International Workshop on Inventory, Modeling and Climate Impacts of Greenhouse Gas emissions (GHG's) and Aerosols in the Asian Region, June 26-28, 2013, Tsukuba

ERTDF S-7 Project

Environment Research and Technology Development Fund

Strategic Research Project - 7

Hajime Akimoto

Asia Center for Air Pollution Research

ERTDF S-7

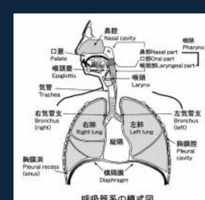
Scientific Analysis of Regional Air Pollution and Promotion of Air Pollution Management in East Asia Considering Co-benefits

FY2009-2013； PL : H. Akimoto

Air Pollution by Factories and Automobiles (NOx, VOC, BC, SO_2, CO_2)

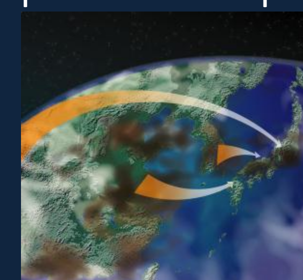
O_3, $PM_{2.5}$

Health Impact



Crops Impact

Transboundary Air Pollution
Hemispherical Transport



BC, O_3, SO_2, CO_2

Global Warming/Climate Change

Co-benefit, Co-control of Air Pollution and Climate

Themes

1. Quantification of East Asian regional air pollution, hemispherical air pollution and evaluation of their climate impacts
   (TL: Y. Kanaya, JAMSTEC)

2. Improvement of emission inventories and development of emission scenarios for air pollutants in East Asia
   (TL: T Ohara, NIES)

3. Research on agreement-forming process for air pollutant reduction in East Asia and on system design of co-benefit approach
   (TL: K. Suzuki, Kanazawa Univ.) → Proposal of ASPAC

3-(6) Evaluation of co-benefit of ozone and aerosol reduction and global warming measures in East Asia（STL: H. Akimoto)

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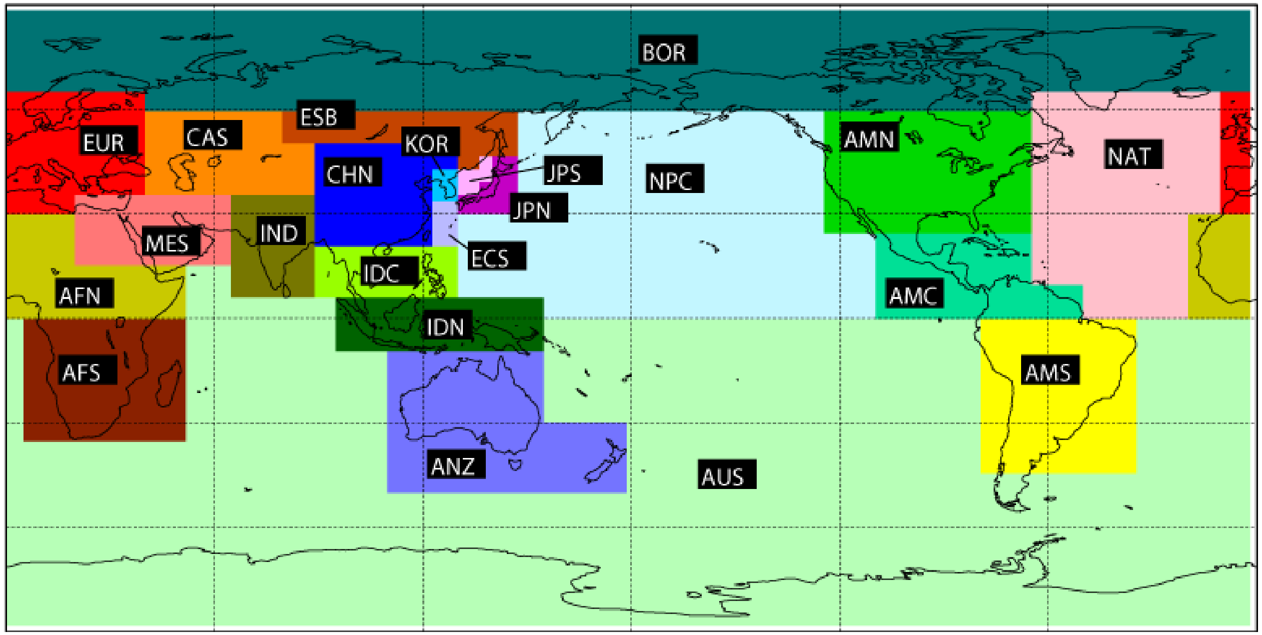
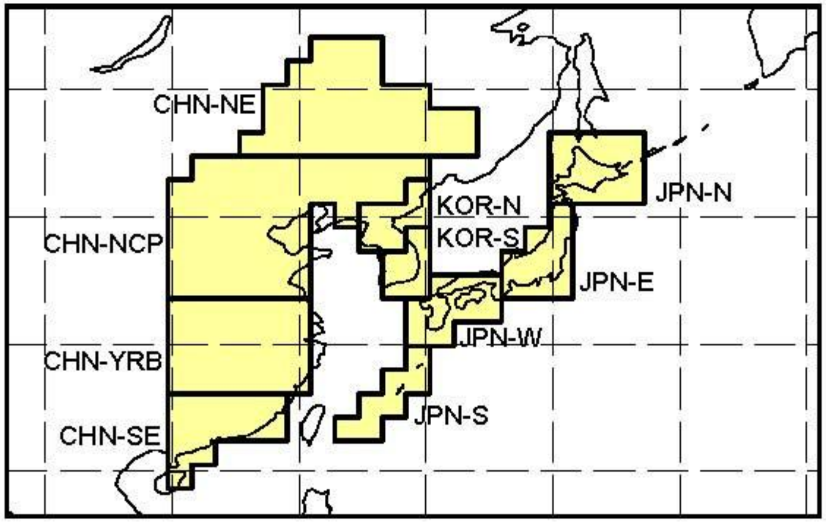
1. Transboundary Air Pollution in East Asia for O_3 and $PM_{2.5}$
2. SLCP co-benefit approach in East Asia
3. Proposal of Asia Science Panel on Air pollution and Climate (ASPAC)

Global Closure of Source-receptor Relationship of Surface Ozone
Tagging Method Using CHASER



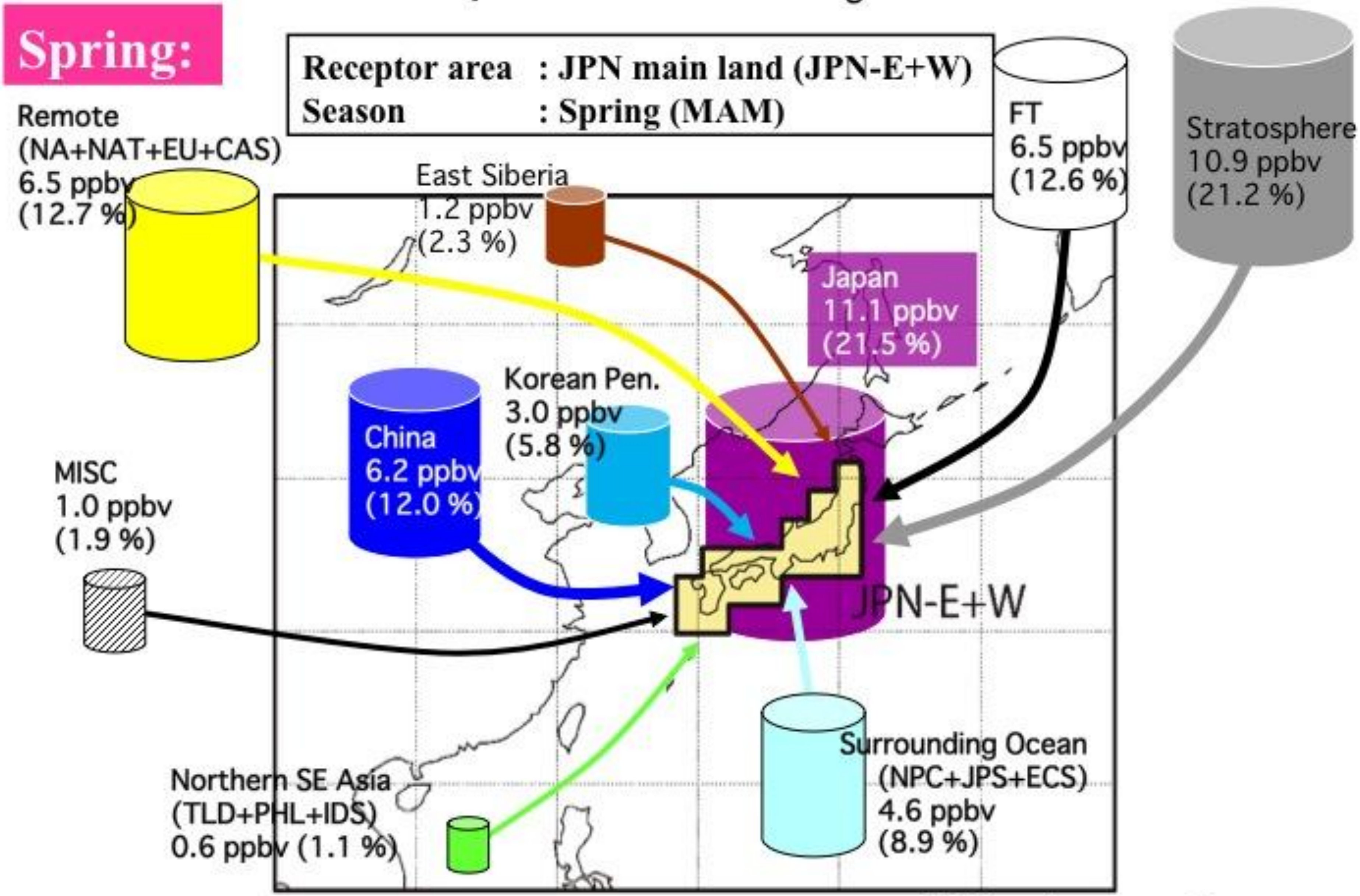
Nagashima et al., ACP 2010

Source Region
Boundary Layer : 22 region
Free Troposphere (FT)
Stratosphere (ST)



Receptor Region
China: Northeast China
China: North China Plain
China: Yanzi River Delta
China: Southeast China
Korea: North
Korea: South
Japan: North, East, West, South

S-R Relationship of Surface O_3 in Northeast Asia

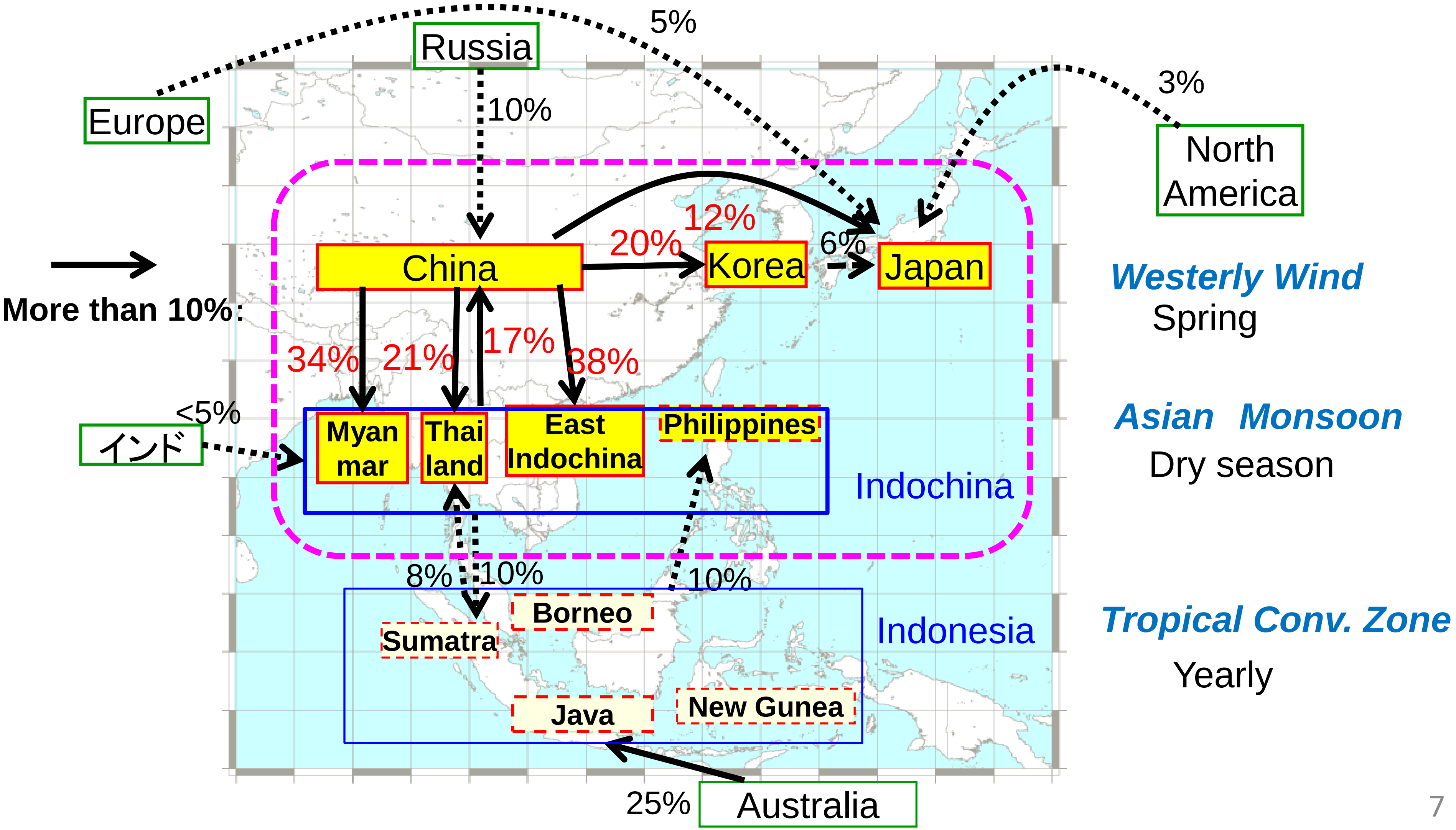


Nagashima et al, ACP (2011)

* All values are 6-yr mean

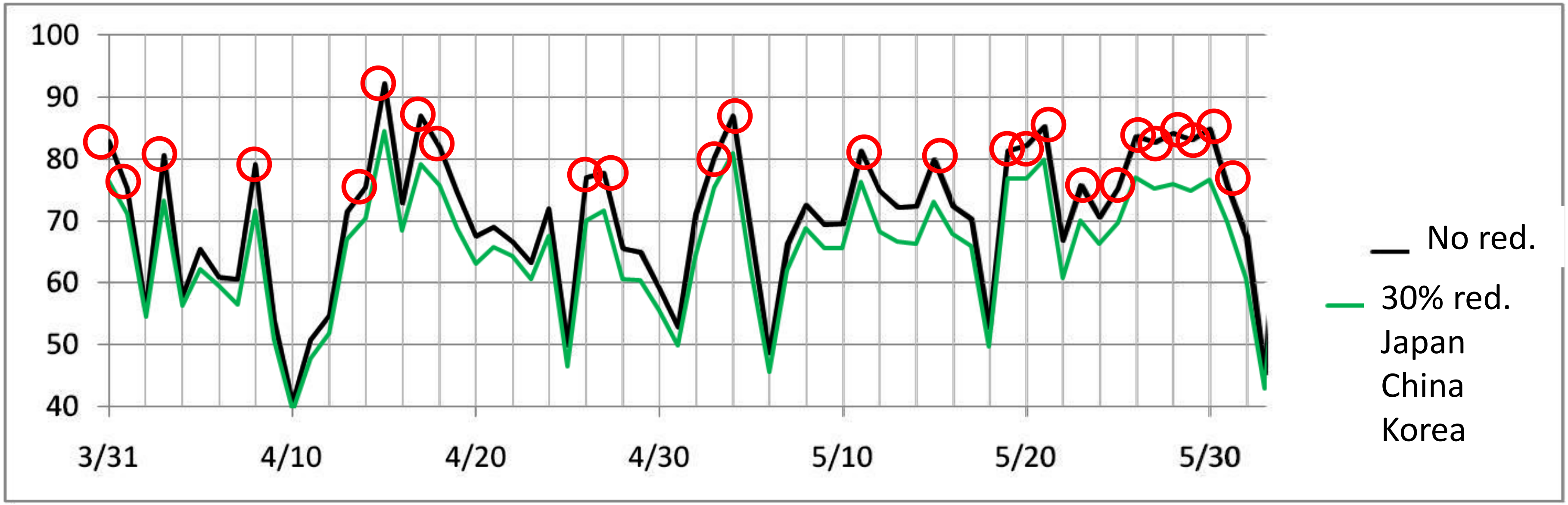
Regional View of S-R Relationship of O_3

International framework for air pollution management in Asia should cover Northeast and Southeast Asia.



Trial reduction plan to attain 75ppb O_3 of in 8-hr average in Japan by simultaneous reduction of anthropogenic emissions of NO_x and VOC in Japan, China and Korea.

Example: Kitakyushu, April-May, Daytime 8-hr average ozone (ppb), by WRF/CMAQ

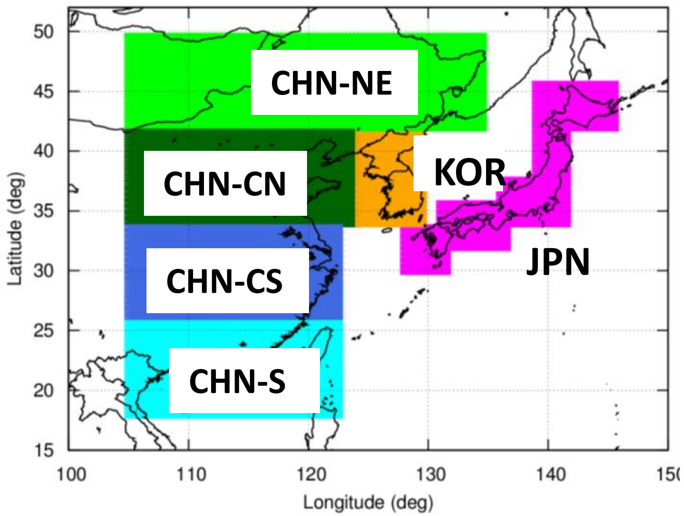


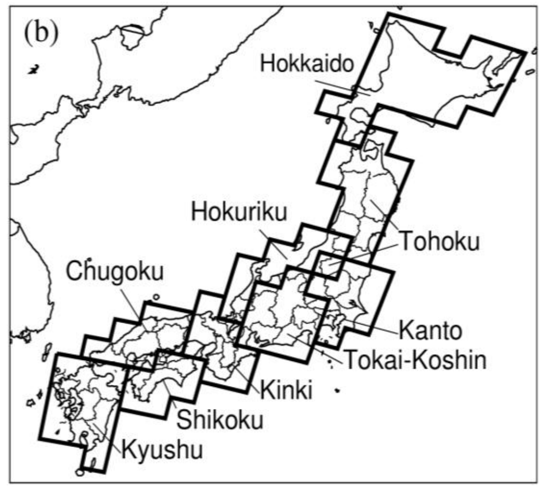
◎ Present exceedance: 41 days in March-August (average concentration : 81.6ppb)

◎ 30% emission reduction in Japan, China, Korea → 7ppb reduction of O_3 concentration

Contributions to annual average concentration of $PM_{2.5}$

Source Region → Receptor Region





◎Contribution to Japan :
Domestic: 21-44%
Korean Peninsular: 2-11%
China: 29-73%

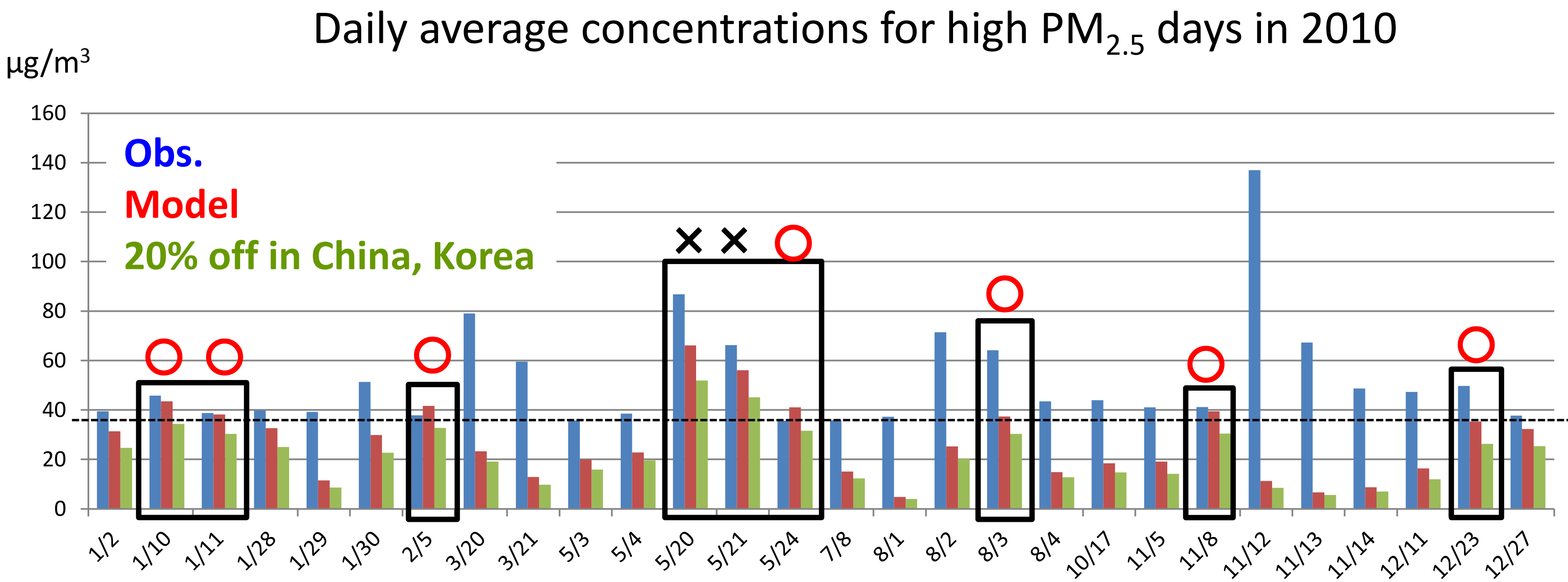
Contribution from each region to different area of Japan in annual average

Receptor / Source	Kyushu	Tyugoku	Shikoku	Kinki	Hokuriku	Tokai	Kanto	Tohoku	Hokkaido
Japan	23% (2.2)	27% (2.6)	24 % (1.9)	37% (3.0)	33 % (2.3)	44% (3.2)	44% (3.6)	32% (1.9)	21% (0.9)
Korean P.	11% (1.0)	11 % (1.1)	8 % (0.6)	7 % (0.5)	6% (0.4)	4 % (0.3)	2% (0.1)	5% (0.3)	4 % (0.2)
China	**63%**	**61%**	**57%**	**50%**	53%	39%	29%	58%	73%
CHN-NE	5% (0.5)	6% (0.6)	5% (0.4)	6% (0.4)	11% (0.7)	5% (0.4)	5% (0.4)	20% (1.2)	37% (1.7)
CHN-CN	41% (3.9)	41% (3.8)	38% (3.1)	33% (2.6)	31% (2.1)	25% (1.8)	18% (1.5)	30% (1.9)	31% (1.4)
CHN-CS	15% (1.5)	13% (1.2)	12% (1.0)	10% (0.8)	10% (0.7)	8% (0.6)	5% (0.4)	7% (0.5)	5% (0.2)
CHN-S	2% (0.2)	1% (0.1)	2% (0.1)	1% (0.1)	1% (0.1)	1% (0.1)	1% (0.1)	1% (0.0)	0% (0.0)

Ikeda et al. , 2013

Effect of 20% Reduction of Primary $PM_{2.5}$ in China and Korea

Example : Fukue, Island west of Kyushu



- Present Exceedance of 35μg/m^3 : 9 days
- 20 % reduction in China and Korea; 7 days among the 9 days attain AQS
- Concentration decreases ca. 20% since more than 90 % is due to transboundary.

Contents

1. Transboundary Air Pollution in East Asia for O_3 and $PM_{2.5}$
2. SLCPs co-benefit approach in East Asia
3. Proposal of Asia Science Panel on Air pollution and Climate (ASPAC)

What is SLCPs (Short-lived Climate Pollutants)?

1. Tropospheric Ozone: Precursors: CH_4, NOx/VOC
2. Black Carbon (BC)

Why SLCP co-benefit approach is important?

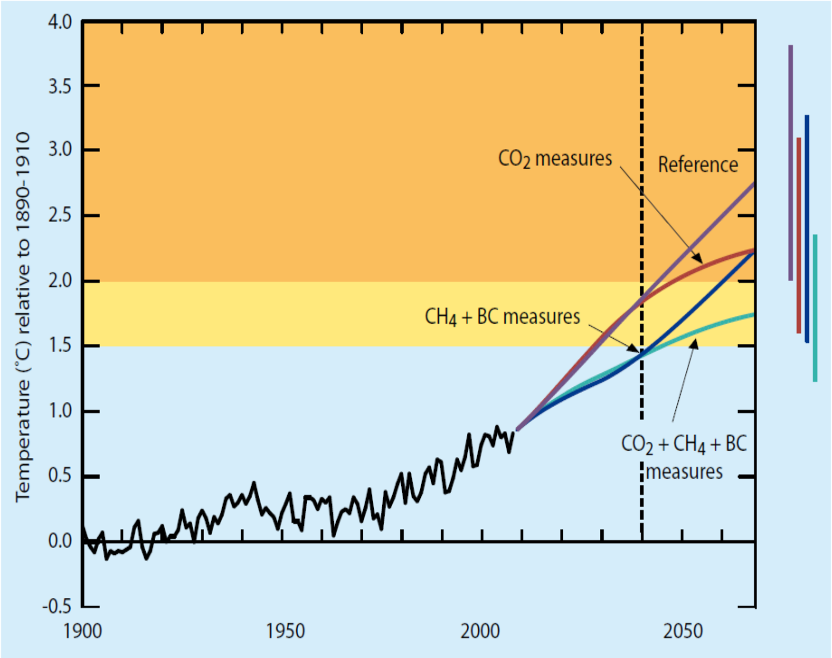
From climate change side :

Mitigation of climate change in 2100 can only be achieved by reducing CO_2.

However, stringent reduction of CO_2 emission does not help to mitigate climate change until 2050.

Particularly, “2 ° C capping” will be difficult by the” CO_2-eq. 450 ppm stabilization scenario” alone.

“SLCP co-benefit scenario coupled with stringent CO_2 control scenario could lead to achievement of the mid-term (2030-2050) mitigation of climate change and the 2 ° C capping.



UNEP-WMO 2011

From air pollution side in Asia:

Co-benefit, co-control approach is important in Asia, which consists of many rapidly growing countries, in which societal incentive for air pollution control is much higher than CO_2 control.

In order to facilitate the SLCP co-benefit approach in Asia, more attention to air pollution mitigation should be paid in order to justify the advantage of the approach.

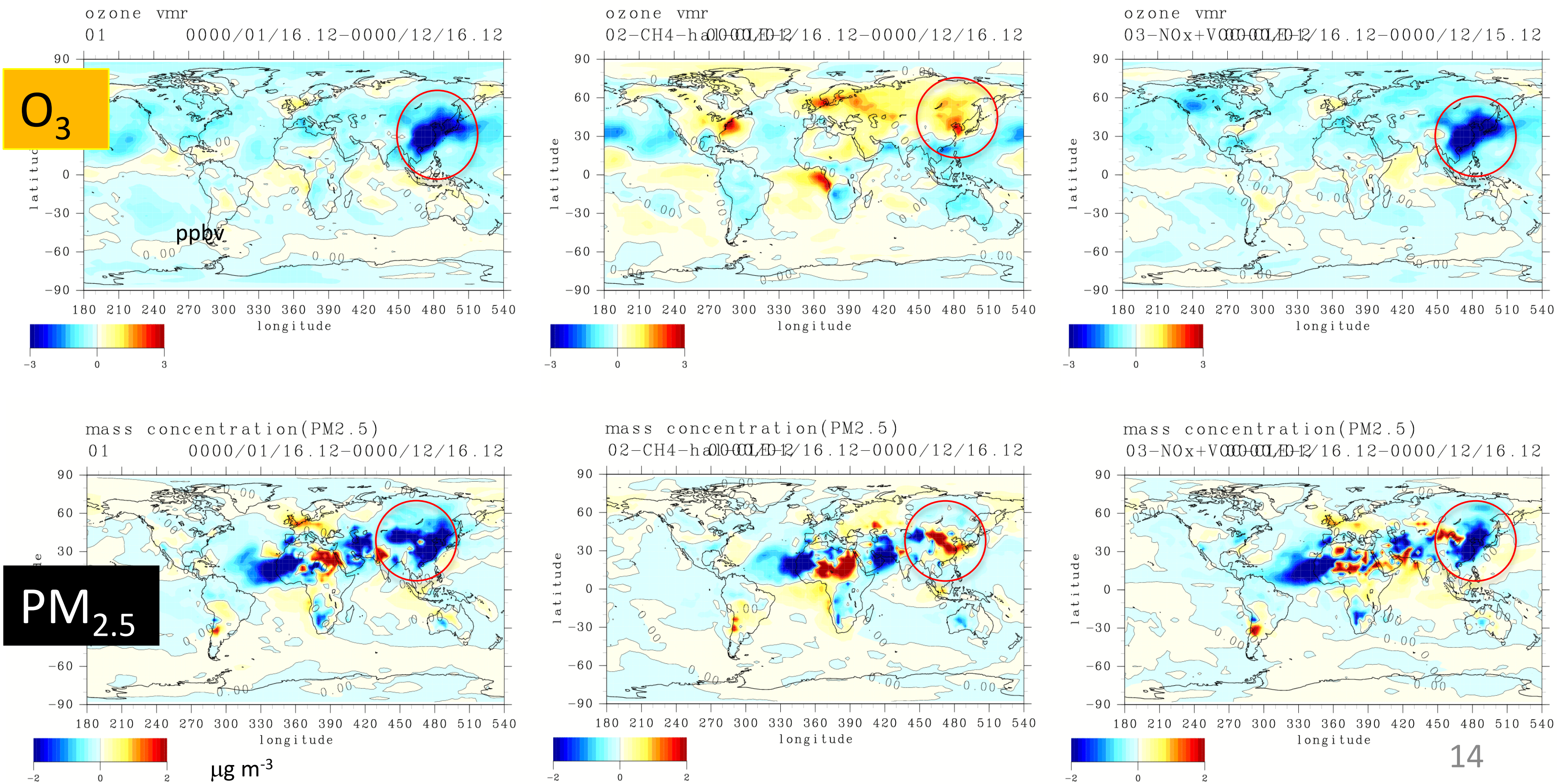
In contrast to the strategy of controlling solely CH_4 for tropospheric O_3 reduction as proposed in UNEP (2011) and CCAC (2012), we propose prioritized reduction of NOx/VOC together with CH_4 in East Asia in order to control regional O_3 so as to alleviate human health impact of O_3 as well as $PM_{2.5}$.

Sensitivity Analysis for the reductions of NOx/VOC and CH_4 for Surface Ozone and $PM_{2.5}$

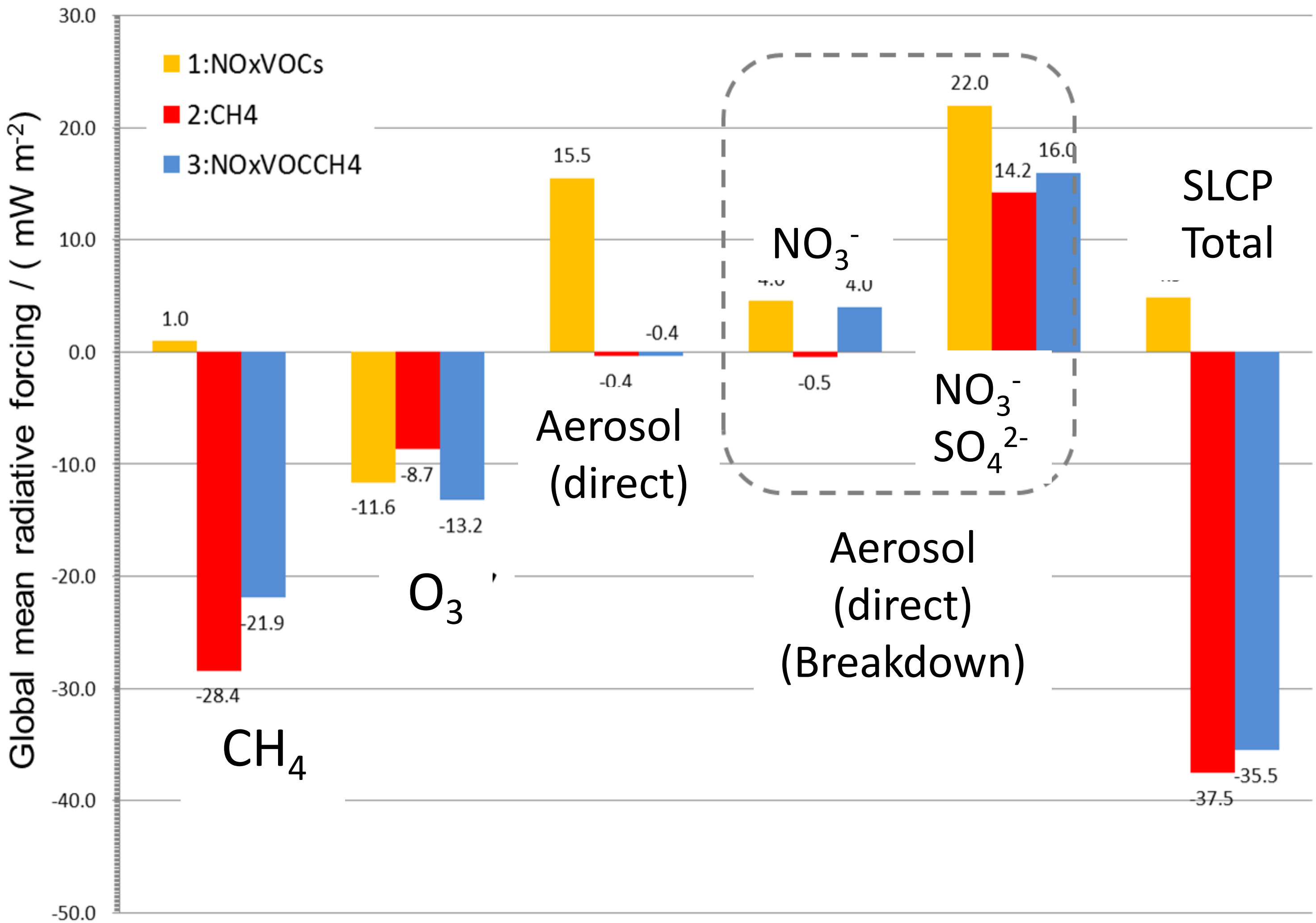
NOx/VOC 50% Reduction in Northeast Asia

CH_4 50% Reduction in Northeast Asia

NOx/VOC and CH_4 Reduction in Northeast Asia



Change in Global Averaged Radiative Forcing



As we expected:

1. NOx/VOC reduction is effective to reduce surface O_3 in East Asia, but reduction of global RF is marginal.
2. CH_4 reduction tends to increase surface O_3 in East Asia, but reduce ozone in the free troposphere, which help reducing global RF.
3. Much of reduction of RF by CH_4 is due to its own greenhouse effect rather than due to O_3 reduction.
4. Simultaneous reduction of NOx/VOC and CH_4 contribute to air pollution mitigation as well as climate change mitigation.

Development of SLCP co-benefit scenario in East Asia

Research Collaboration with IIASA

Target year: 2030 ; Base year: 2005
Target area: East Asia (Northeast and Southeast)
Model :
- IIASA: GAINS
- S-7 Team : CHASER/MIROC (Global), WRF/CMAQ (Regional)

Scenarios
- Initial calculation: GAINS Reference Scenario
  - CLE (Current Legislation Scenario)
  - CO_2–eq 450 ppm Stabilization Scenario
  - MFR (maximum Feasible Reduction Scenario)
- Air pollution control strengthened scenario
  - 450 ppm –cntr Scenario

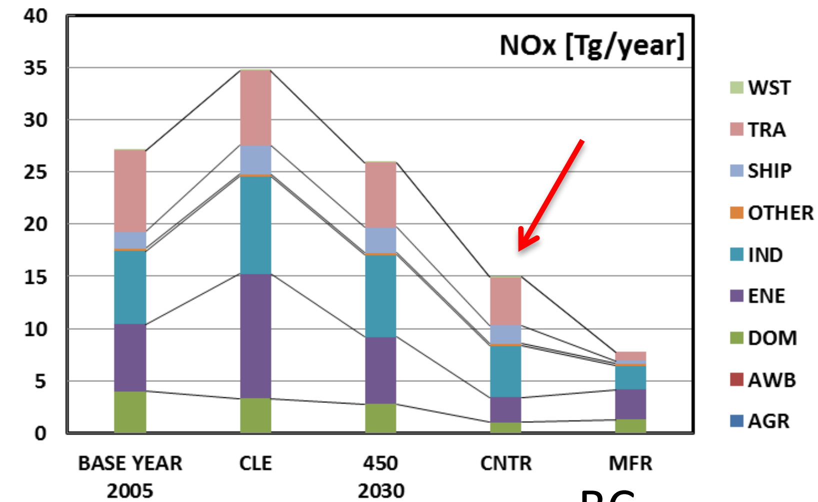
IIASA Emissions for East Asia in 2030 : CLE, “450ppm”, and MFR Scenarios

“450 ppm-cntr” Scenario

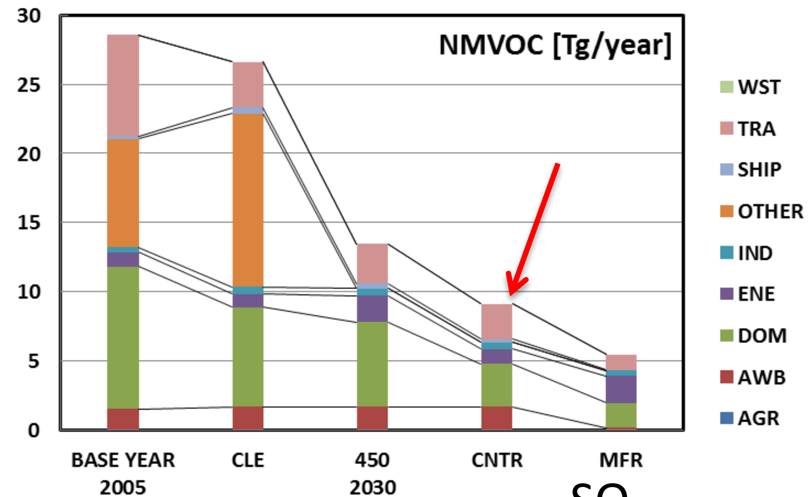
NO_x: 30- 50% reduction, VOC and BC: about 30% reduction for East Asia in 2030

Compared to the ” 450 ppm” scenario (no change for CH_4 and SO_2)

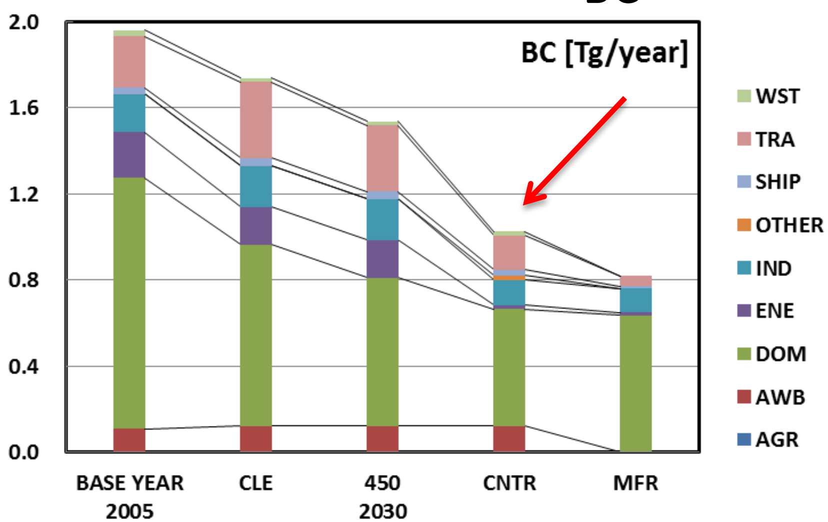
NOx



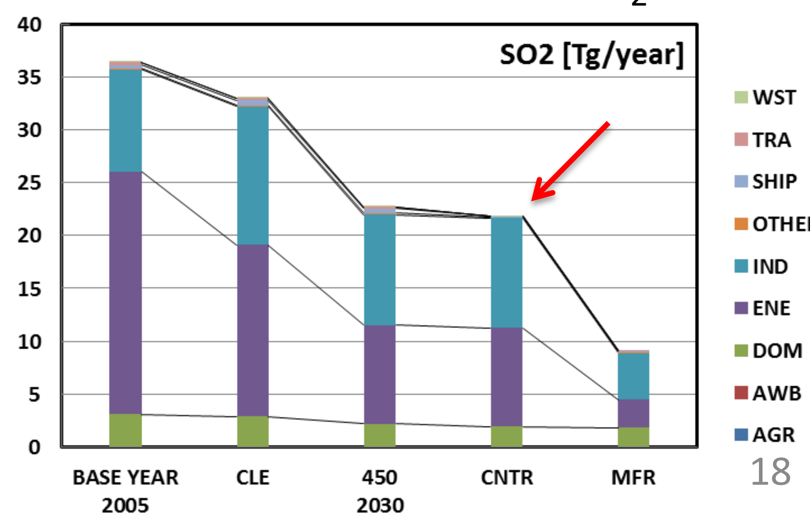
NMVOC



BC

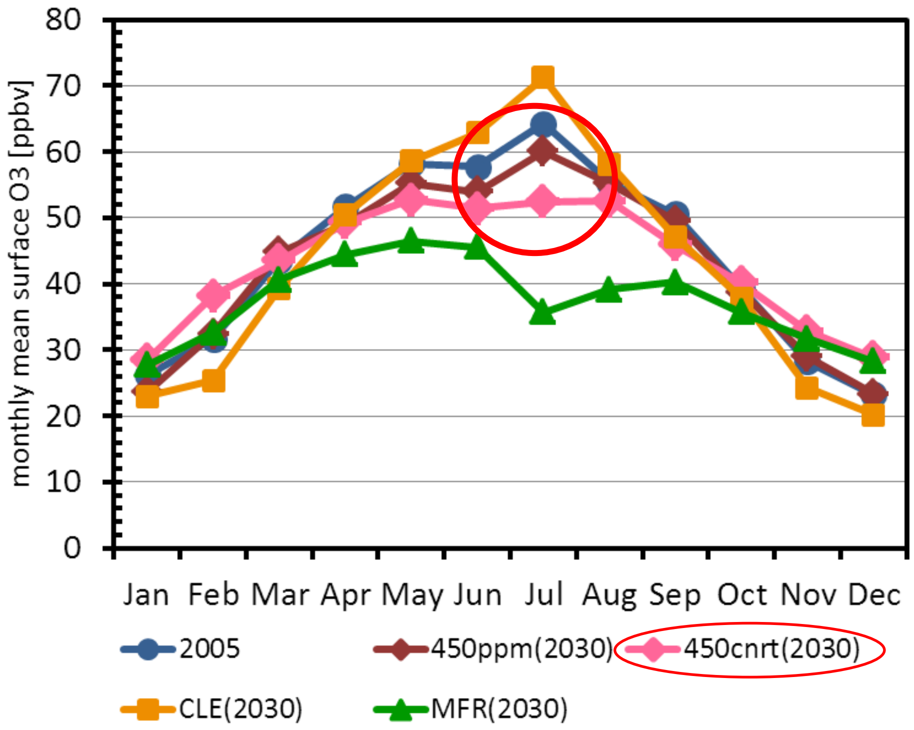


SO_2

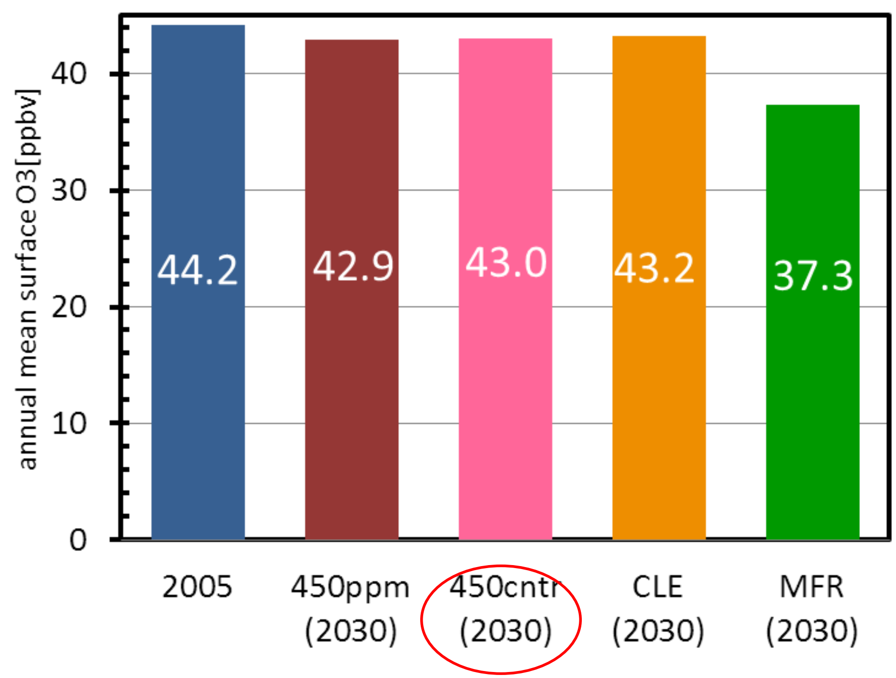


Impact on Surface O3 in Central East China (CEC)

Temporal variation of surface O_3 averaged over CEC region



Annual means of surface O3 averaged over CEC region



- Annual mean surface O_3 for both 450 ppm and 450 ppm-cntr scenario are similar.
- However, compared with 450ppm, 450 ppm-cntr scenario decrease surface O_3 in summer.

Change in high surface O_3 days

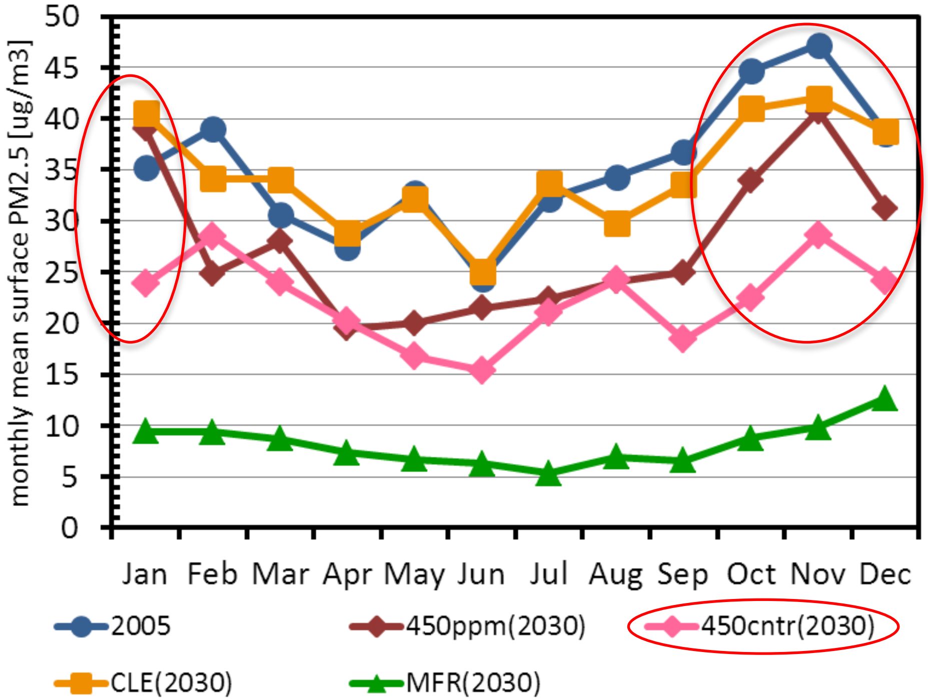
Number of days with "daily max 8h mean O_3" > 75 ppb

[day]	2005	450 ppm	450-cntr	CLE	MFR
CEC	66.1	58.0	24.3	92.4	3.58
KOR	57.7	57.0	34.3	85.8	4.30
JPN	39.0	9.81	3.90	47.1	0.25

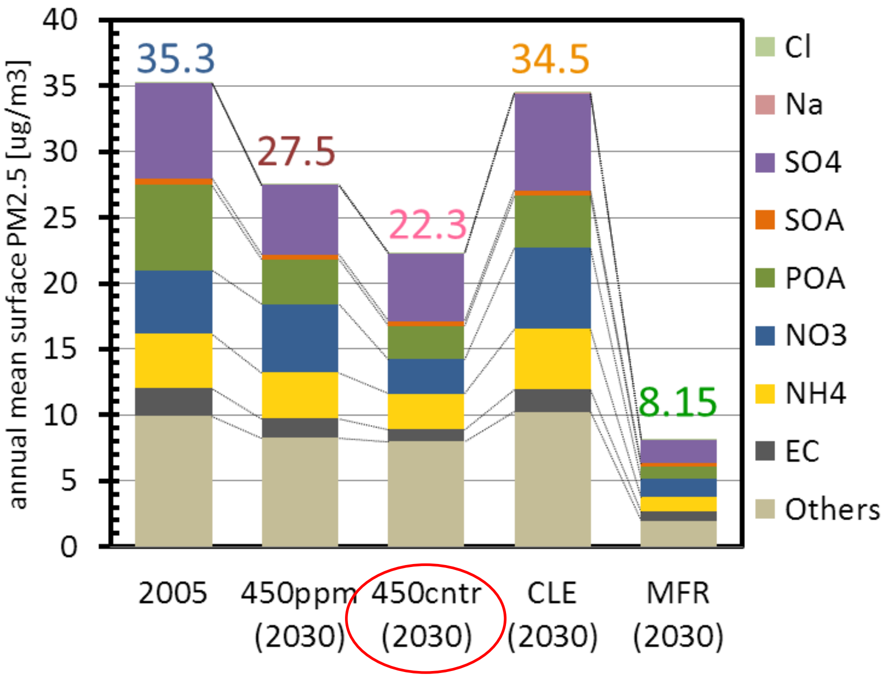
PM$_{2.5}$

Impact on PM$_{2.5}$ in Central East China (CEC)

Temporal variation of surface PM$_{2.5}$ averaged over CEC region

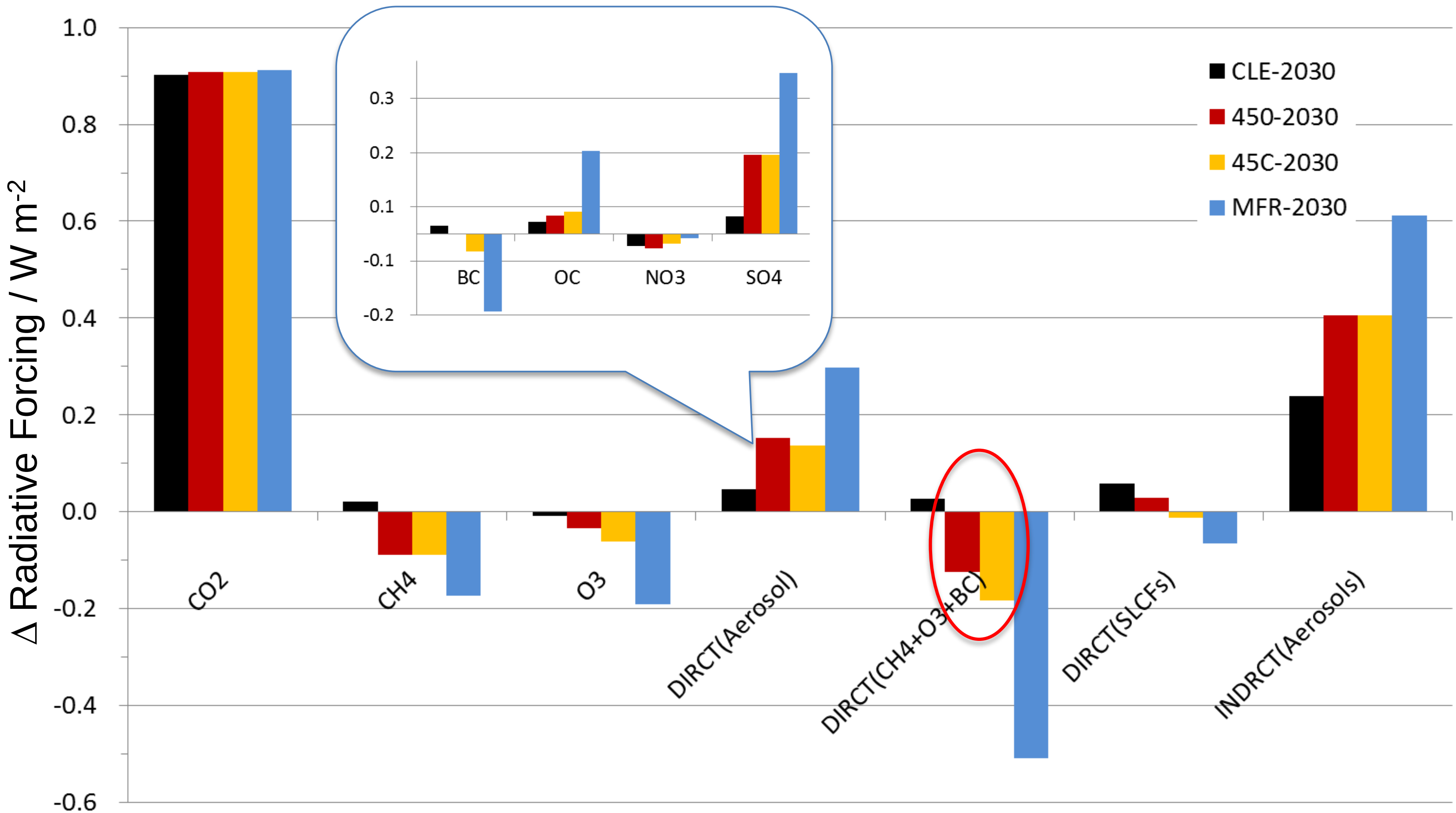


Annual means of surface PM$_{2.5}$ and its composition averaged over CEC region



The 450-cntr Scenario decreases annual mean concentration of PM$_{2.5}$ substantially and improves winter time PM$_{2.5}$ significantly.

Changes in RF（2005～2030）
-- Global Mean --



We conclude :

1. Strengthening NOx/VOC reduction in East Asia reduces summer time surface O_3 in this region.
2. Strengthening NOx/VOC and BC reduction in East Asia reduces winter time $PM_{2.5}$ in this region.
3. Strengthening NOx/VOC and BC reduction also reduces radiative forcing by about 0.2 W cm^{-2}.

Next:

We will evaluate the reduction cost of air pollutant emissions and economic benefit of reducing health effects by O_3 and $PM_{2.5}$ according to the 450 ppm-cntr scenario.

Contents

Situation of Scientific Information sharing on Regional Air Pollution in Asia

Different from:

Climate Change Issue

Framework Convention on Climate Change (FCCC)

IPCC (Intergovernmental Panel for Climate Change)

Air Pollution Issue in the West (Europe/North America/FSU)

Convention on Long-range Transboundary Air Pollution (CLRTAP)

EMEP, HTAP, etc.

No Framework Convention on Air Pollution in Asia

No framework for synthesizing scientific knowledge in Asia

1) among scientists

2) between scientists and policy makers

Proposal to create an epistemic scientific community in (East) Asia

Asian Scientific Panel on Air and Climate (ASPAC)

(i) to establish an epistemic community of Asian scientists;

(ii) to develop a common understanding among scientists and policy makers; and

(iii) to develop an international initiative for an integrated approach to air pollution and climate change reflecting views of Asian scientists.

Possible Contents of ASPAC (1)

While the concept of ASPAC is still in the premature stage, the preliminary research identified several important issues to be considered:

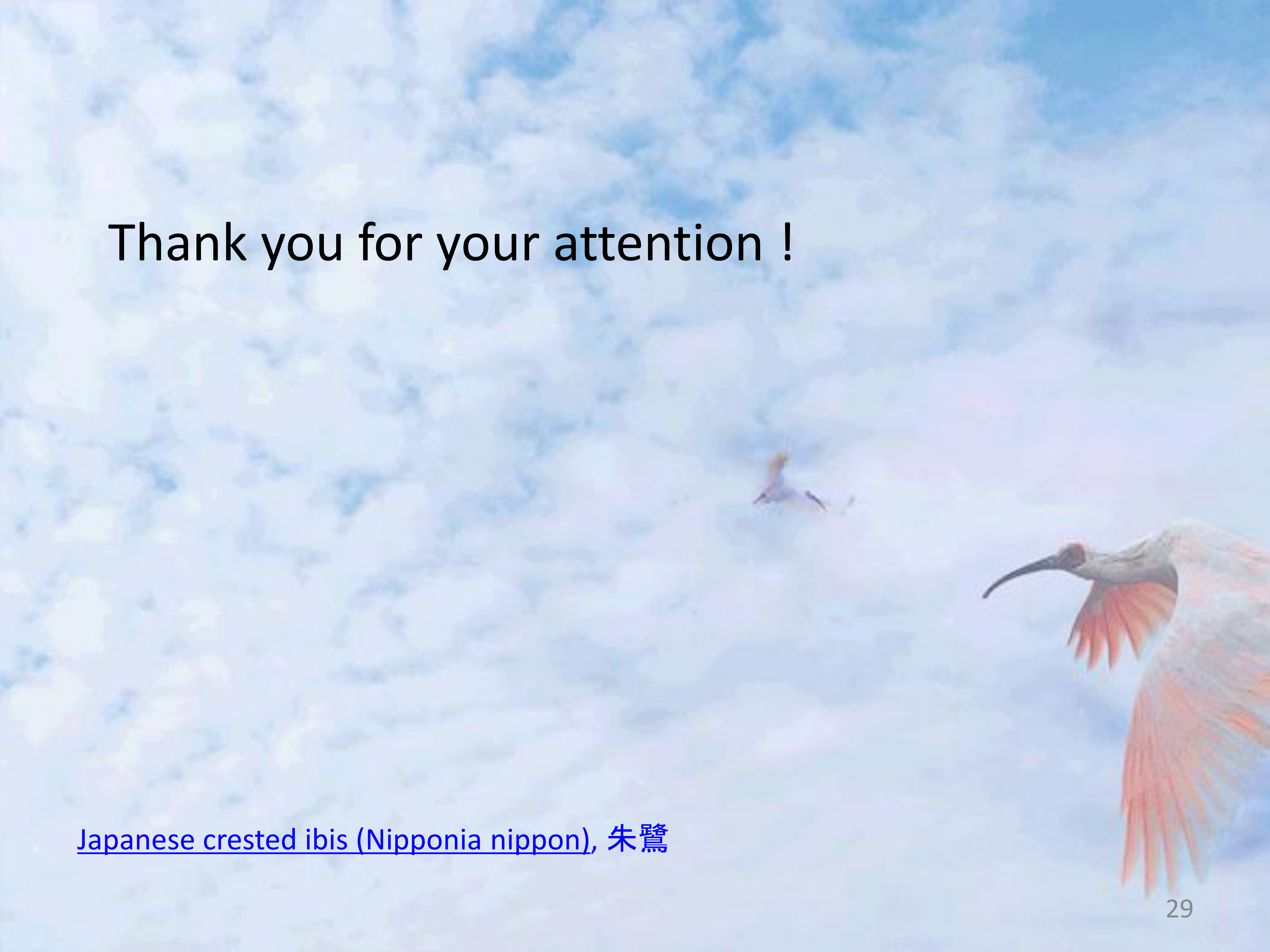
(i) Plausible major functions of ASPAC

- Synthesis of newly emerging scientific findings for consensus building among scientists (and policy makers)
- The scope of targeted area or research?
    - Atmospheric science
    - Impact studies
    - Short-term/long-term mitigation measures
- Not only the review of existing research, but should also includes enhanced research collaboration and capacity building?

Possible Contents of ASPAC (2)

- Geographical scope
  - Asia as a whole
  - East Asia
  - any other geographical scope
- Organizational structure of ASPAQ, including the secretariat
  - Collaboration with Existing frameworks :
    UNEP, CAA (Clean Air Asia)
- Possible funding sources
  - National contributions
  - international funding
  - use of existing funding mechanisms such as climate funding?

We would appreciate your support and collaboration.



Thank you for your attention !

Japanese crested ibis (Nipponia nippon), 朱鷺