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NIES, Tsukuba, JAPAN

Recent Progress of Air Pollution Modelling for co-benefit estimation

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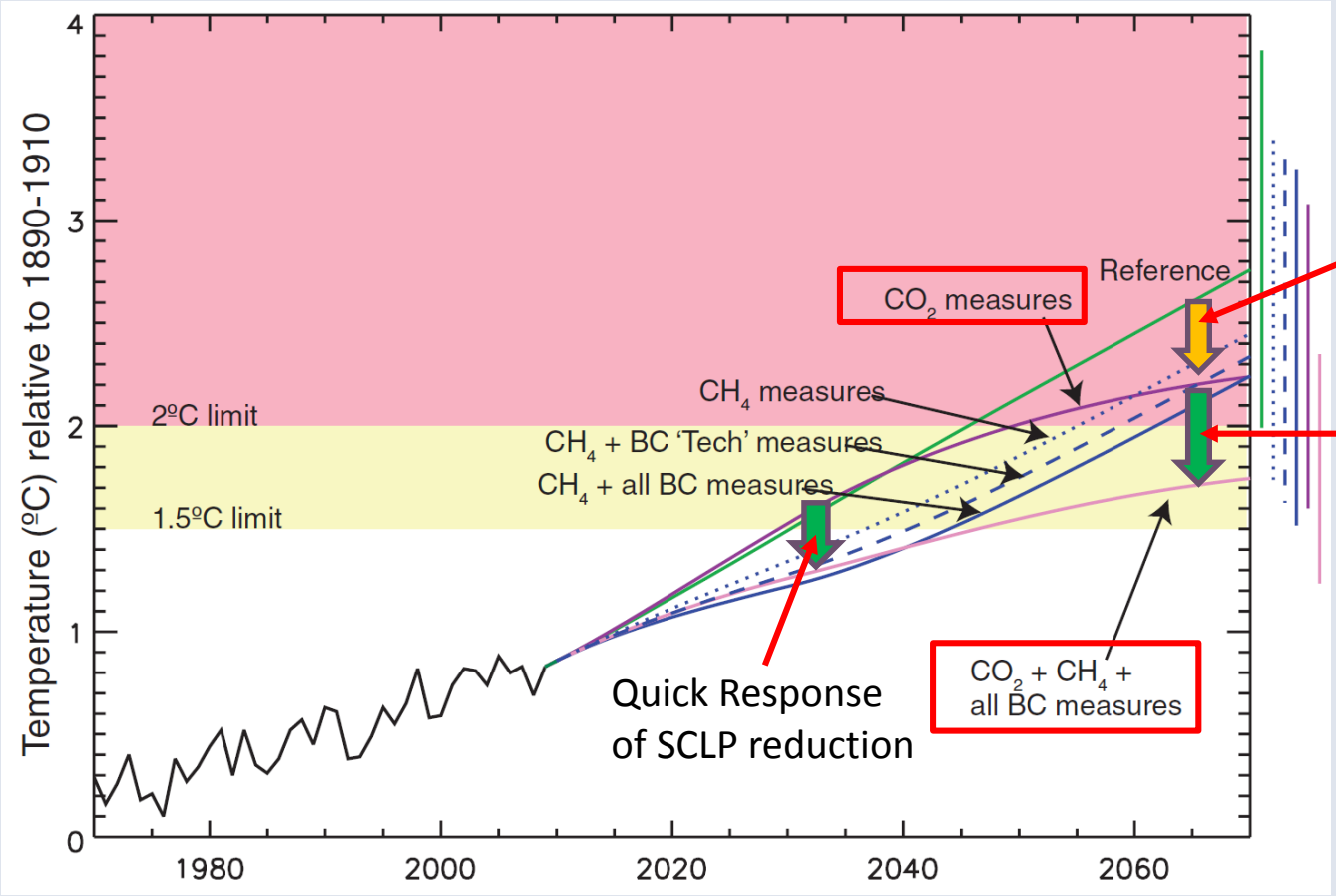
Kyoto University

Short-lived Climate Pollutants (SLCP)



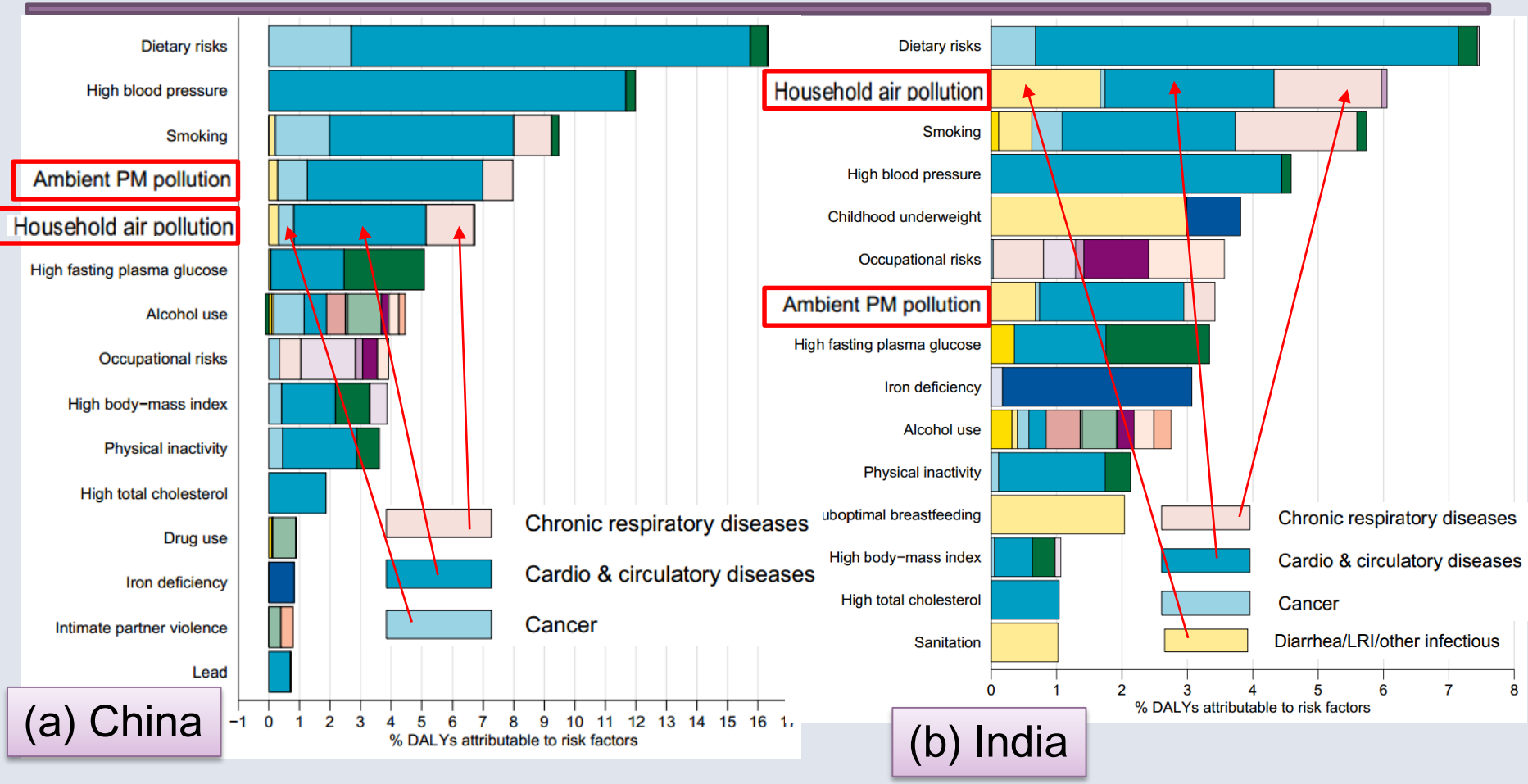
Reduction by CO_2 measure.

Additional Reduction by CH_4 + BC measure.

Shindell et al., (2012)

- Recently, the contribution of Short-lived Climate Pollutants (such as Black Carbon, Ozone, CH_4) to global warming is identified about 0.5 ^{o}C
- And, a study said that the rapid reduction of CH_4 and BC can reduce the temperature increase around 0.5 ^{o}C soon after the reduction.

Global Burden of Disease (China/India)

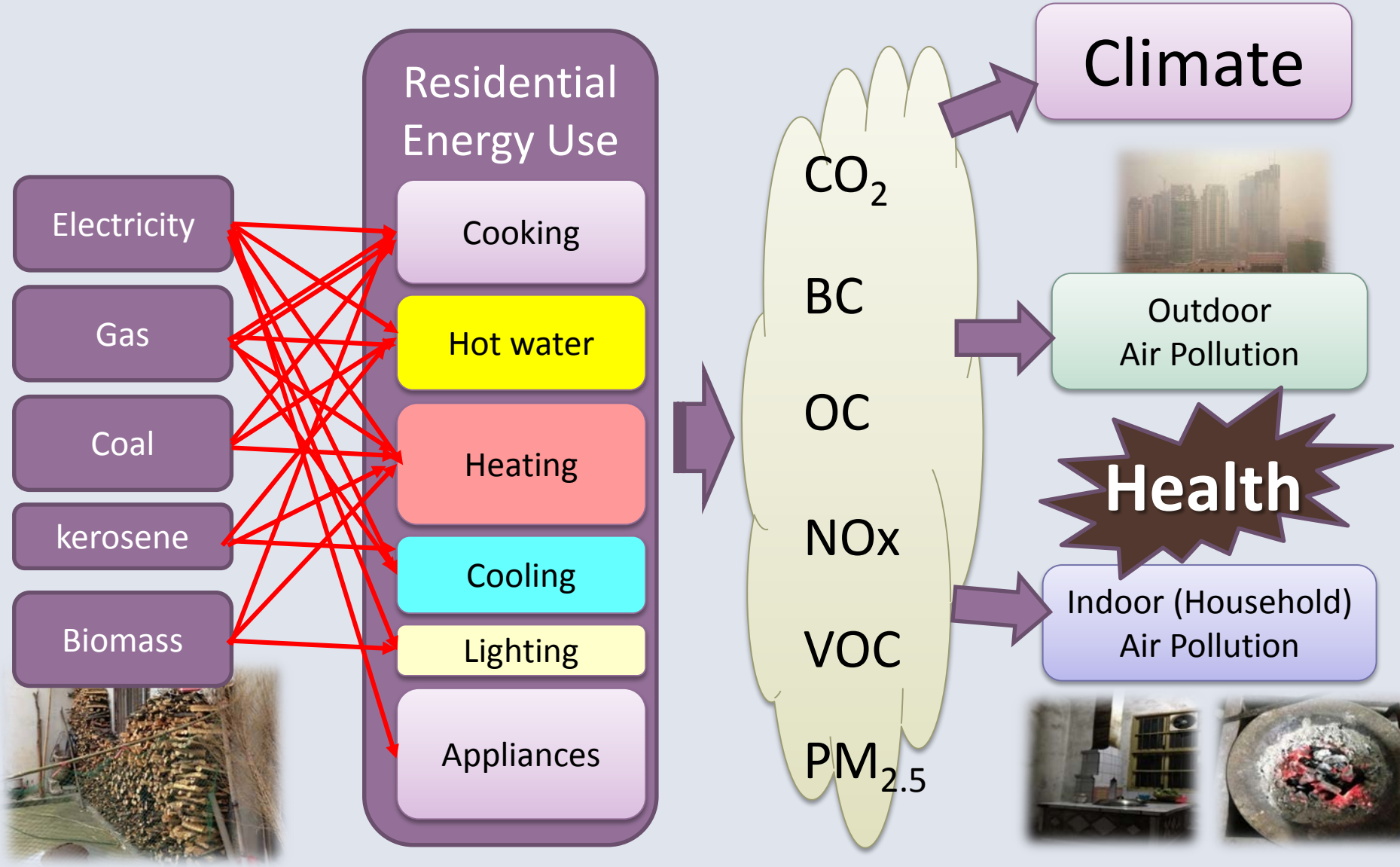


Burden of disease attributable to 15 leading risk factors in 2010 (% of DALY)

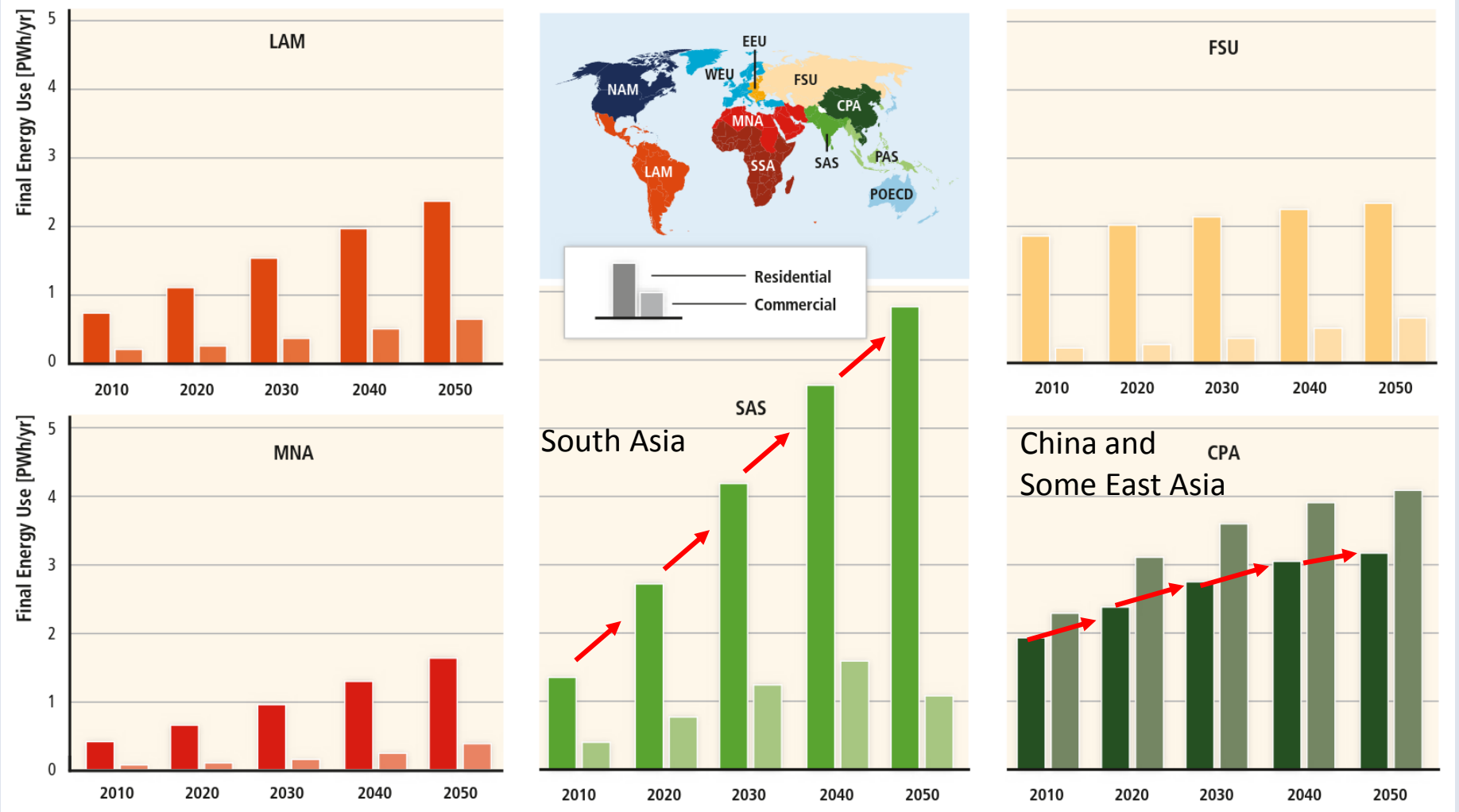
Source : IHME http://www.healthdata.org/

Estimation of current and future emission of air pollutants from Residential sector is very important.

Relationship between Residential Energy Use and Environmental Impact



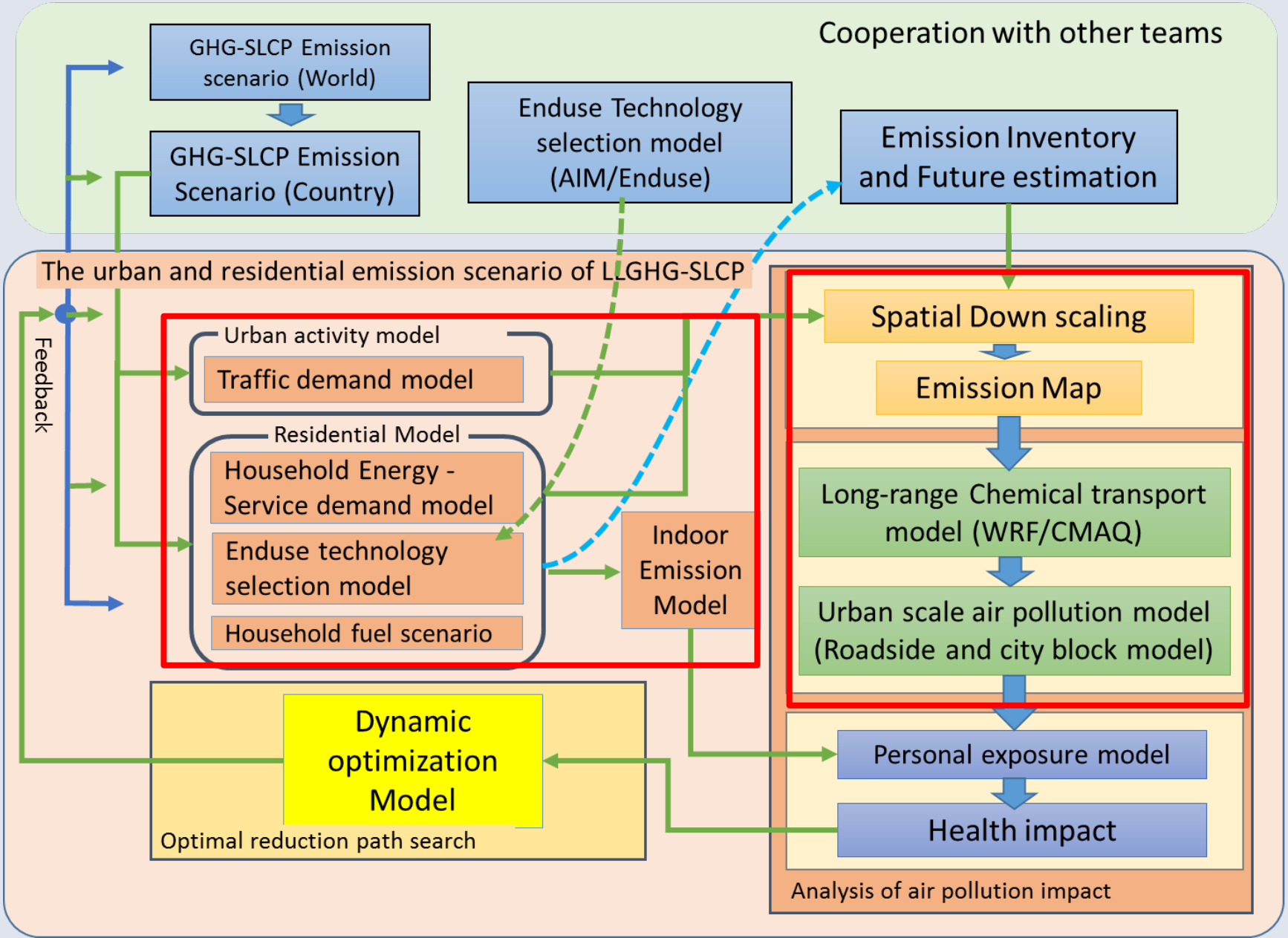
Future Residential Energy use estimation



Final thermal energy demand
in Frozen Efficiency Scenario

(Source : IPCC AR5)

Outline of the study



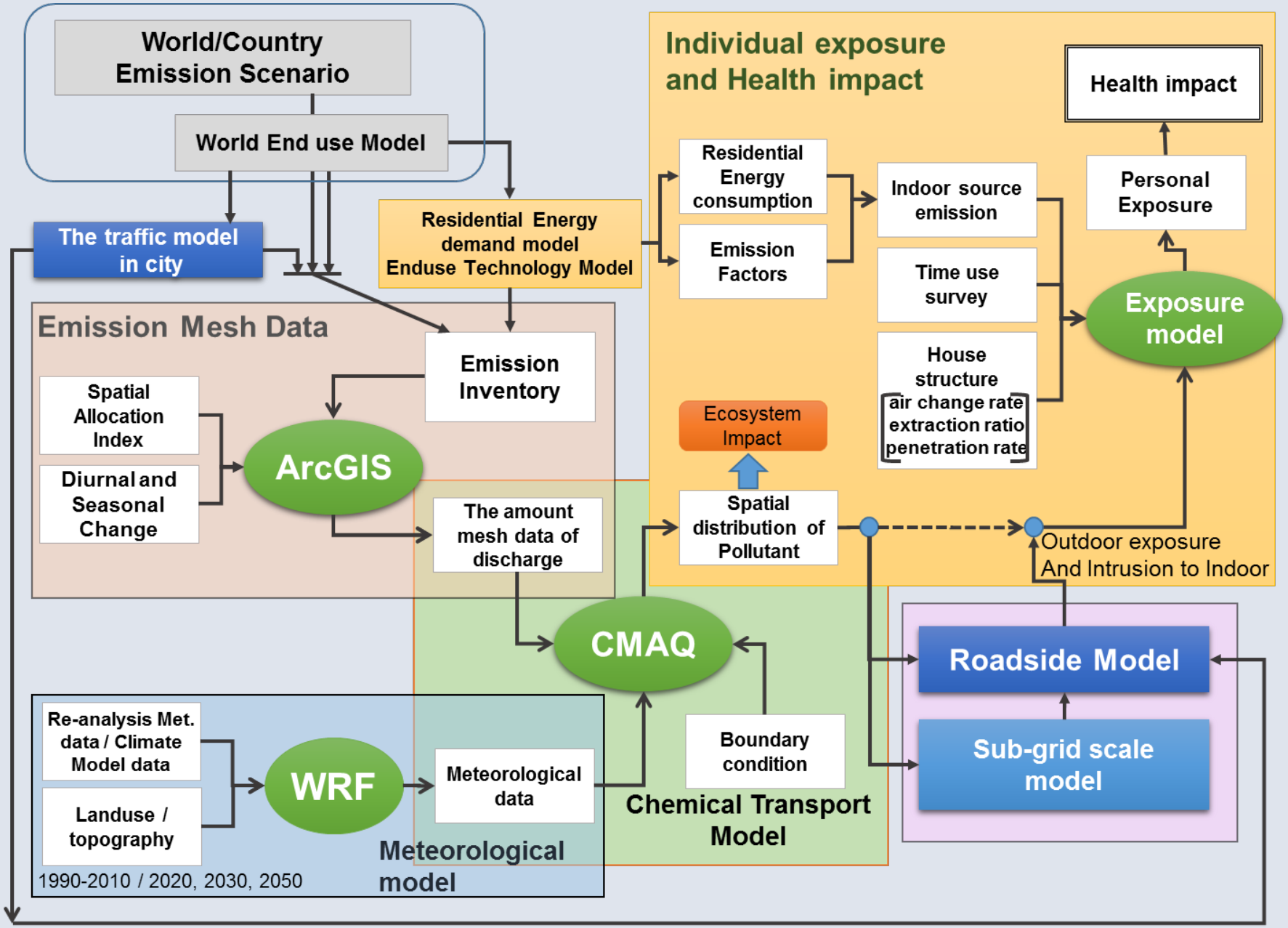
Evaluation of Effect of Chinese Pollution Prevention Action plan

- Severe air pollution occurs not only at Beijing city, many other cities in China undergo the similar pollution.
- Kyoto Univ. and ERI, China are evaluating the effects of provincial Pollution prevention action Plan of four province (Sichuan, Shaanxi, Hubei and Jiangsu) toward 2017.

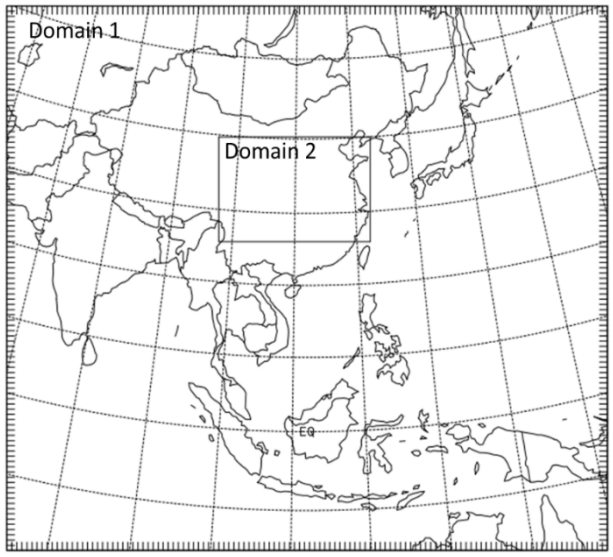
Chinese National Target of Particulate Matter

Target Area	Target year	Target
Whole China	2017	10% PM_{10} concentration Reduction compare to 2012
Whole China	2017	Increase the number of "Healthy Day (< 35μg/m^3)"
Beijing, Tianjin and Hubei	2017	Reduce $PM_{2.5}$ concentration by 25%, and less than 60 μg/m^3
Yangzi Delta (Shanghai)	2017	Reduce $PM_{2.5}$ concentration by 20%
Pearl River Delta (Guangzhou)	2017	Reduce $PM_{2.5}$ concentration by 15%

Detail schematic diagram of models



Model Simulation to quantify the contribution of the emission from Residential sector in Asian region



Domain setting of China PM2.5 Study

WRF Input/setting

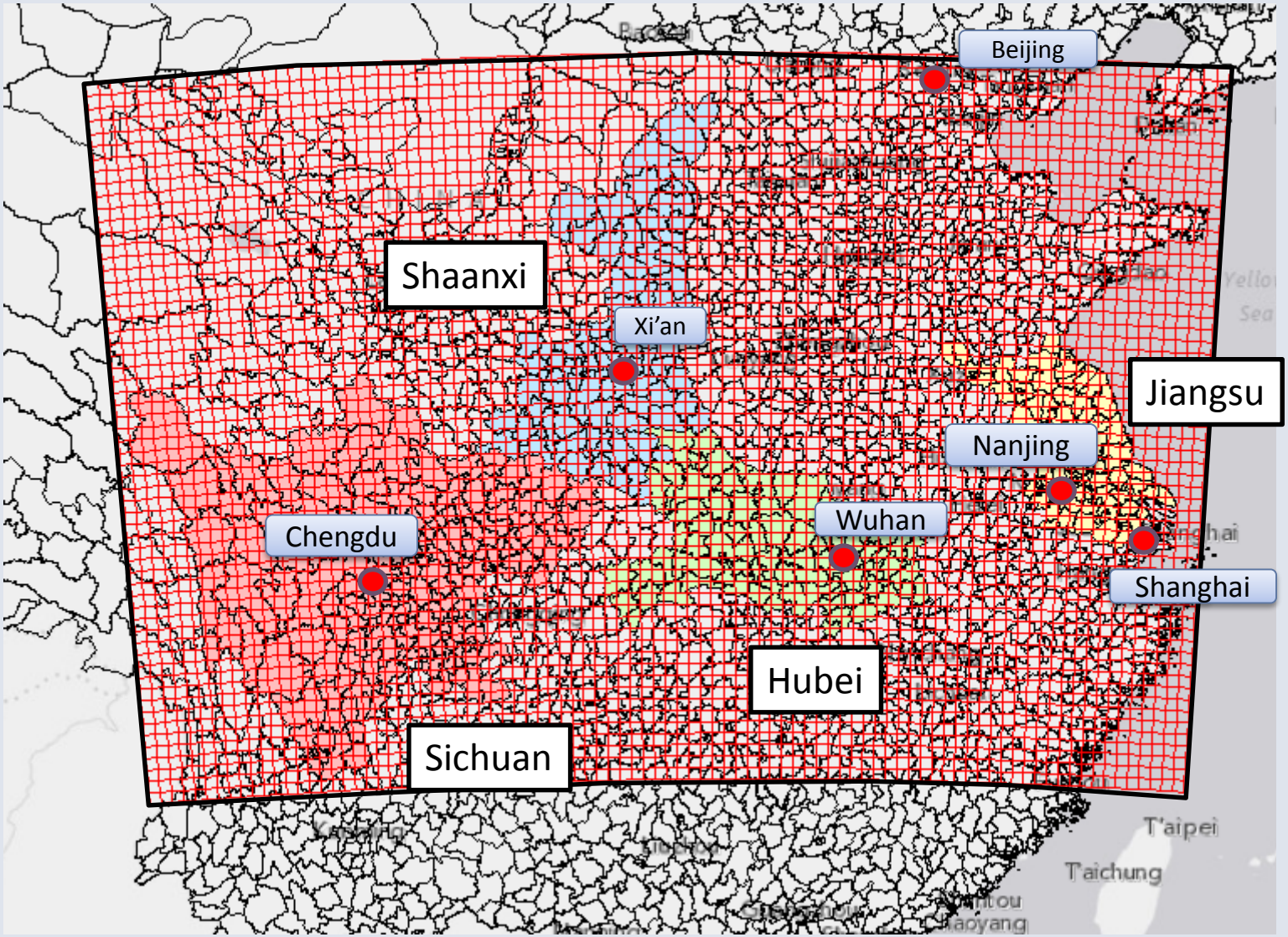
- Version: 3.4.1
- Input Met.: NCEP FNL 1x1° 6hr
- Cloud Physics: Simple ice scheme
- Cumulus Param.: Kain-Fritsch Scheme
- Land Surface: Noah land-surface model

CMAQ input/setting

- Version: 5.0.1
- Chemistry: SAPRC-99 Aero5
- Boundary cond.: MOZART4
- Biogenic emission: MEGAN 2.0.4
- Anthropogenic emis.: INTEX-B, TRACE-P

Case	Description	Met. Field
2012 Emission	Base year Run, (JAN – DEC, 2012) Using emission data of **2012**	2013
2017 Emission	Target year Run (JAN – DEC, 2017) Using emission data of **2017**	2013

Target Provinces and Area of Domain 2



Grid size = 26.6 km

Provincial Target and Action Plans (Sichuan)

Sichuan province.

Target Area	Target year	Target
Whole Province	2017	**10%** PM_{10} concentration Reduction compare to 2012
Chengdu city	2017	**25%** $PM_{2.5}$ concentration Reduction compare to 2012

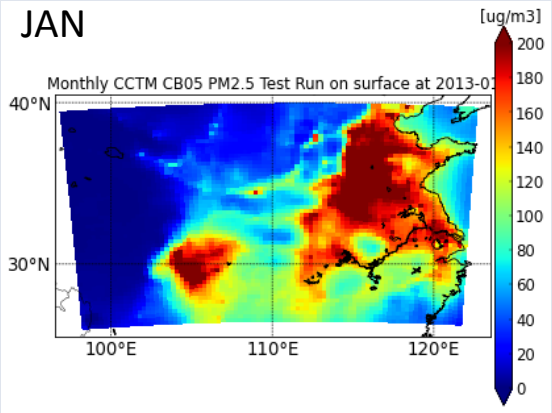
1. Prevent **biomass burning** in certain area. Encourage biomass resource recycle.
2. Control the TSP emission from **construction site**.
3. Control the **Coal consumption** in Sichuan.
4. Prevent **high emission fuel combustion** in certain area.
5. Prevent **high emission vehicle** to enter Chengdu urban area.
6. Update **petrol** standard to State IV standard, same as Euro IV emission standard before 2016.
7. **Desulfurization** implementation rate increases to 90% for coal combustion, and **denitrification** rate increases to 70%.
8. **Emission standard** update: (TSP) 20mg/m^3 for Chengdu, 30mg/m^3 for others.
9. Desulfurization rate of **Steel industry** increases to 70%.
10. Denitrification rate of **Cement industry** to 60%.

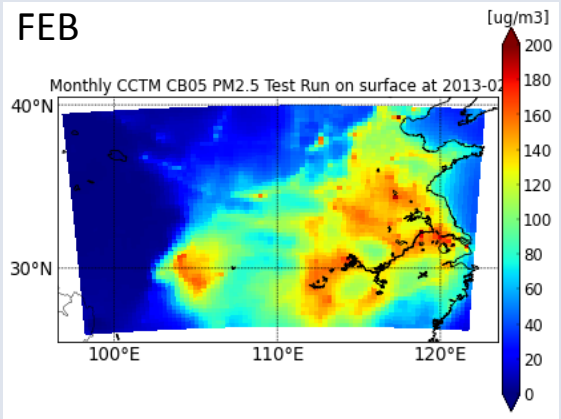
Estimated Emission in four provinces

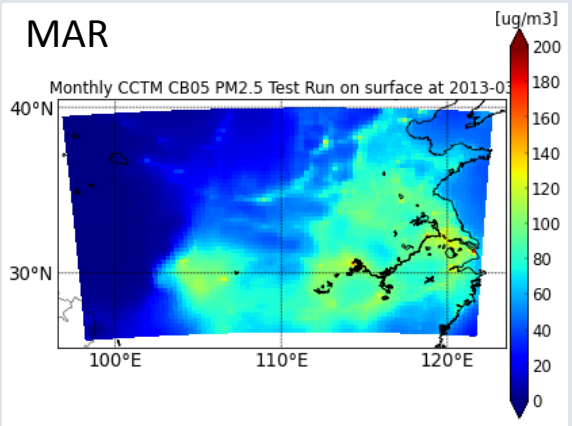
	Sichuan		Jiangsu		Shannxi		Hubei	
(kt/year)	2012	2017	2012	2017	2012	2017	2012	2017
$PM_{2.5}$	795	641	1,314	1,088	784	785	944	803
		-19%		-17%		±0%		-15%
SO_2	878	617	1,168	690	1,510	970	1,305	987
		-30%		-40%		-35%		-24%
NOx	771	589	1,096	1,071	1,487	1,389	1,090	946
		-24%		-2%		-7%		-13%
NH_3	860	982	924	1,012	193	215	920	1,016
		+14%		+10%		+11%		+10%
VOC	554	632	1,397	1,651	492	567	511	594
		+14%		+18%		+15%		+16%

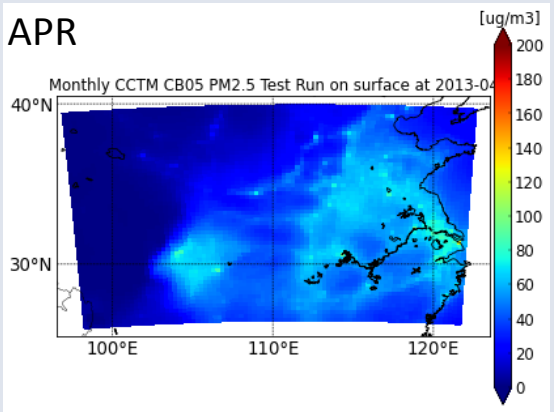
(Data was provided by ERI)

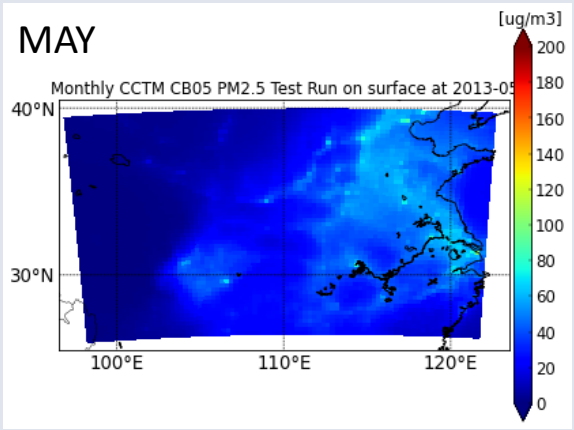
Result (Monthly average of $PM_{2.5}$) (1)

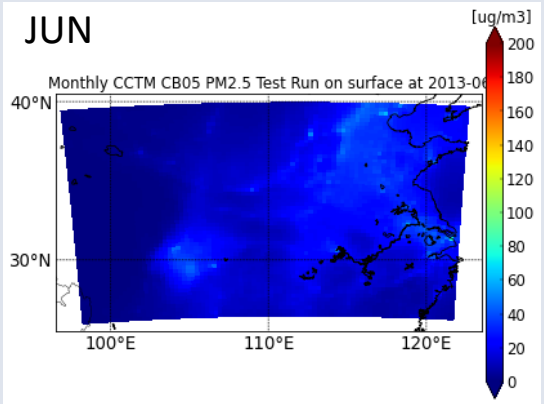






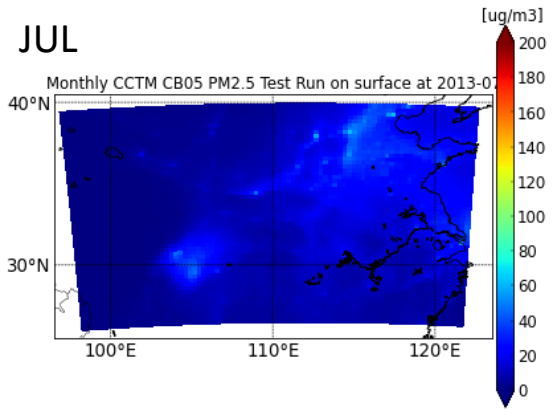


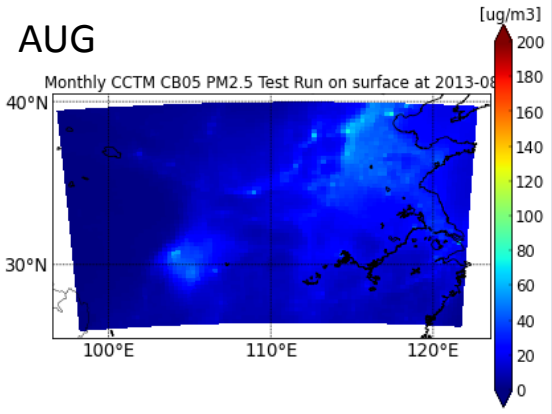


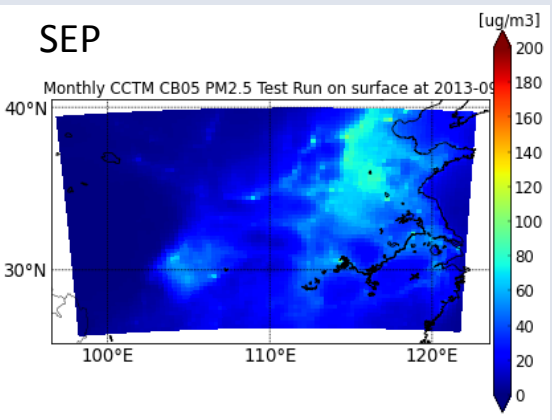


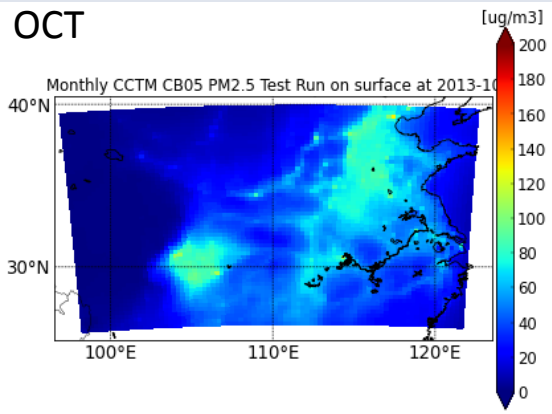
Base year (2012) Emission Case

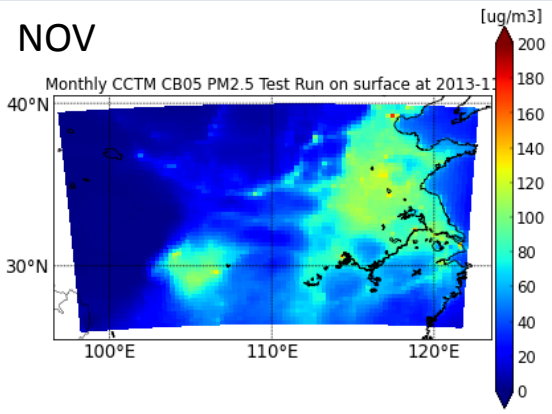
Result (Monthly average of $PM_{2.5}$) (2)

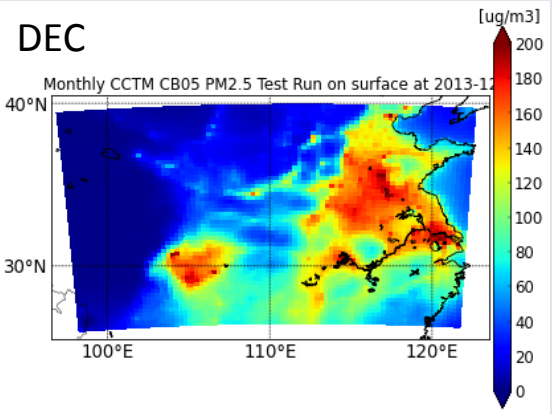






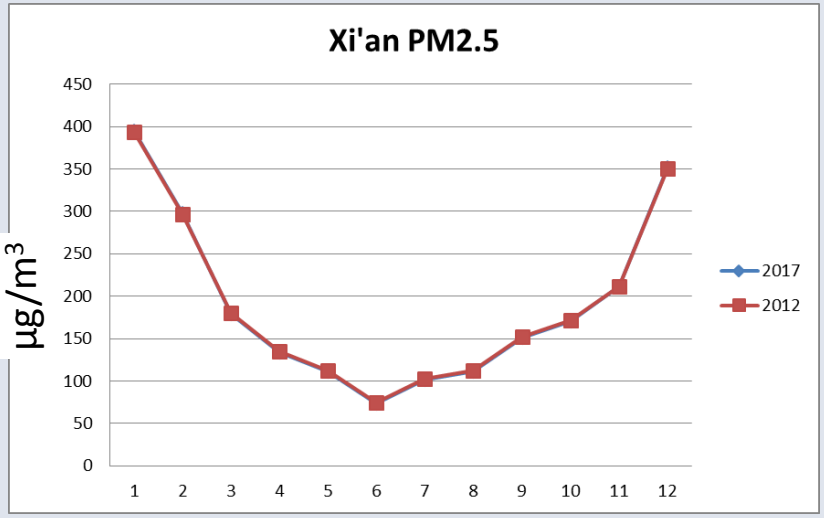


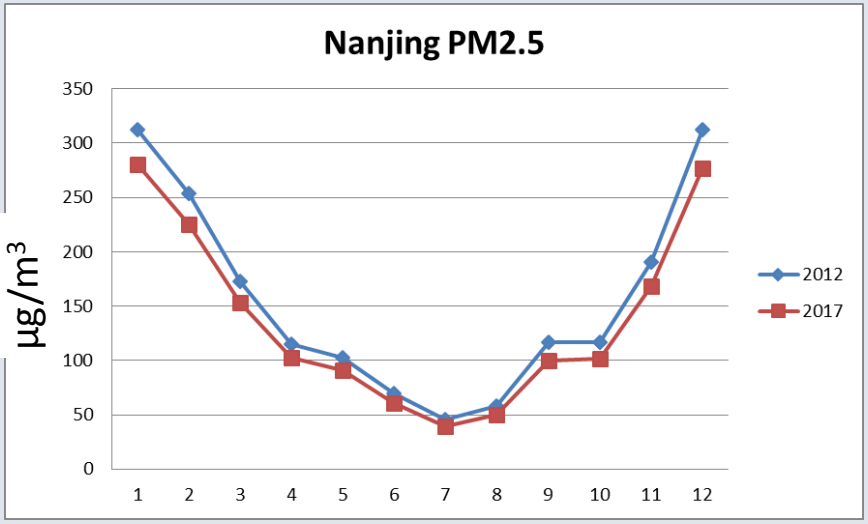


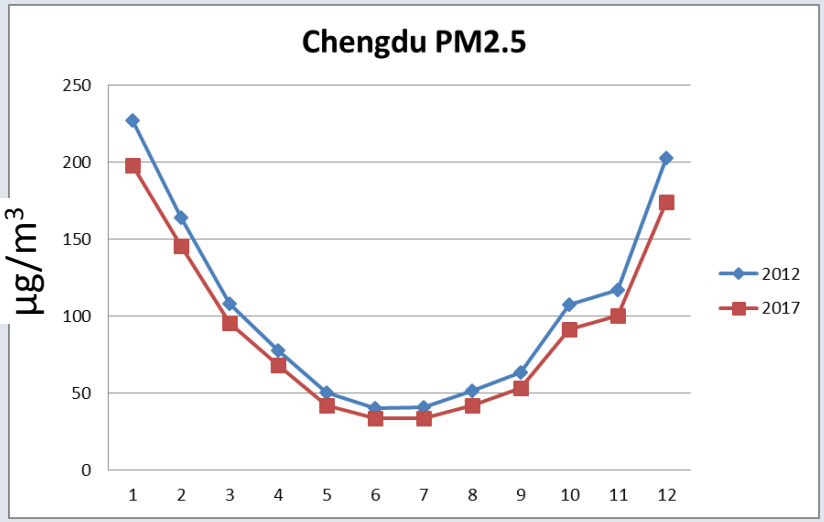


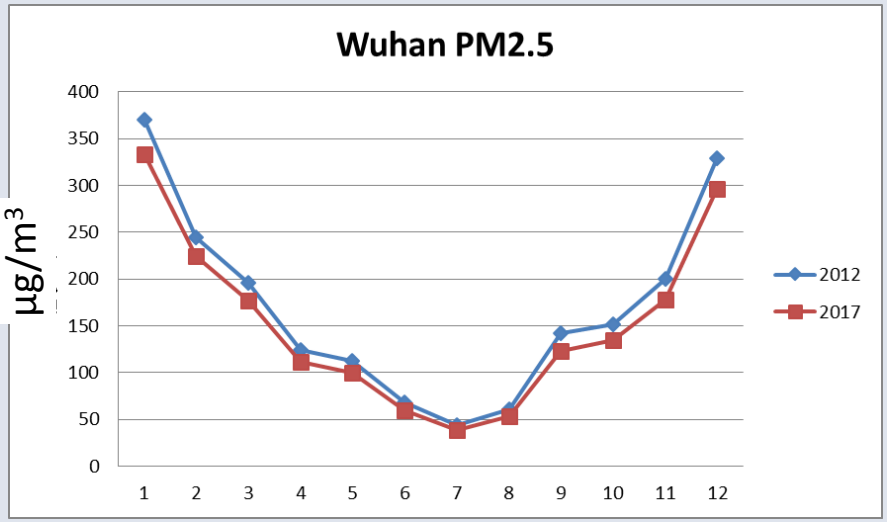
Base year (2012) Emission Case

Effects of “Prevention Action Plan” at Capital cities

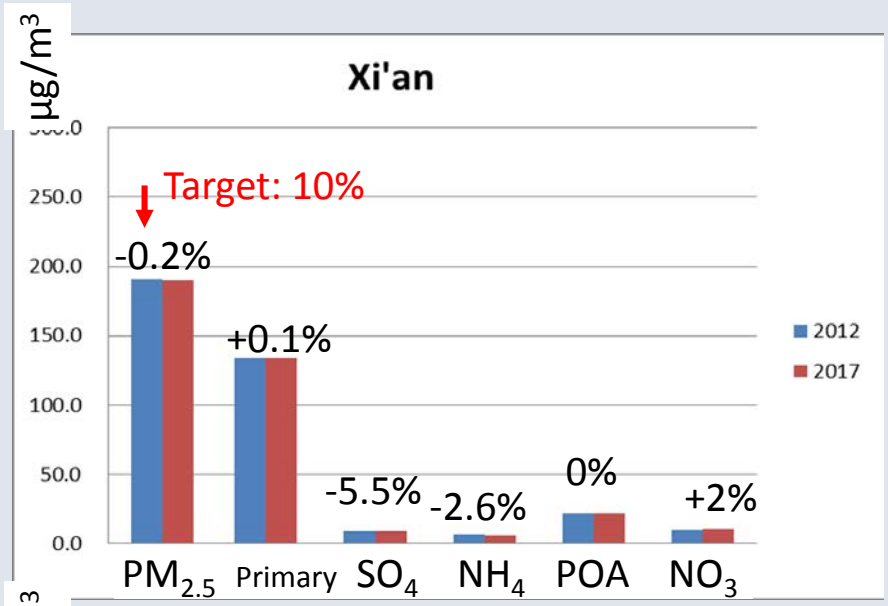


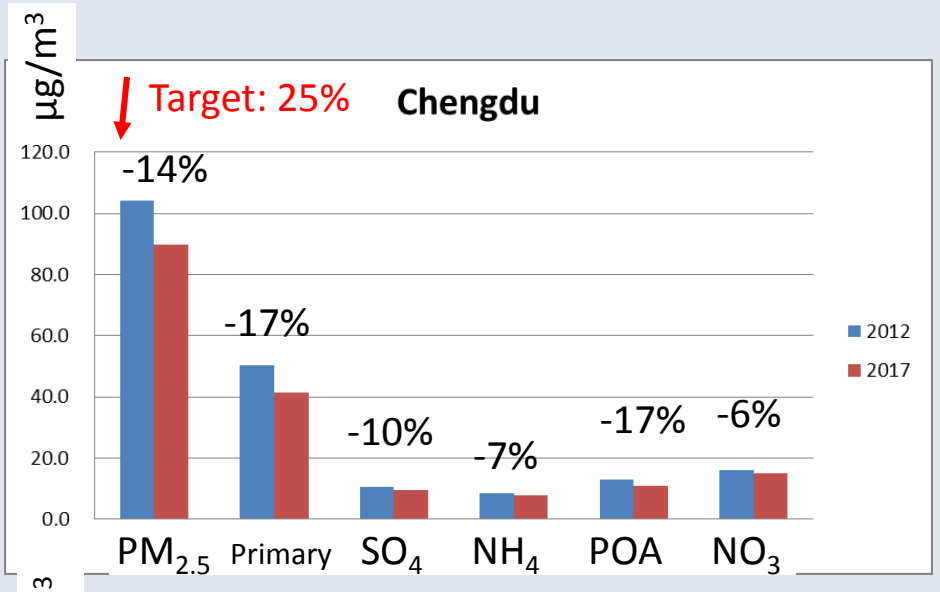


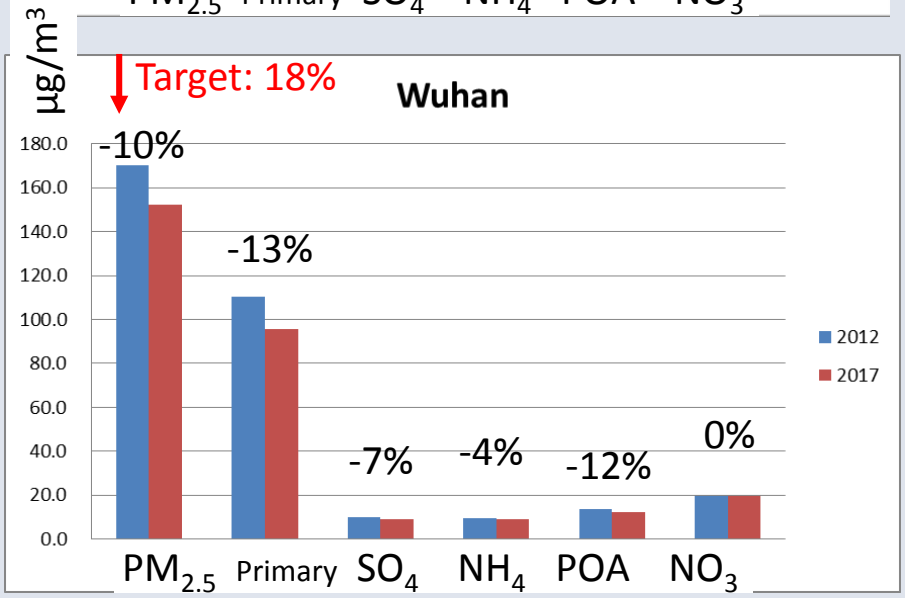


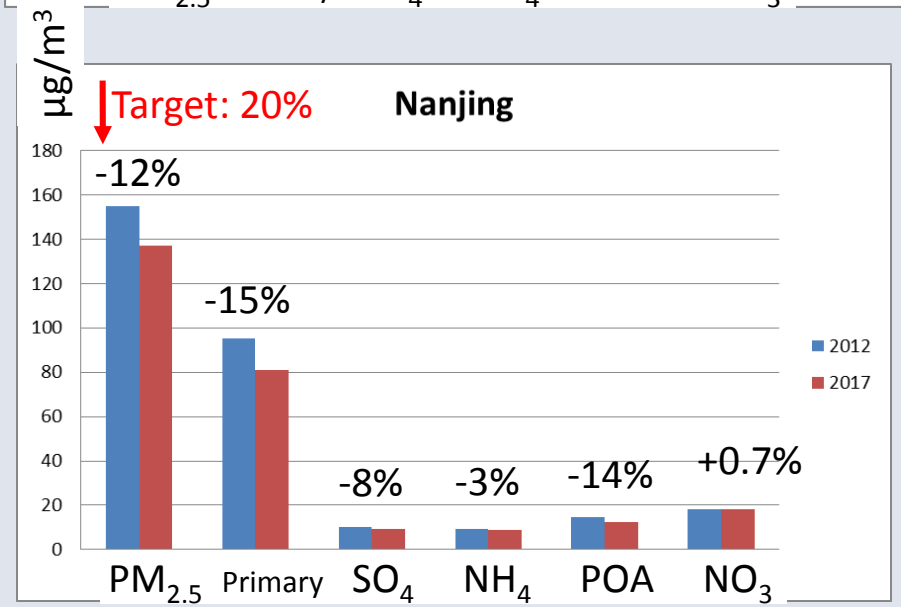


Change of Composition of $PM_{2.5}$









Summary Table of Effect of Prevention Action Plan

		Sichuan		Jiangsu		Shannxi		Hubei	
	city	Chengdu		Nanjing		Xi'an		Wuhan	
		2012	2017	2012	2017	2012	2017	2012	2017
Emission	Primary $PM_{2.5}$ [kt/year]	795	641	1,314	1,088	784	785	944	803
			-19%		-17%		±0%		-15%
	SO_2 [kt/year]	878	617	1,168	690	1,510	970	1,305	987
			-30%		-40%		-35%		-24%
Concentration	$PM_{2.5}$ (yearly ave.) [μg/m³]	104.2	89.8	155.0	136.9	190.8	190.4	170.0	152.1
			-14%		-12%		-0.2 %		-11%
	Reduction Target		25%		20%		10%		18%

Summary and Next Step

- In order to assess the provincial level “Air Pollution Prevention Action Plan” , Air Quality Model, CMAQ, calculation was performed.
- As a result, provincial target couldn’t be achieved by only the current action plan. However, if the emission of surrounding region is also decreased, target may be achieved.
- Validation with Satellite Data is necessary.

Thank you for your attention.