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International Meeting on Land Use and Emissions in South/Southeast Asia

S-12 project and Regional Emission Inventory in Asia (REAS)

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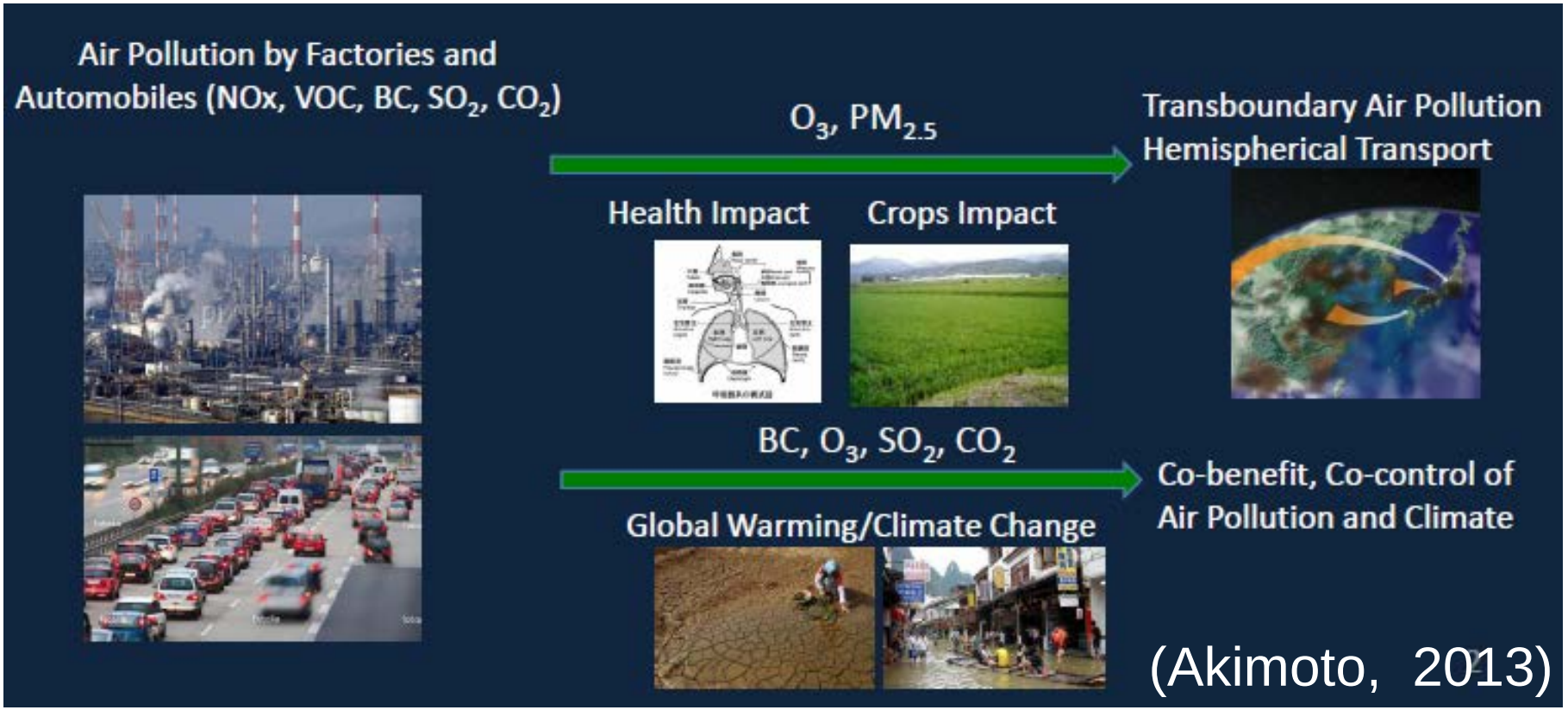
What is SLCPs (Shout-lived Climate Pollutants)

1. Tropospheric ozone: Its precursors: CH_4, NOx/VOC
2. Black carbon (BC)



1. Air pollution reduction
2. Climate change mitigation

Why SLCP mitigation now?

(1) Climate Policy Side

CO_2 control can mitigate climate change only after 2050 for grand and grand-grand children generation, but the present climate change is more urgent issue and mitigation in mid-term future (2030-2050) should also be concerned for our own and our children generation.

SLCP control must be useful to accomplish the near future mitigation of climate change.

(2) Air Pollution Policy Side

Present situation of health and vegetation impact by surface ozone and PM is serious from human health and economic damage point of view.

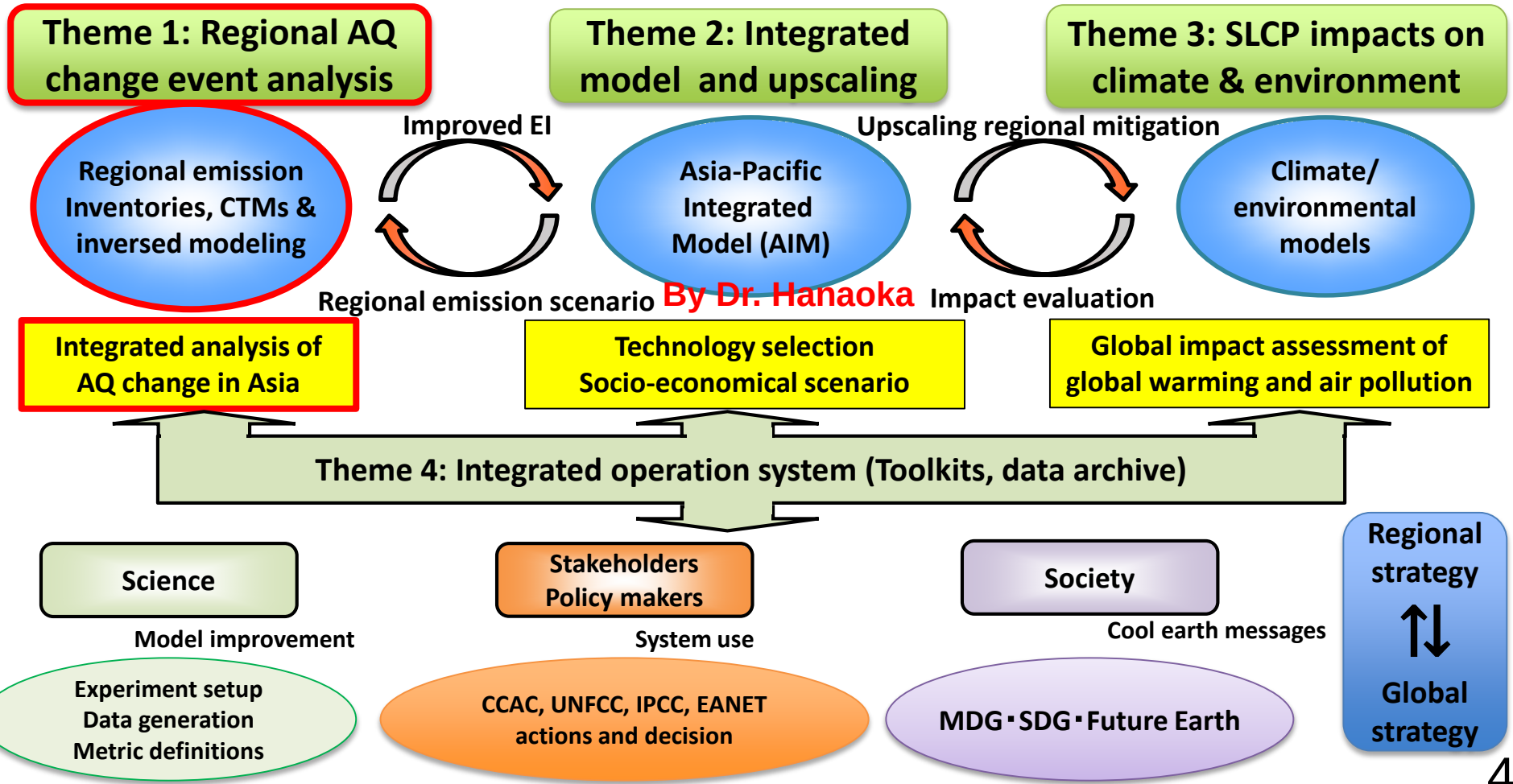
This is particular so in Asia!

In order to facilitate mitigation of air pollution, SLCP control by co-benefit approach must be useful particularly in developing countries giving more incentives.

Much need of SLCP mitigation in Asia

MOEJ-S12: Active evaluation of SLCP impacts and seeking the optimal pathway (2014-2018) *PI: Terry Nakajima*

- Reduction of SLCP is easier than that of LLGHG due to their short lifetime, but the effects are very complex.
- Therefore, search for optimum mitigation paths is important for society.
- It is needed to develop an active evaluation system for LLGHG and SLCP mitigation policy, by overarching emission inventory, integrated models, and climate models.



Aim of Theme 1 of S12

(1) The **air quality change events caused by air pollution control and socioeconomic variations**, which are considered to be social experiments of SLCP mitigation, are analyzed by means of regional/global chemical transport modeling (CTM), inverse modeling (IM) and regional emission inventory (EI).

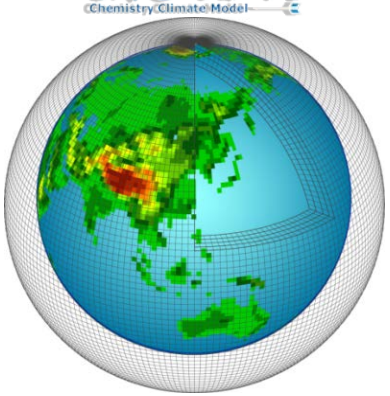
(2) CTM, IM, and EI are integrated as an **analysis/verification system** for quantifying the emission reduction and air quality improvements due to SLCP mitigation. The system is validated by the analysis of air quality change events.

(3) The system is applied to **assessment for SLCP mitigation** policy and future emission scenario.

Structure of analysis/verification system for regional air quality changes

Global CTM

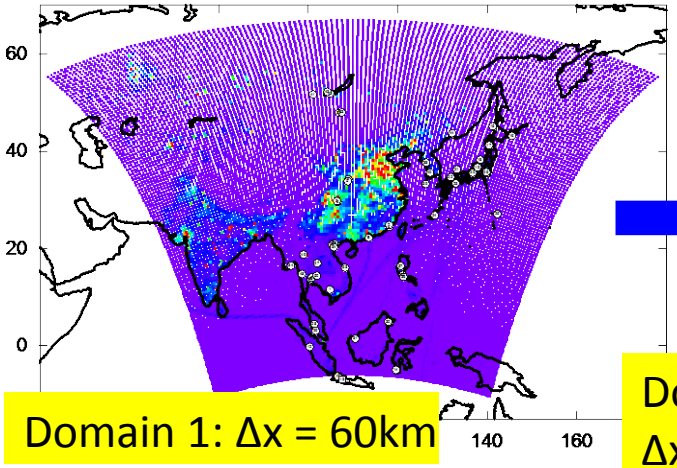
CHASER Chemistry Climate Model



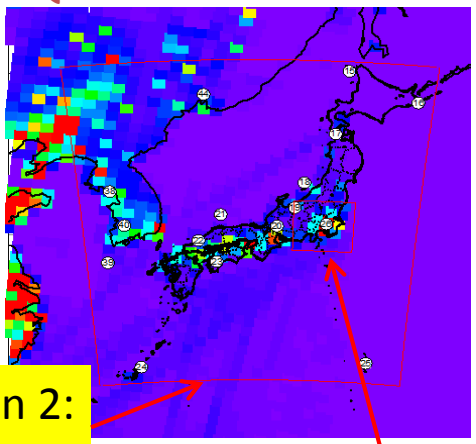
Δx = 180 km（T63）

Regional CTM

WRF/CMAQ



Domain 1: Δx = 60km



Domain 2: Δx = 15km

Domain 3: Δx = 5km

Another model: NICAM-Chem (Multi-scale seemless CTM)

Emissions

Modeled results

Ground, Lidar & satellite monitoring data

CTM

Emissions

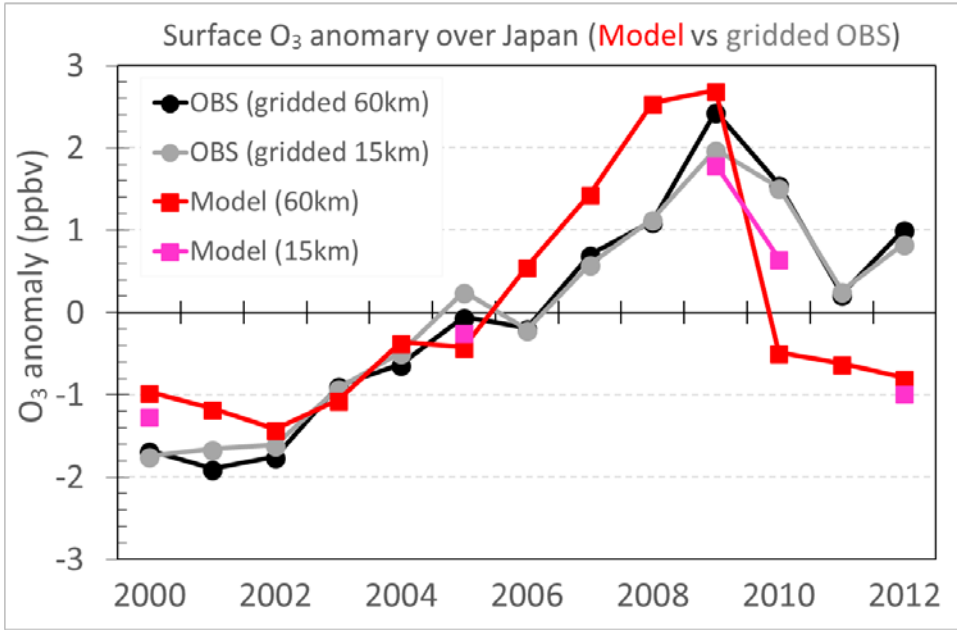
Emission inventory

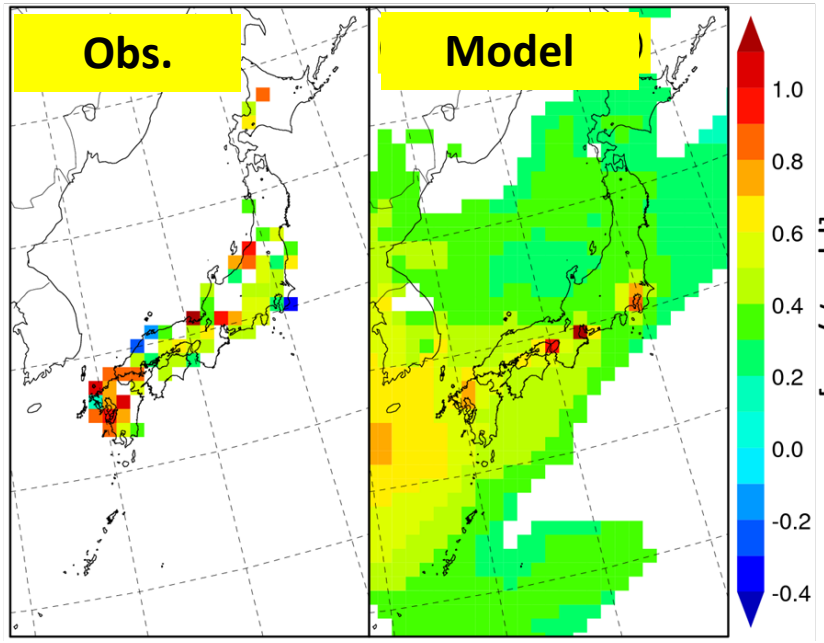
A priori emission

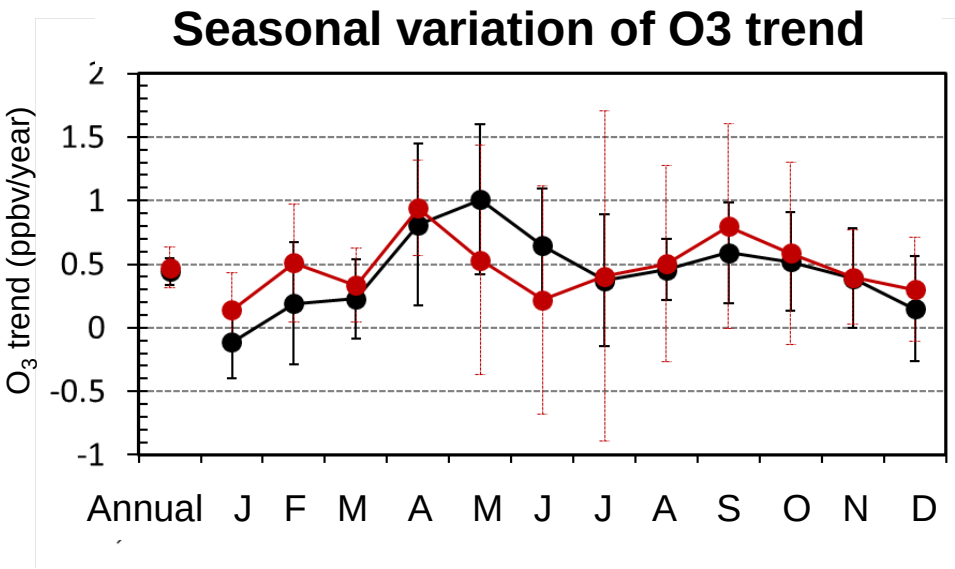
A posteriori emission

Inverse modeling

Simulated long-term variation of surface ozone in Japan







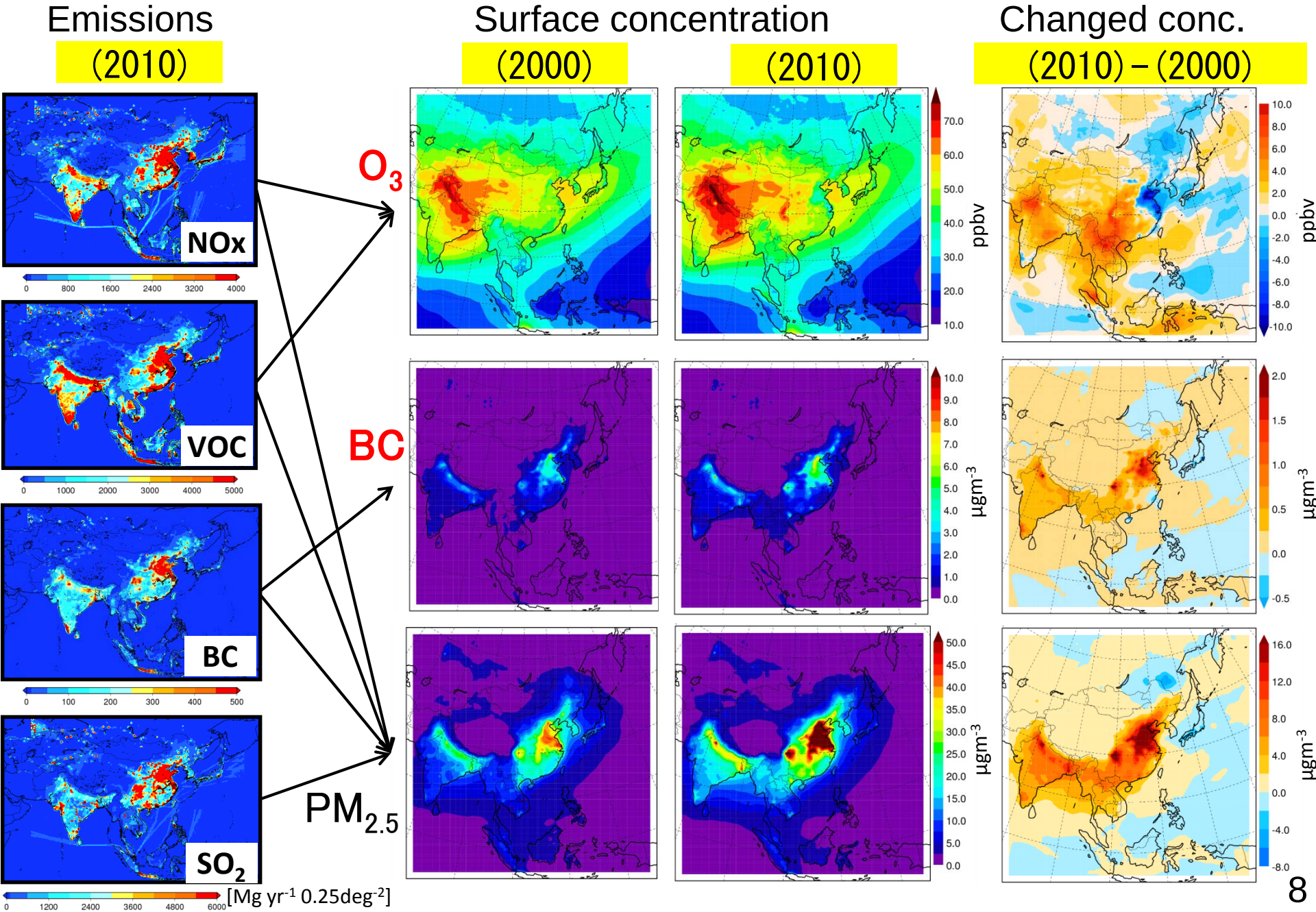
Successful modeling of

- ✓ O3 increase during 2000-2009 and its decrease after that
- ✓ Seasonal and spatial variations of O3 trend during 2000-2009

  Spring, Autumn > Summer, Winter

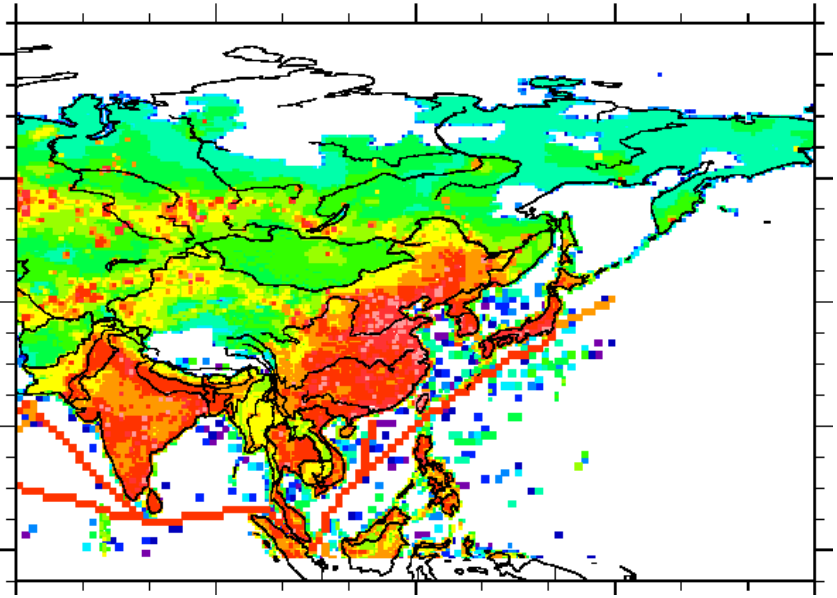
  West > East

Changes of O3, BC, and PM2.5 in Asia during 10 years



Regional Emission inventory in ASia (REAS)

[Ver.1] Ohara et al. (2007) ACP; [Ver.2] Kurokawa et al. (2013) ACP



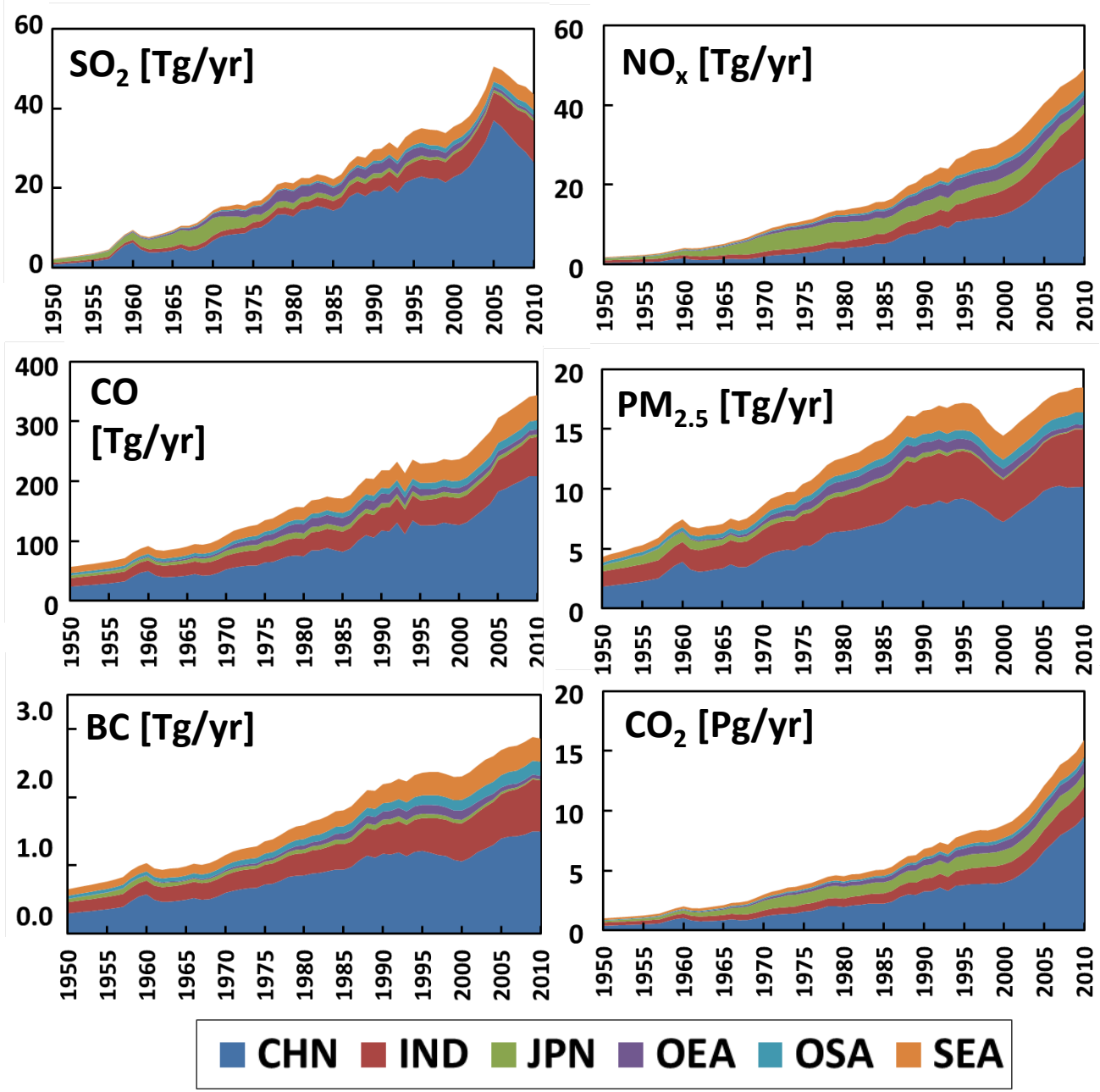
Item	Description
Emission sources	Anthropogenic
Areas	E, SE, and S Asia + Russian & Central Asia
Years	2000-2008
Spatial Resolution	0.25 x 0.25 degree
Temporal Resolution	Monthly

	SO_2	NO_x	CO	PM_{10}	$PM_{2.5}$	BC	OC	NMV	NH_3	CH_4	N_2O	CO_2
Fossil Fuel Biofuel	●	●	●	●	●	●	●	●	●	●	●	●
Industrial Process	●		●	●	●	●	●	●	●		●	●
Fertilizer use		●							●	●	●	
Livestock									●	●	●	
Others								●	●	●	●	

Recent progress of REAS update

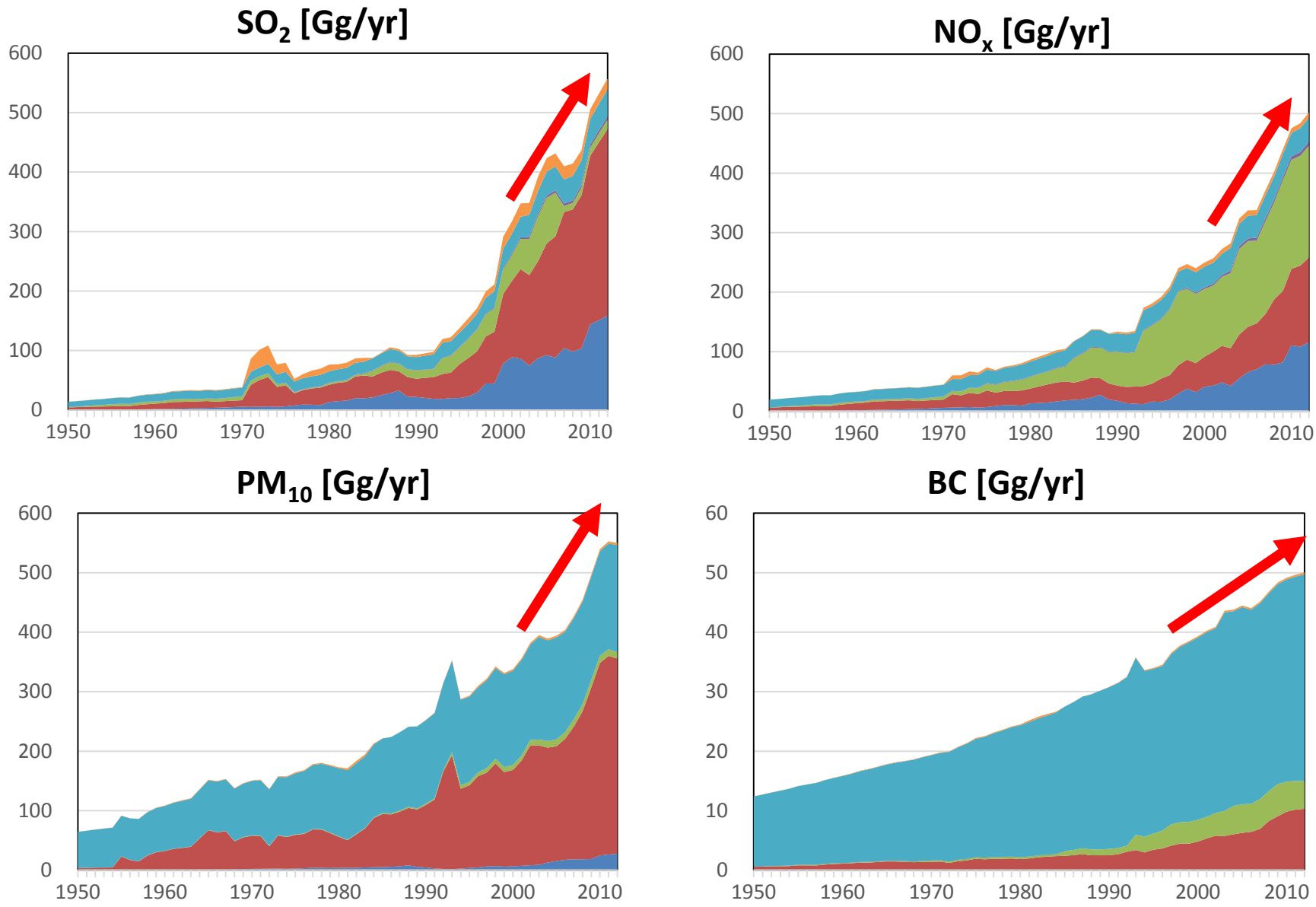
- ✓ Developing emission inventory system
- ✓ Historical emissions (1950 – 2011)
- ✓ Updating for recent years and collaboration with inverse modeling

Historical emissions in Asia during 1950-2011



- EMs of all species in Asia increased significantly during these six decades.
- Recently, first and second contributors of EMs in Asia are China and India.
- SO_2 and NO_x EMs in Japan increased drastically after 1960 and they were majority of Asian EMs before 1970 and 1980.
- EMs from SEA and SA, especially India were increasing recently, but those from OEA were basically decreasing.

Historical emissions in Vietnam during 1950-2012

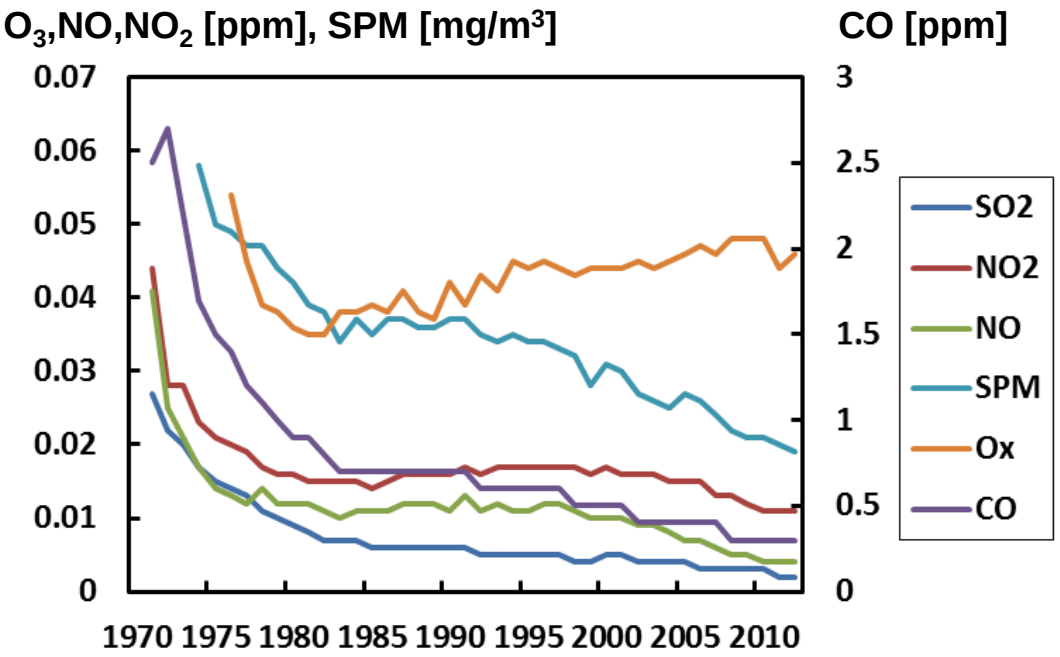


History of Air quality in Japan

Yokkaichi

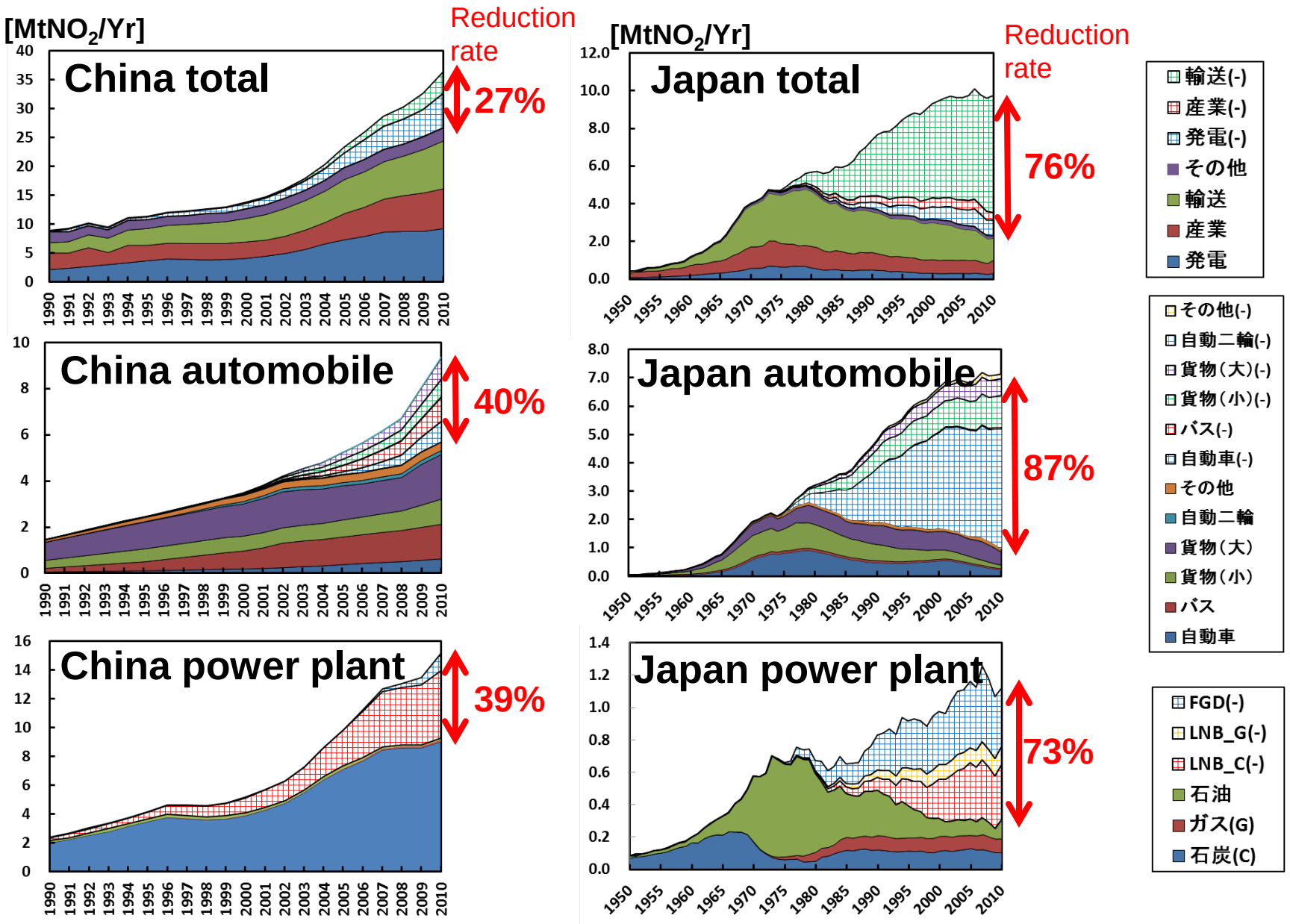
Kita kyushu

Annual averaged concentration of air pollutants in Japan



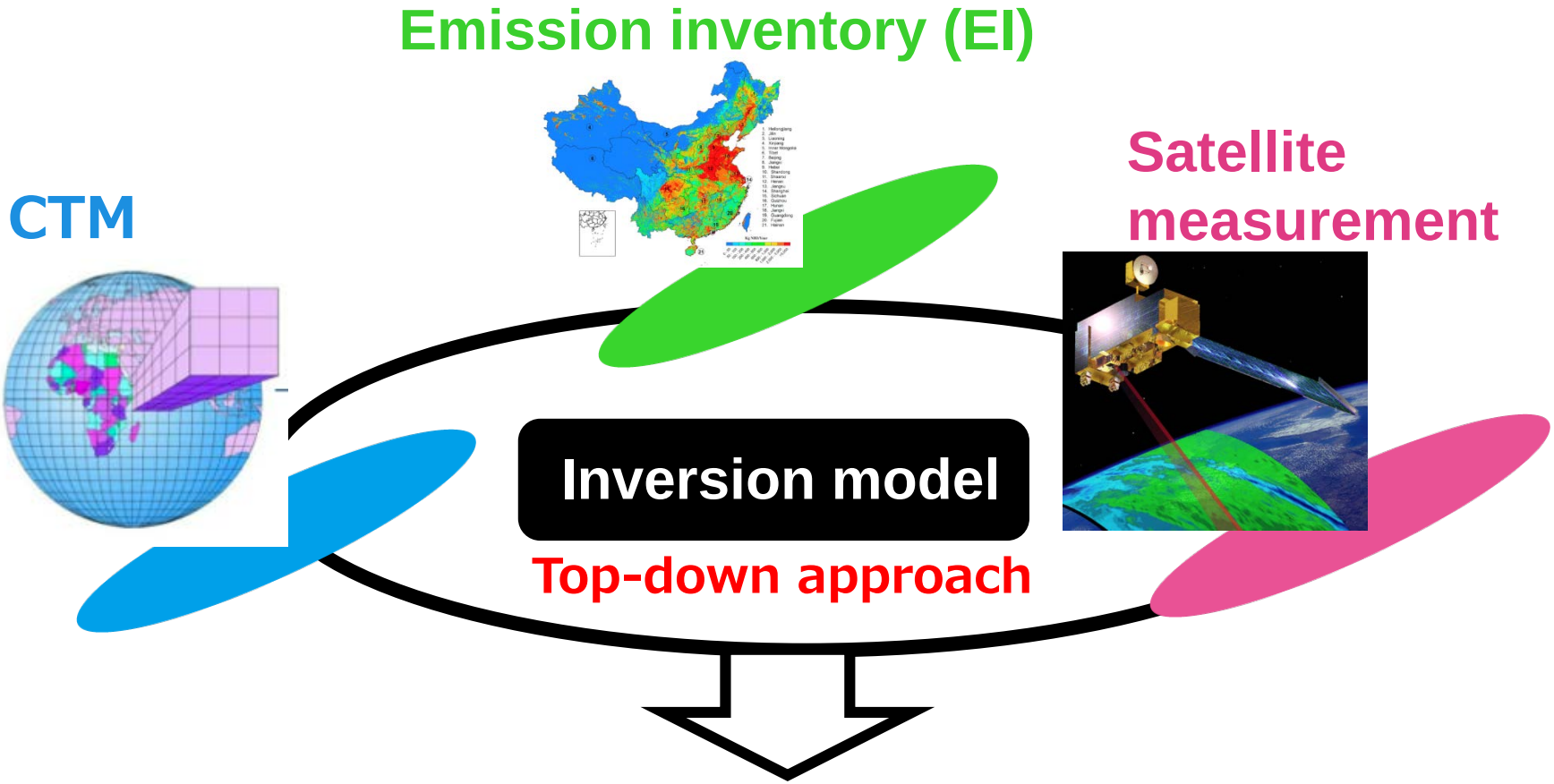
Year	Major National Laws and Regulations
1968	Air Pollution Control Law
1974	Regulations for SO_2 emissions for stationary sources
1978	Regulations for road transport emissions
1977	Regulations for NOx emissions from HDV
1981	Regulations for NOx emissions for stationary sources
1992	Automobile NOx Law
1993	Basic Environmental Law
1993	Regulations for PM emissions from road transport
2001	Automobile NOx/PM Law
2011	Regulations for stationary VOC emissions

Estimated NOx emission reduction due to emission control in China and Japan



Schematic diagram of inversion modeling system

Yumimoto et al. (2015)



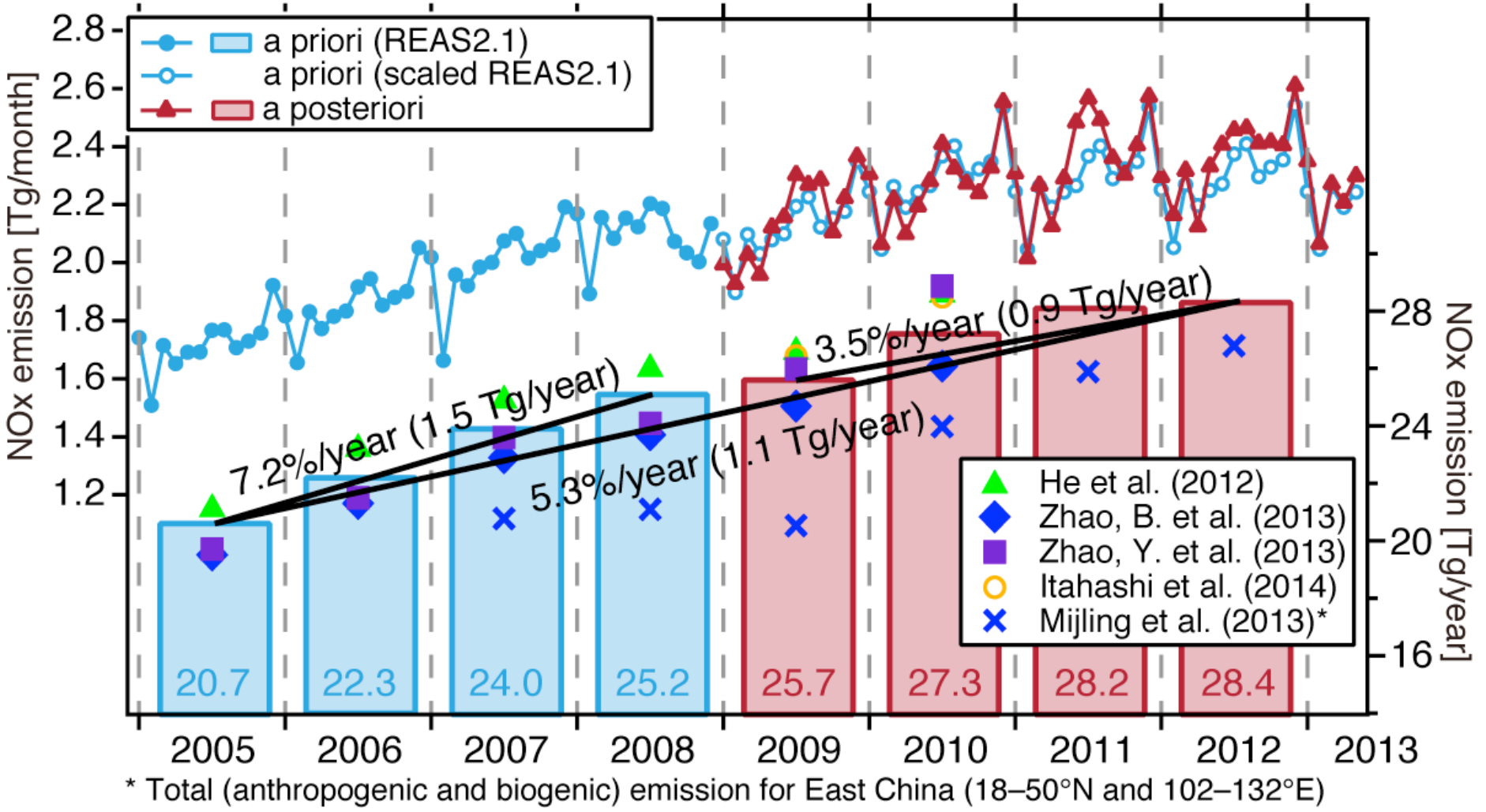
Development of better EI with lower uncertainties

Semi-real time update of EI

Analysis of air quality change events

NOx emission trend in China from top-down and bottom-up approaches

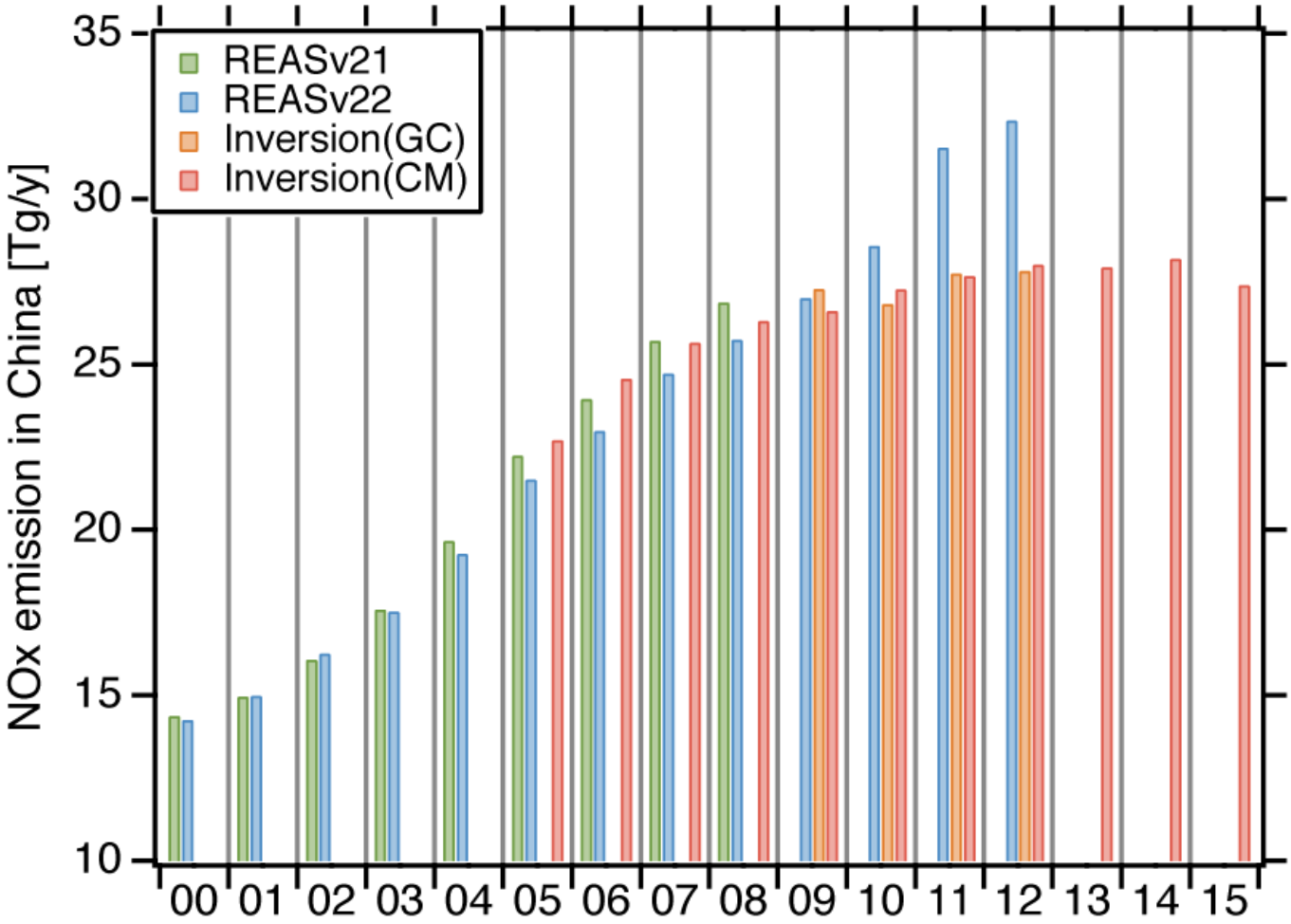
Yumimoto et al. (2015)



By combination of two approaches, we can update emissions with two years lag.

Recent changes of NOx emissions in China estimated by top-down and bottom-up approaches

-10% target of NOx emission based on 12th five years plan (during 2011-2015) is successful or fail ?



Since 2010, different trends between top-down (inversion) and bottom-up (REAS)

Analyzing the reason why?

Toward improvement of EI

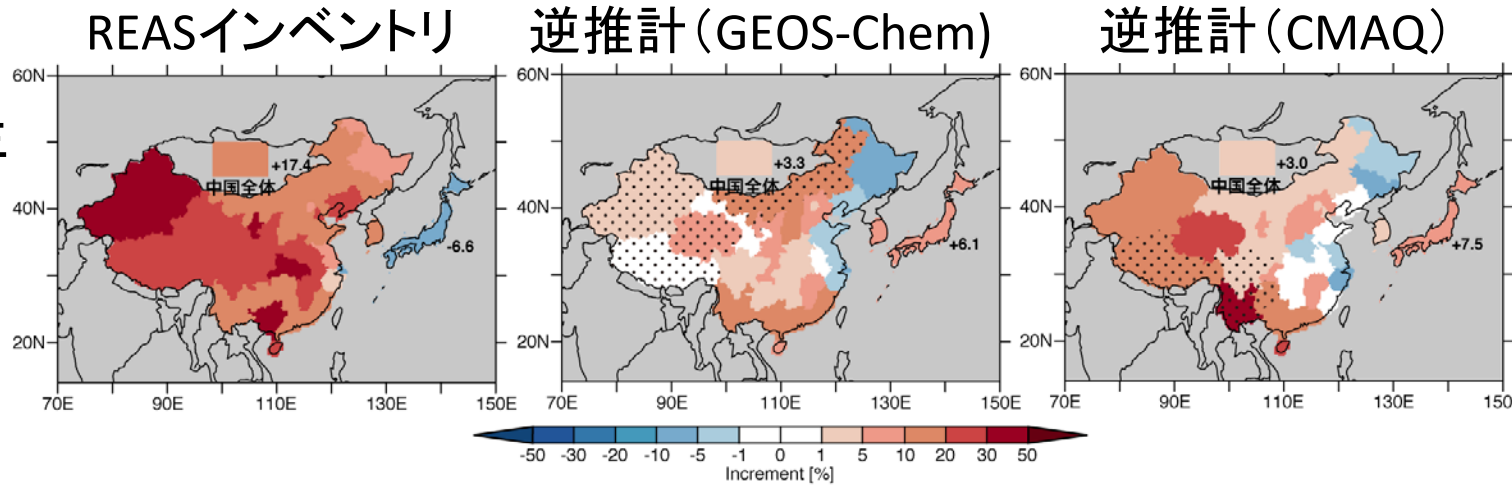
Summary

1. Asian approach for SLCP mitigation should be paid attention to air pollution reduction. S-12-1 project is developing an analysis/verification system for quantifying the emission reduction and air quality improvements due to SLCP mitigation.

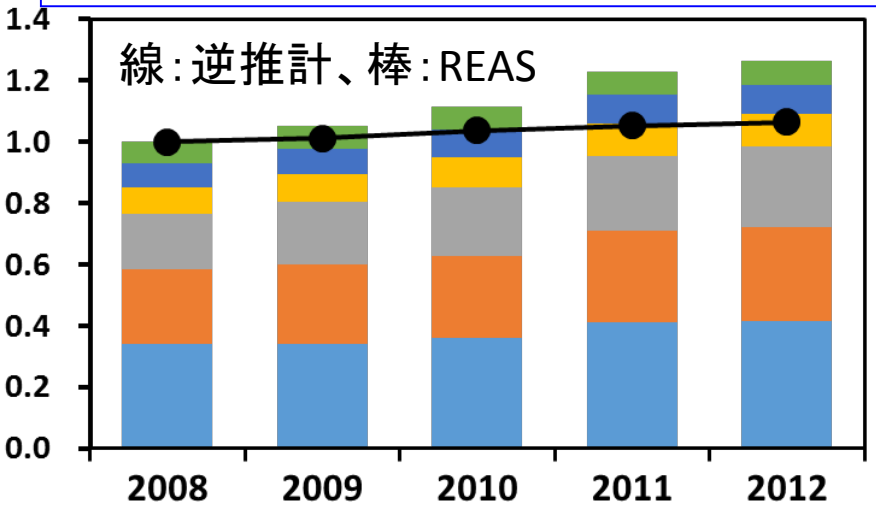
2. Regional Emission Inventory in Asia (REAS) are being updated to historical and latest emissions, and improved using top-down approach. More linkage of two approaches is needed and also more collaboration with inventory group in each country is important.

NOx排出量の最近の変化の解析

2008～2011年の変化率（%/年）

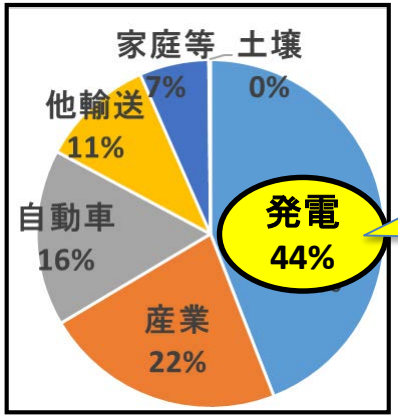


・REASでは中国全土で増加しているが、逆推計では減少している地域もある。
・逆推計結果のモデル依存性は少ない。 ・日本ではREASと逆推計の傾向が逆



2008-2012年の中国のNO_x排出量トレンド
※ 2008年を1.0とした場合の比率

2010→2011年の排出量増加において逆推計とREASの差が大きい10省のセクター別内訳



REASでは発電の脱硝装置設定が過小か？

Comparison of emission inventory in Vietnam (Power plant and industry only；Gg/year)

Species	EDGAR 2008-2010	CGRER 2006	REAS 2.1 2008	MONRE 2009
CO	407	128	77	–
NO_x	175	138	179	656
SO_2	326	268	341	1,117
NMVOC	31	103	16	268
TSP	–	–	–	673
PM_{10}	145	630	262	–

* MONRE (Ministry of Natural Resource and Environment)