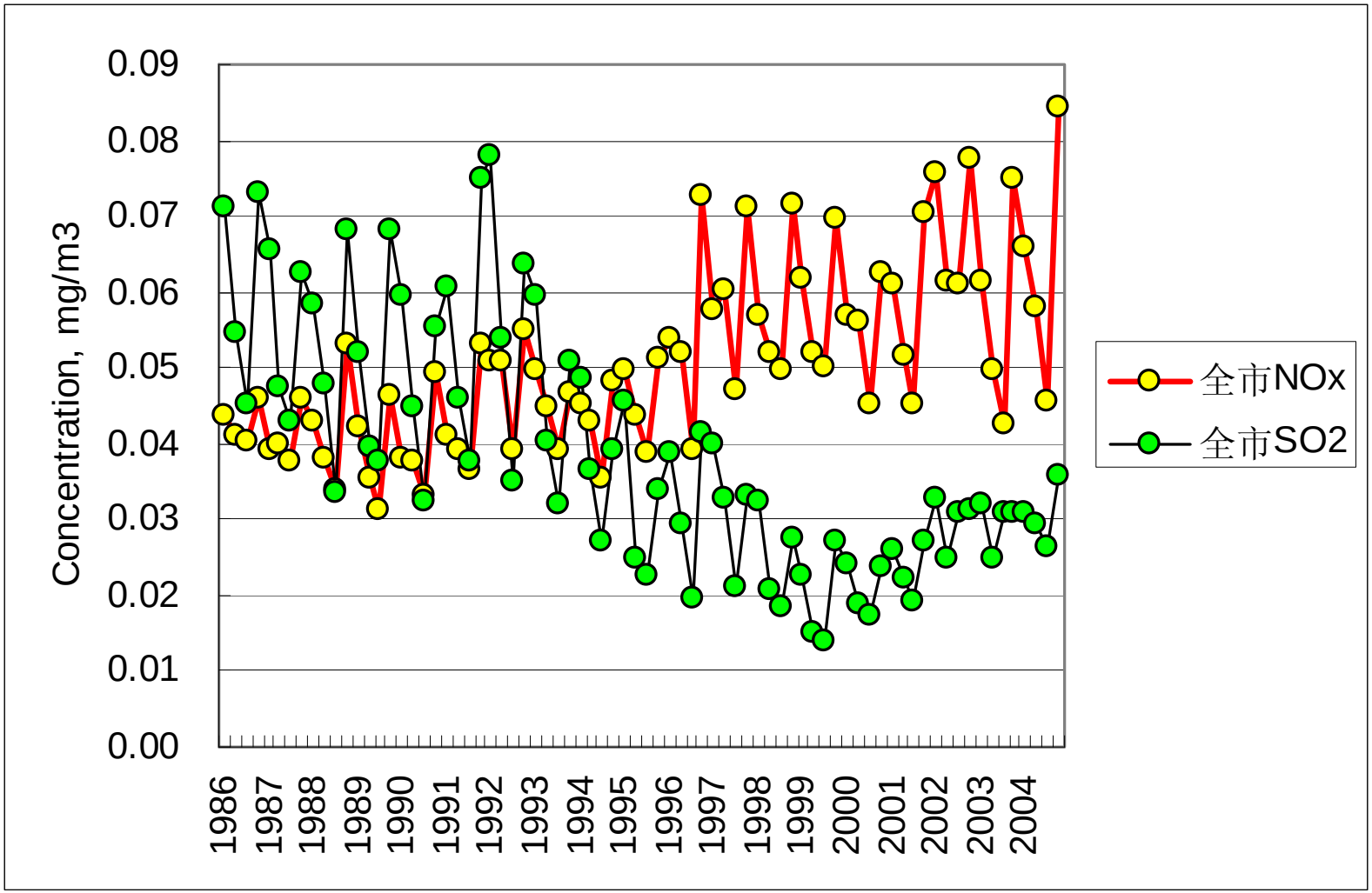
SO_2 : 25%↓

CO: 22%↓

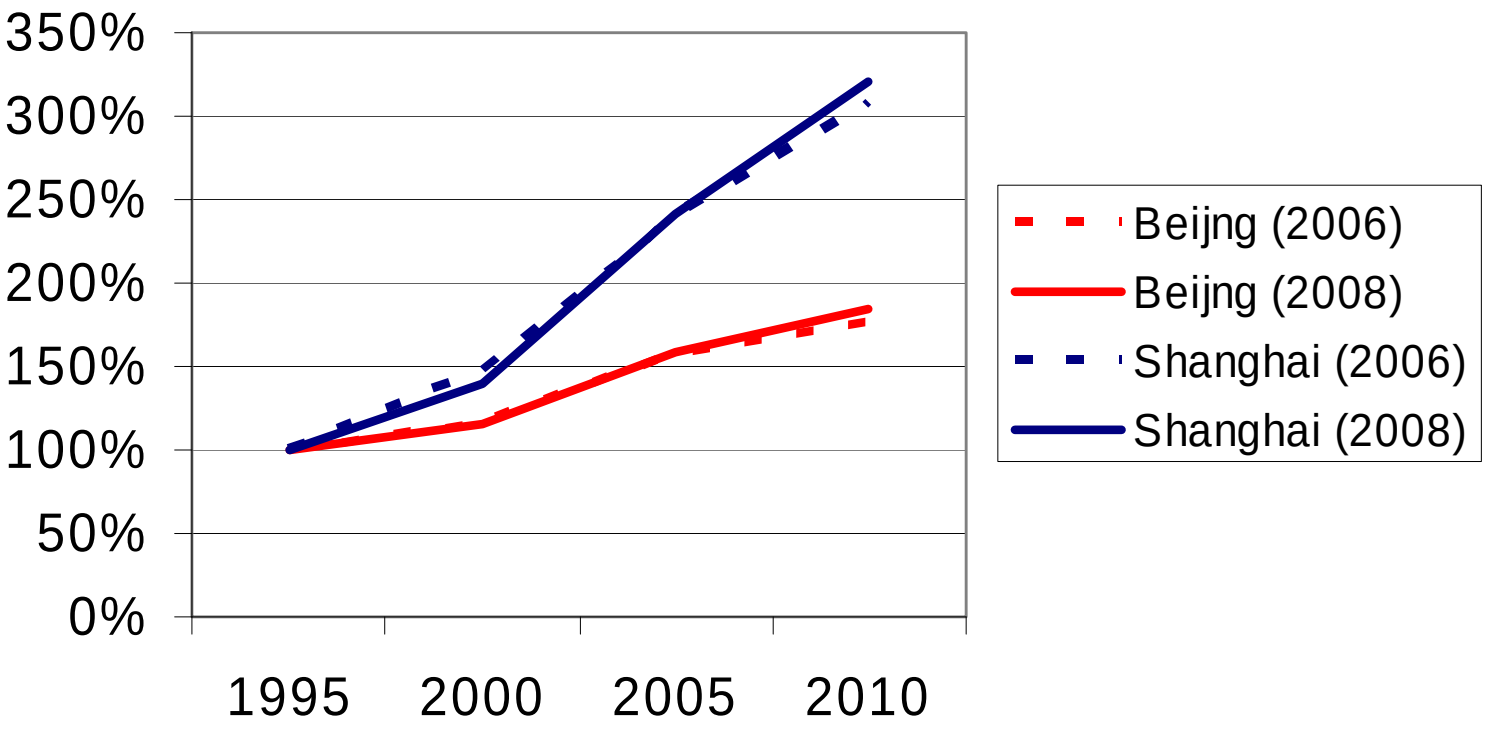
NO_2: 7%↓

PM_{10}: 0.6%↓

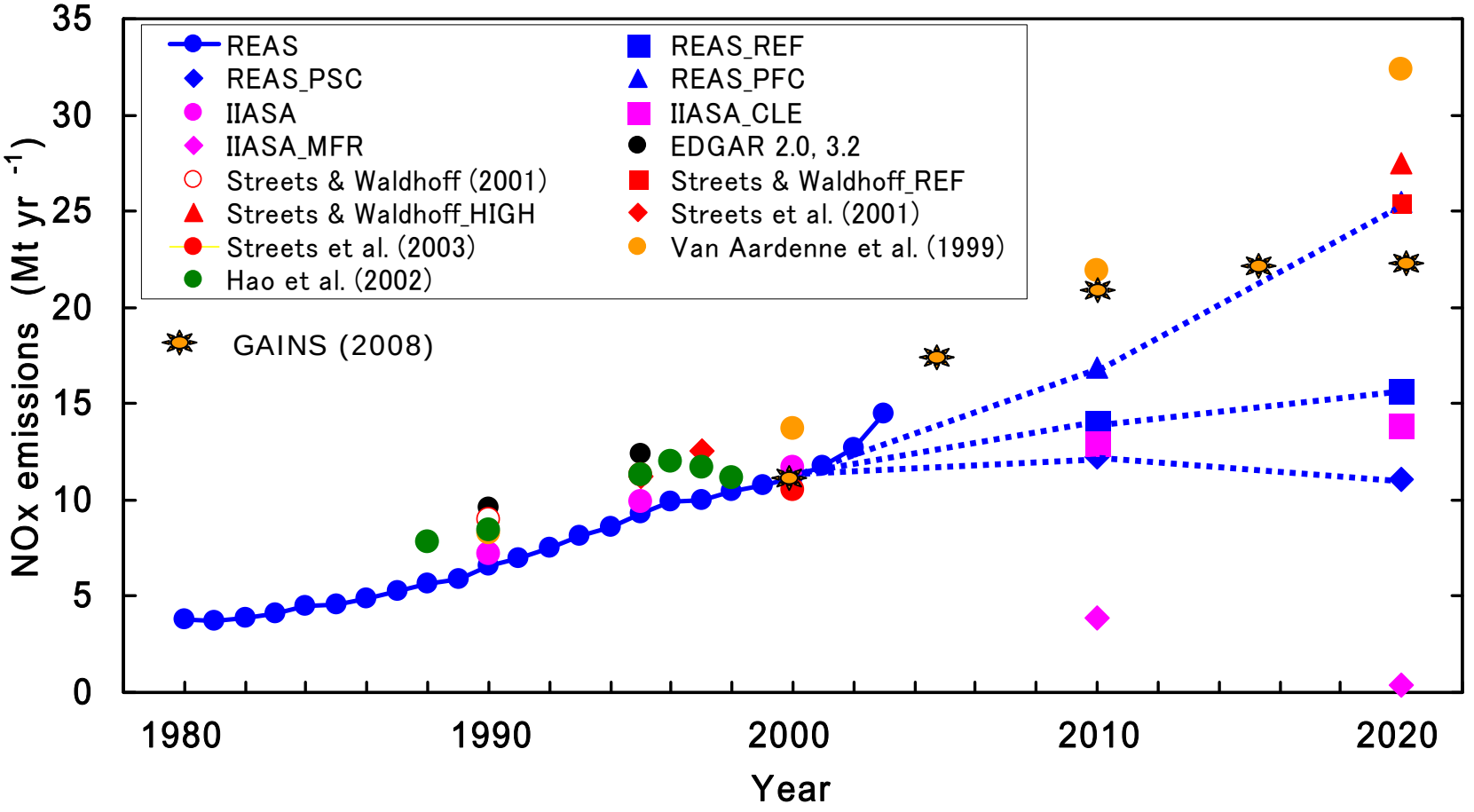
Trends of Air Quality in Shanghai (Wang t al., 2007)



NOx emission estimates for China in GAINS



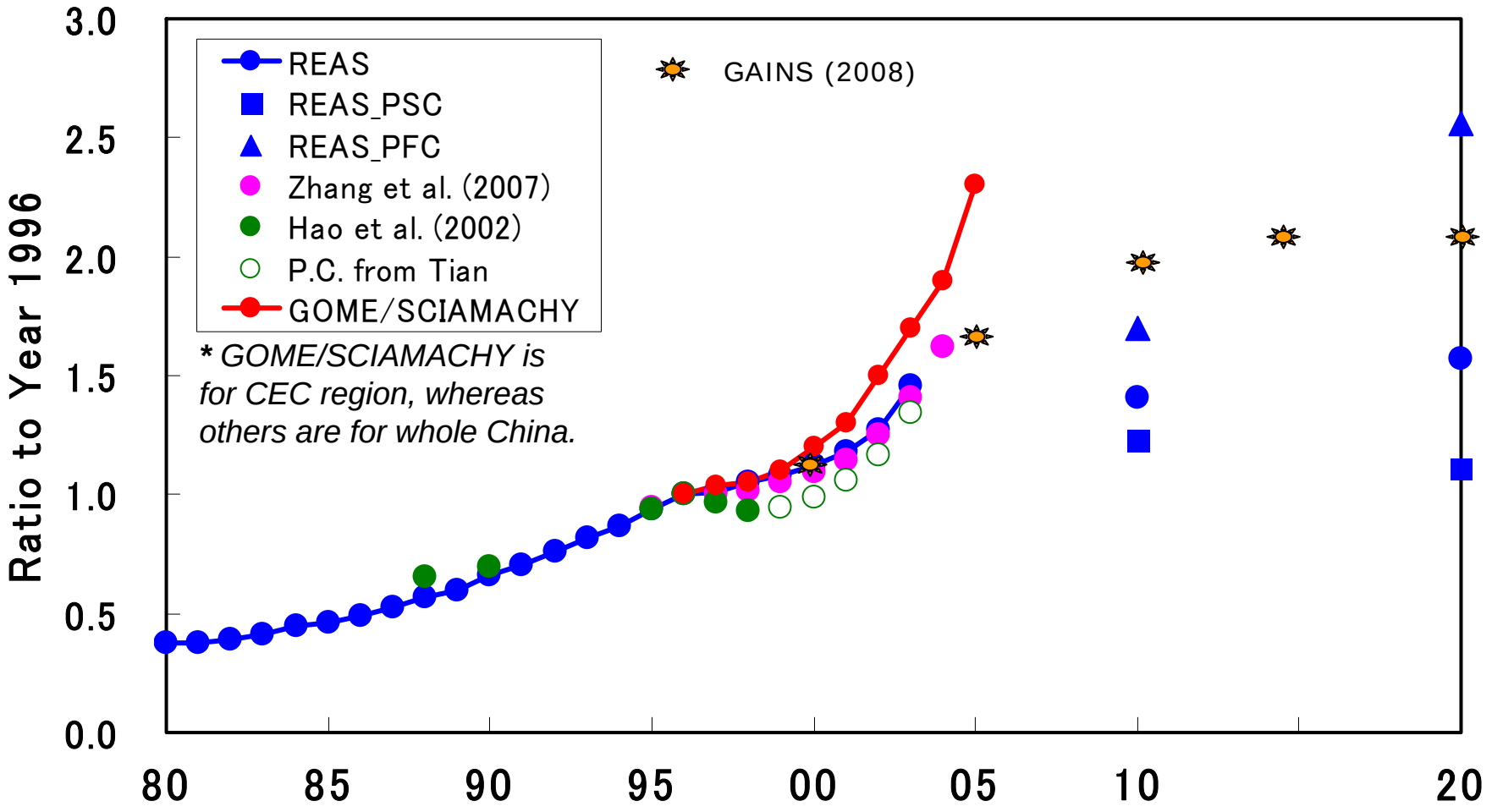
Comparison of time series of NOx emissions in China (1) (Ohara et al., 2007)



Before 2000, the difference of NOx emissions from each inventory is within 30 %. REAS is slightly lower.

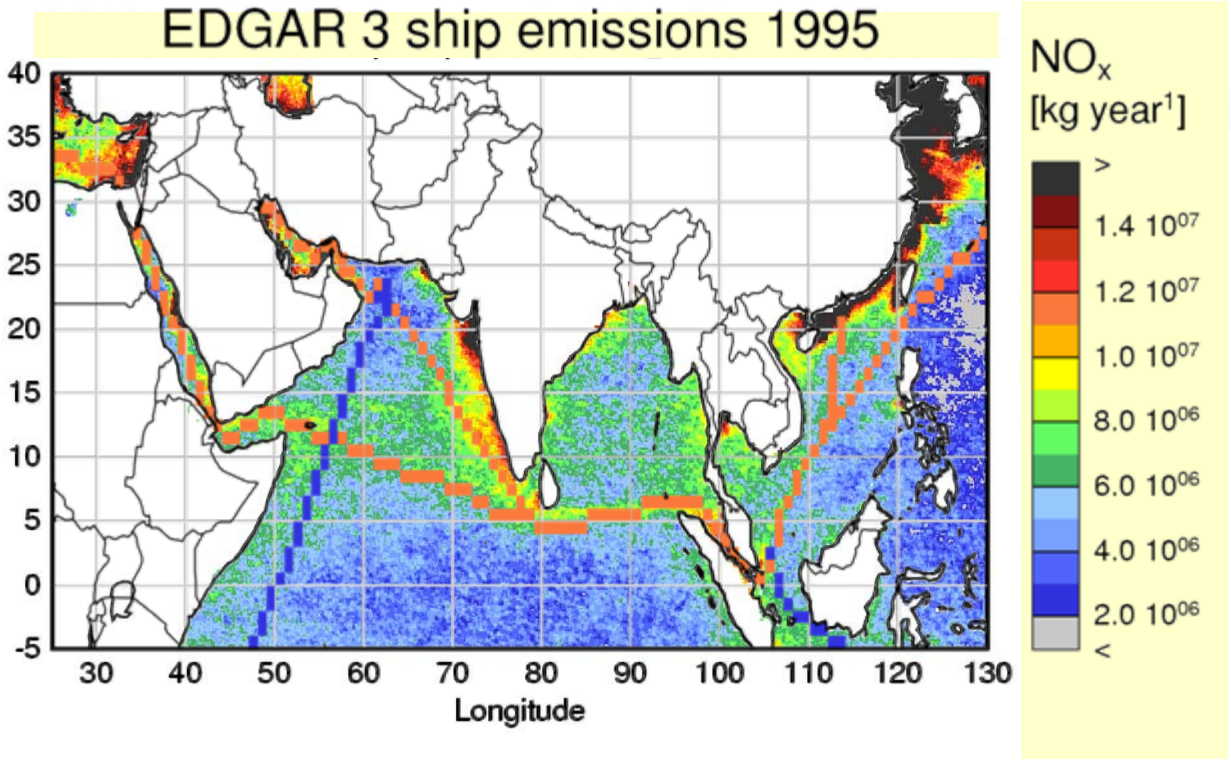
The results of future projection strongly depend on the scenario.

Comparison of time series of NOx emissions in China (2) (Ohara et al., 2007)



Growths between 1996-2003 in three inventories is quite similar, although their methodology and input data are different each other. However, they are lower than that of GOME/SCIAMACHY NO_2 VCDs.

Example: Detection of Shipping Emissions (Richter et al., 2007)



With estimate of NO_2 lifetime, NO_x emissions can be estimated => agreement within error bars.

But: error bars still large (mainly from lifetime)

Ship emissions:

- large source of NO_x, SO_x and aerosols
- relevant input into marine boundary layer
- well defined NO_2 patterns in Red Sea and Indian Ocean in SCIAMACHY data
- consistent with pattern of shipping emissions

A. Richter et al., Satellite Measurements of NO2 from International Shipping Emissions, *Geophys. Res. Lett.*, **31**, L23110, doi:10.1029/2004GL020822, 2004