

AIM application on GHG stabilization scenarios

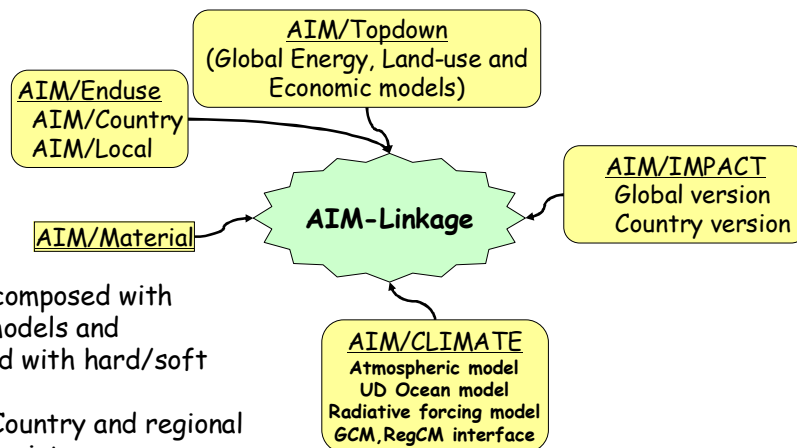
Workshop on GHG Stabilization Scenarios
Tsukuba, Japan on January 22-23, 2004

Yuzuru MATSUOKA
Kyoto University, Japan
and
Mikiko KAINUMA
National Institute for Environmental Studies, Japan

Matsuoka and Kainuma

1

AIM model family

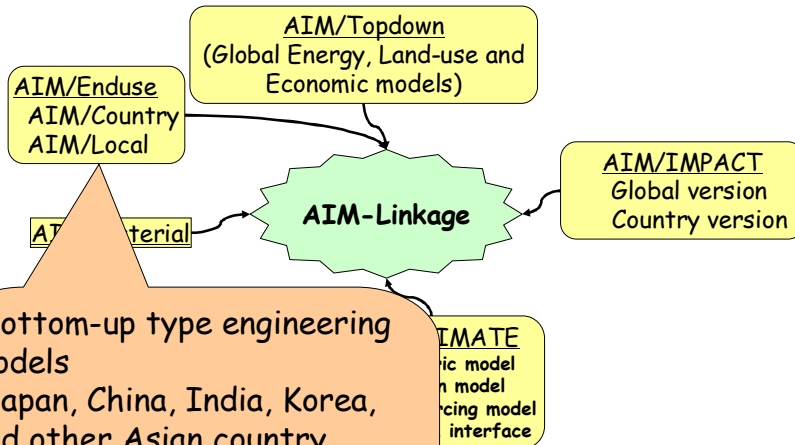


- AIM is composed with various models and connected with hard/soft linkage
- Global, Country and regional versions exist
- Developed and supported by International collaborating teams in Asian countries

Matsuoka and Kainuma

2

AIM model family

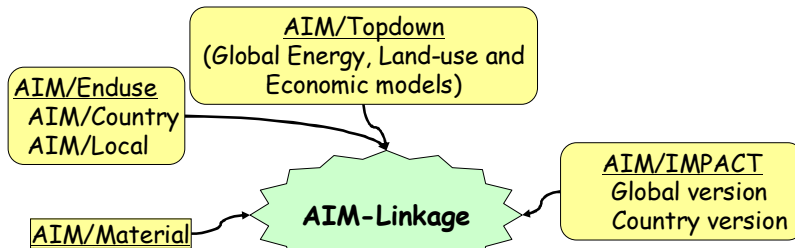


- Bottom-up type engineering models
- Japan, China, India, Korea, and other Asian country studies and regional studies
- Coupled with county level high resolution emission inventories

ama

3

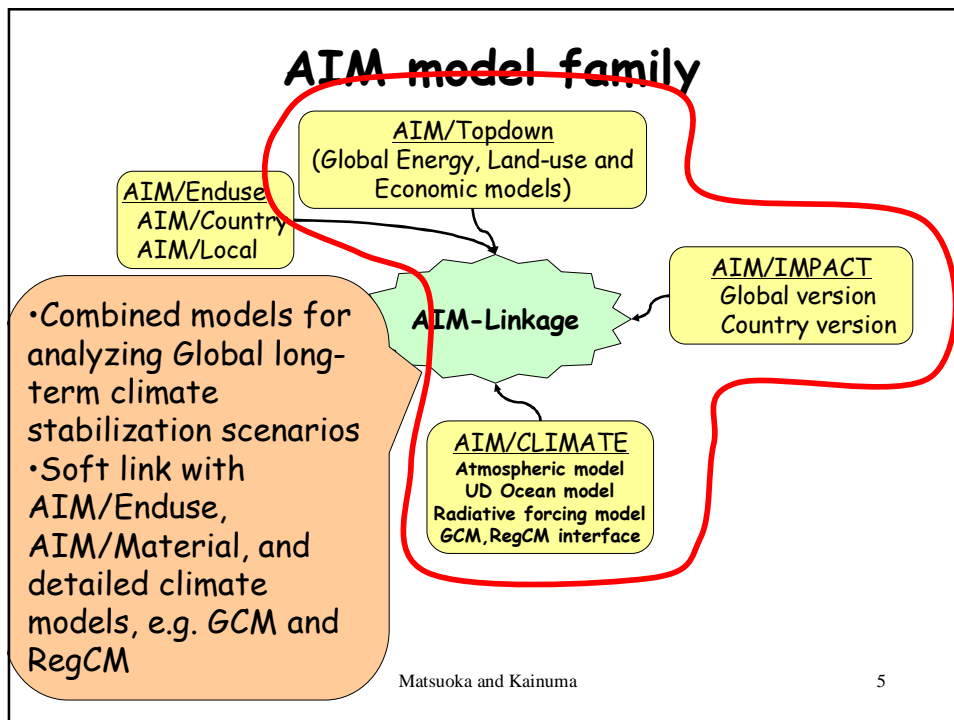
AIM model family



- A model which couples economic CGE approach and engineering bottom-up approach
- One regional model for a country environment, energy, and material problems
- Applied to Japan, China, and India

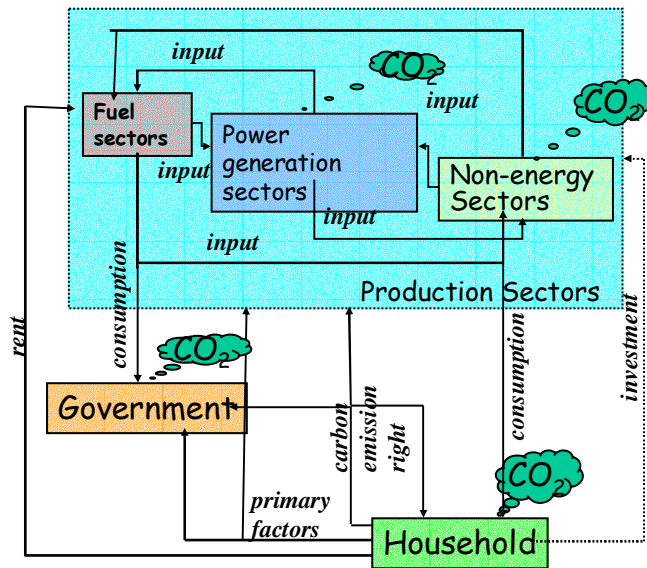
E
del
ice

4



- ## Abstract of AIM/Topdown
- **Type: Multi-regional, multi sector CGE, sequential equilibrium**
 - **Programmed with GAMS/MPSGE**
 - **Year period: 1990-2100**
 - **Regions: 21 regions**
 - **Production Sectors: 13 sectors**
 - **Energy depletion, electricity mix**
 - **Several extended and modified version are developing, e.g. AIM/CGE(Asia).**
- Matsuoka and Kainuma
- 6

Structure of AIM/Topdown



Some features

- Simple cohort structure of stocks
- Investments are determined with rate of return and previous preference
- Logit type share preference of energy in order to keep energy balance in trade and market electricity production by various generation methods
- Resource vs. cost functions are supplied for each region

Matsuoka and Kainuma

7

Regional Aggregation of AIM 21 regions

JPN	Japan
AUS	Australia
NZL	New Zealand
CAN	Canada
USA	United States of America
EUR	West Europe
FSU	Former Soviet Union
CHN	China
HKG	Hong Kong
IDI	India
MEA	Middle East and North Africa
KOR	Republic of Korea
TWN	Taiwan
SGP	Singapore
IDN	Indonesia
MYS	Malaysia
PHL	Philippines
THA	Thailand
LAM	Latin America
SSA	Sub Saharan Africa
ROW	Rest of the World

Matsuoka and Kainuma

8

Sectors in AIM/Topdown

13 production sectors and 8 production sub-sectors, 2 final demand sectors

1	COL	Coal production	8	AGR	Agriculture
2	GAS	Natural gas production	9	FRS	Forestry
3	CRU	Crude oil production	10	LVK	Livestock
4	OIL	Refined oil products	11	EIS	Energy Intensive Industries
5	RNW	Renewable energy supply	12	OTH	Other Industries
6	ELE	Electricity and heat production with oil, coal, gas, hydo, nuc, solar, biomass subsectors	13	SER	Service
7	TRN	Transport			

Matsuoka and Kainuma

9

Assumptions for experiments

- Regional population and GDP changes follow SRES B2
- Global CO₂ emission to achieve 450, 550 and 650 ppm stabilization after 2150, calculated with AIM/SSG
- Contraction and Convergence approach for burden sharing, i.e.
 - Per capita CO₂ emission convergence after 2050
 - Annex B: Kyoto protocol till 2012 and start convergence linearly to 2050 target
 - Non annex B: After 2015, each region joins convergence when the emission surpasses the per capita CO₂ emission permit
 - Carbon trade market is opened for capped regions

Matsuoka and Kainuma

10

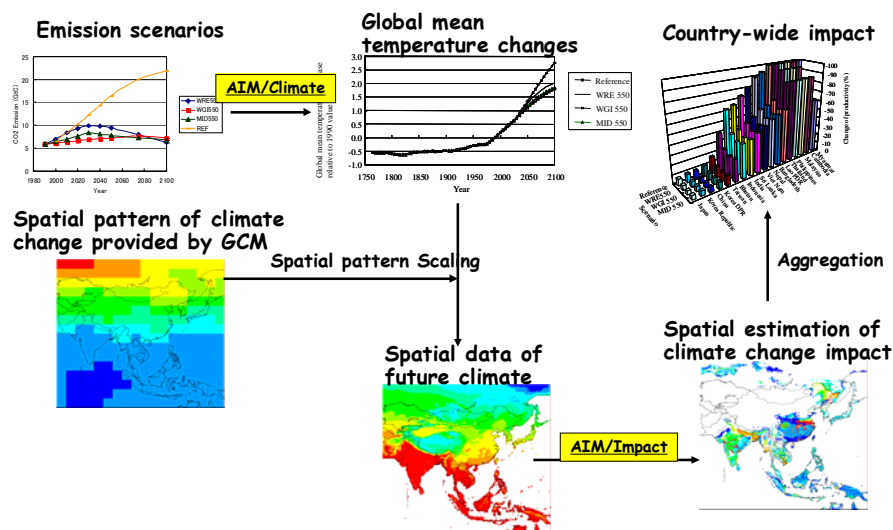
Climate and Impact modules of this calculation

- CO₂ concentration with AIM/SSG (Stabilization Scenario Generator): Simplified carbon cycle model based on Joos model
- Radiative forcing expression based on IPCC report (WG1, 2001)
- Upwelling diffusion model for energy balance
- Spatial pattern scaling of climate change with IPCC/DDC's GCM library
- Country level aggregated version of AIM/Impact for impact analysis

Matsuoka and Kainuma

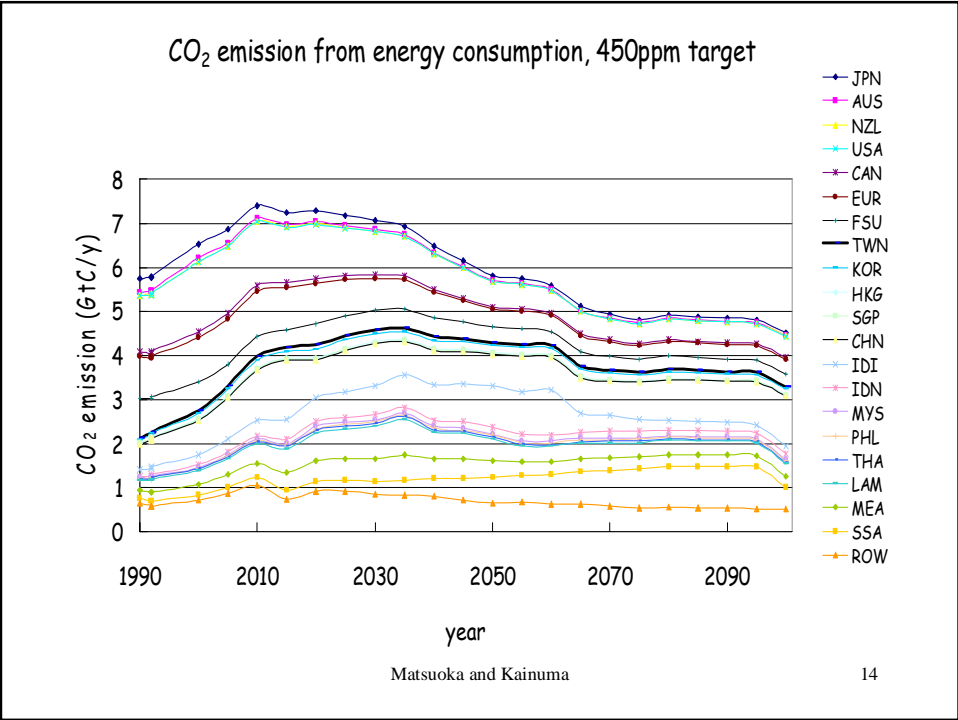
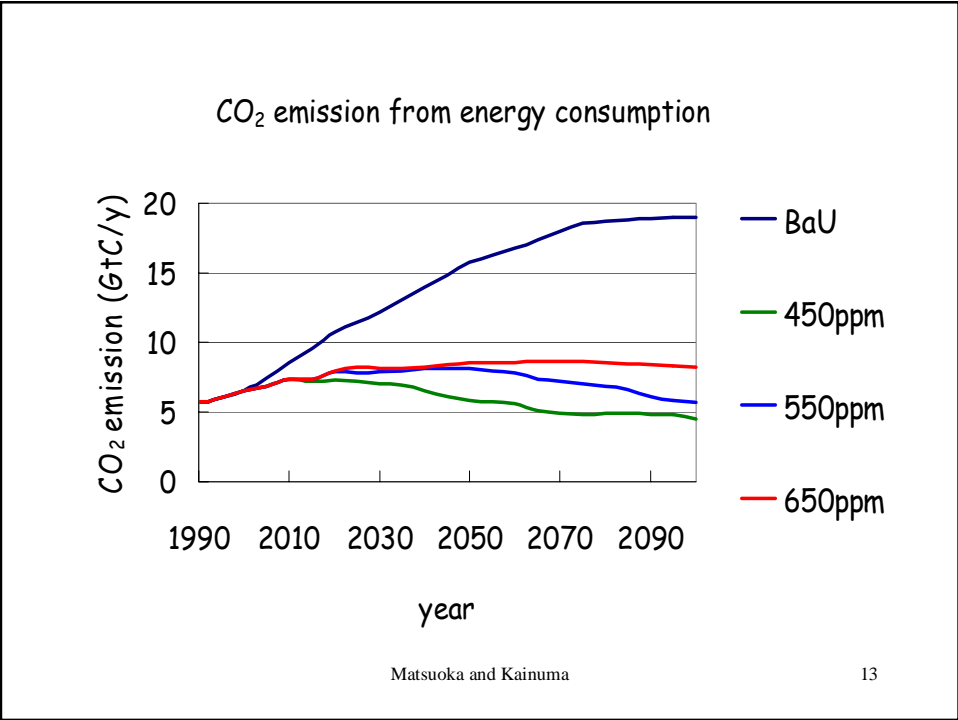
11

Frame of impact estimation

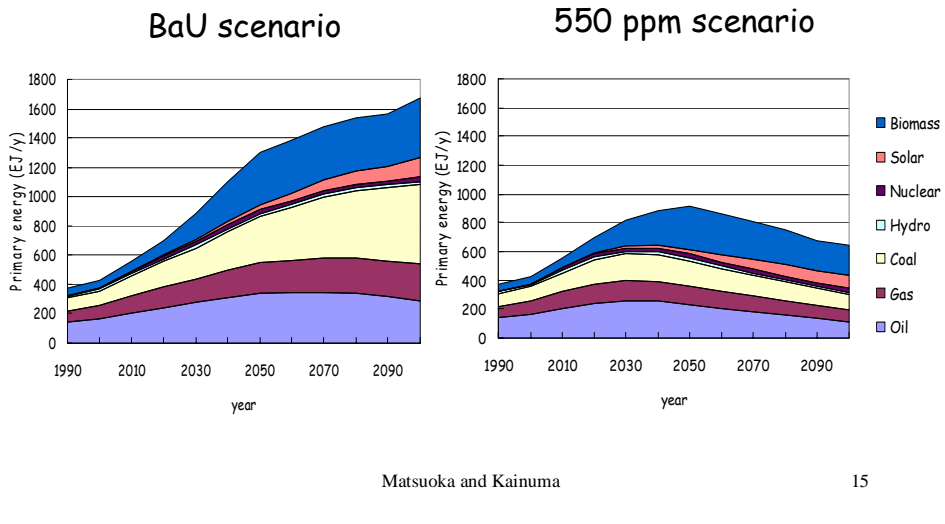


Matsuoka and Kainuma

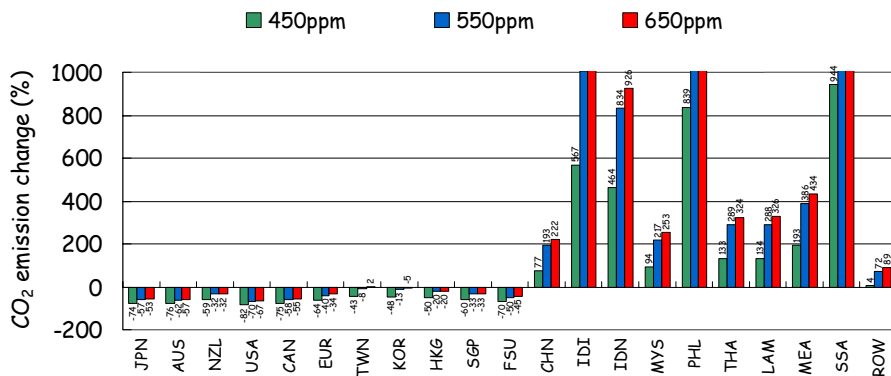
12



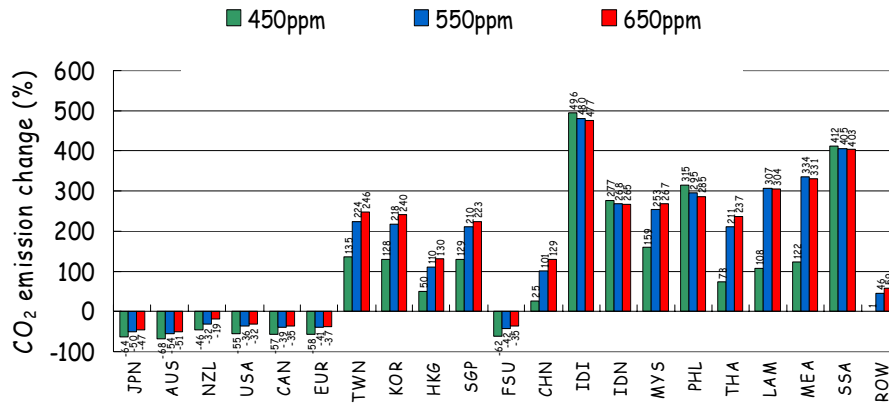
Primary energy supply



Required CO₂ emission changes in year 2050 compared with 1990



CO₂ emission changes in year 2050 compared with 1990

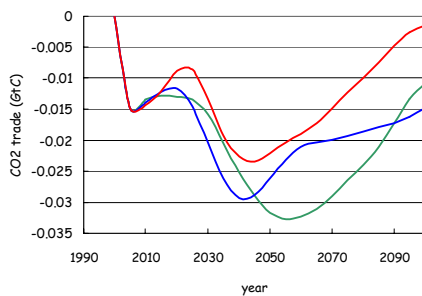


Matsuoka and Kainuma

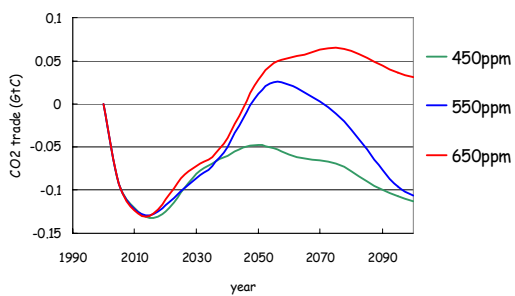
17

Trade of CO₂ emission

Trade of CO₂ emission, Japan



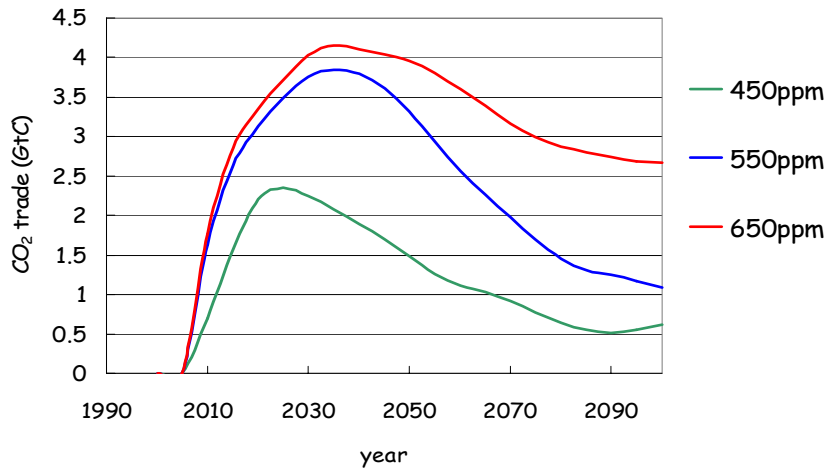
Trade of CO₂ emission, West Europe



Matsuoka and Kainuma

18

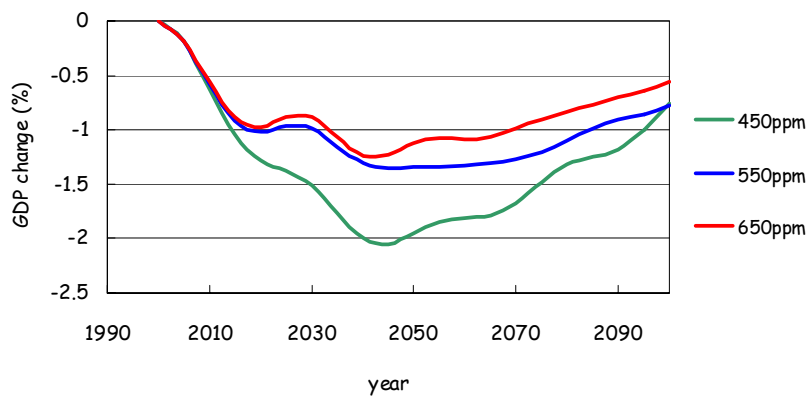
Trade of CO₂ emission, from LDC to DC



Matsuoka and Kainuma

19

World Economic Production Change

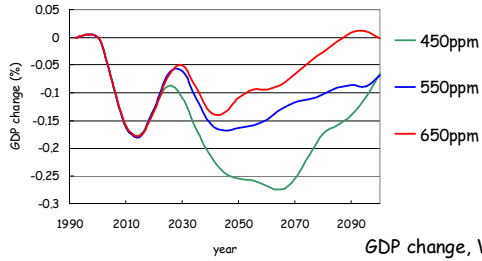


Matsuoka and Kainuma

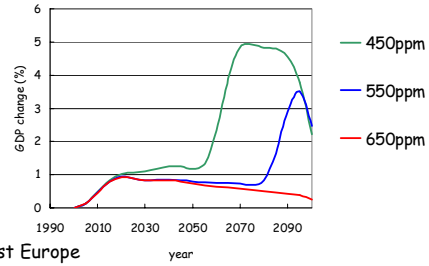
20

Regional GDP change

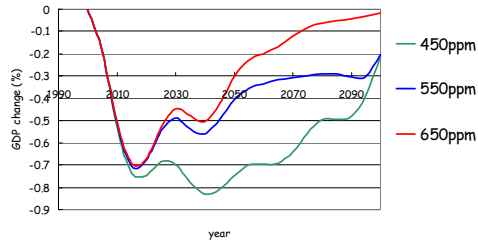
GDP change, Japan



GDP change, India



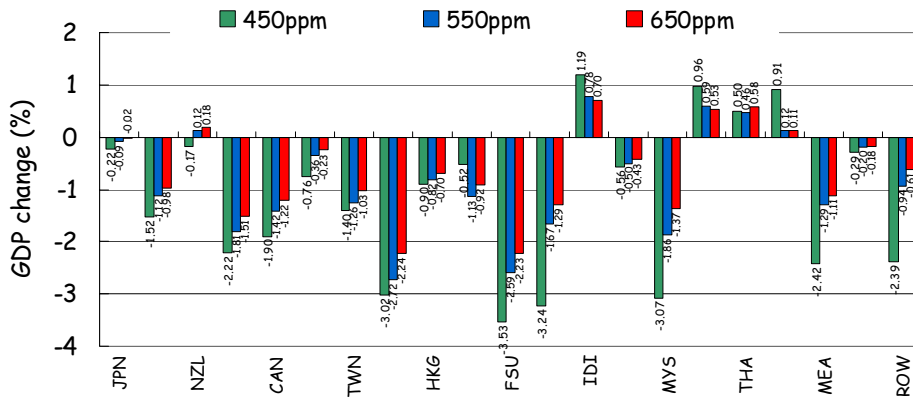
GDP change, West Europe



Matsuoka and Kainuma

21

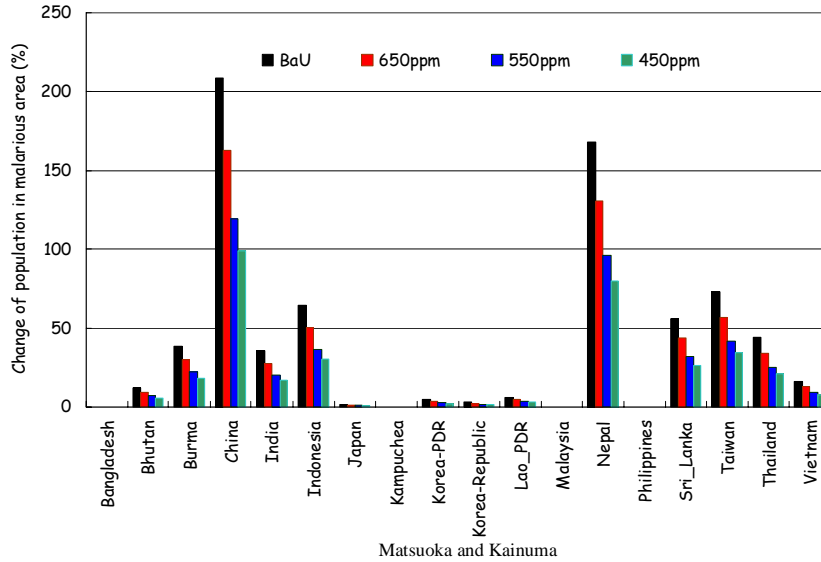
GDP changes in 2050



Matsuoka and Kainuma

22

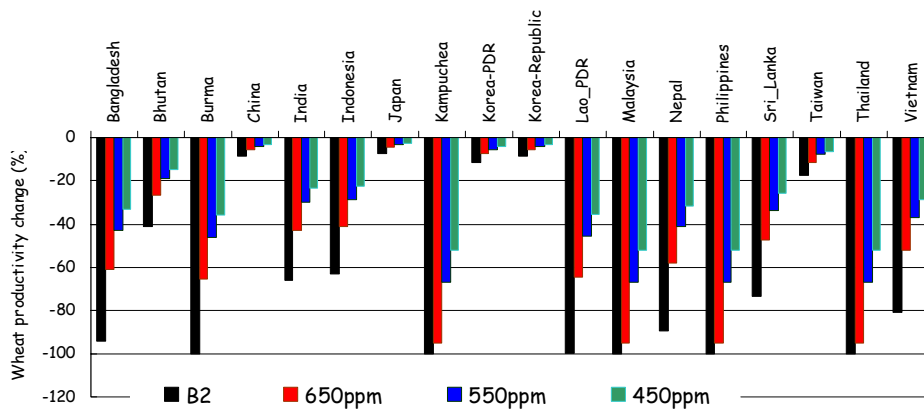
Change of malarious area in 2070's



Matsuoka and Kainuma

23

Wheat productivity change in 2070's



Matsuoka and Kainuma

24

Final remarks

- Introduce recent application of AIM for Stabilization scenarios, especially on per capita convergence approach.
- In case of convergence year is 2050, DC must reduce 60-80% (450ppm) compared with 1990 emissions.
- In case of full-scale carbon trading, required domestic reduction becomes 60%

	Emission permits in 2050		
	450ppm	550ppm	650ppm
Japan	26(36)	43(50)	47(53)
USA	18(45)	30(64)	33(68)
West Europe	36(42)	60(59)	66(63)
China	177(125)	293(201)	322(229)
India	667(596)	1106(580)	1214(577)

% of 1990 emission. () is net actual emission considering carbon trading and sink

Final remarks (continued)

- World economic losses of these reduction are 1.2-3% in the middle of this century.
- Some regions loss more, up to 4%, and some regions gain mainly caused by carbon trading
- Impacts decrease substantially by these mitigation effort, and their examples were shown.
- The extension of this approach to multi-gas reduction will also introduced by Dr.Fujino, continuously, and as for impact by Dr.Takahashi, tomorrow