Climate Target

- Multigas and CO2 Sequestration -

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= Outline =

1. Introduction
2. Climate Stabilization Target and Possible Indicators
3. GRAPE Model
4. GHG Mitigation under Climate Target
   - 4.1 Multigas
   - 4.2 CO2 Sequestration (Eng. Sink)
5. Discussion and Summary

1. Introduction

Warning from scientific communities

>>> Climate impact reduction by mitigation and adaptation

>>> UNFCCC and Kyoto Protocol

Flexibility of mitigation measures

Where and when

Kyoto GHGs / Multigas basket target

CO_2, CH_4, N_2O, HFCs, PFCs, SF_6

Sinks (LULUCF, engineering)

2.Climate Stabilization Target and Possible Indicators

Table 1. Indicators for attribution to climate change and their characteristics

	Figure 2	Close to impacts	Understandable	Certain	Backward discounting
Cumulative emissions	A	-	●●●●	●●●[4]	-
Concentrations	B	●	●●●●	●●◖	●●●
Integrated concentrations	C	●◖	-	●●◖	●●
Radiative forcing (due to increased concentrations)	D	●●	●●	●●	●●●
Integrated past radiative forcing	E	●●●	-	●●	●●
Integrated future radiative forcing	F	●●●◖	-	●●	●●●
Temperature	G	●●●●	●●●●	●◖	●●
Rate of temperature change	-	●●●●	●●[5]	●	?
Sea level rise	-	●●●●	●●●●	◖	●

Source : FCCC/SBSTA/2002/INF.14

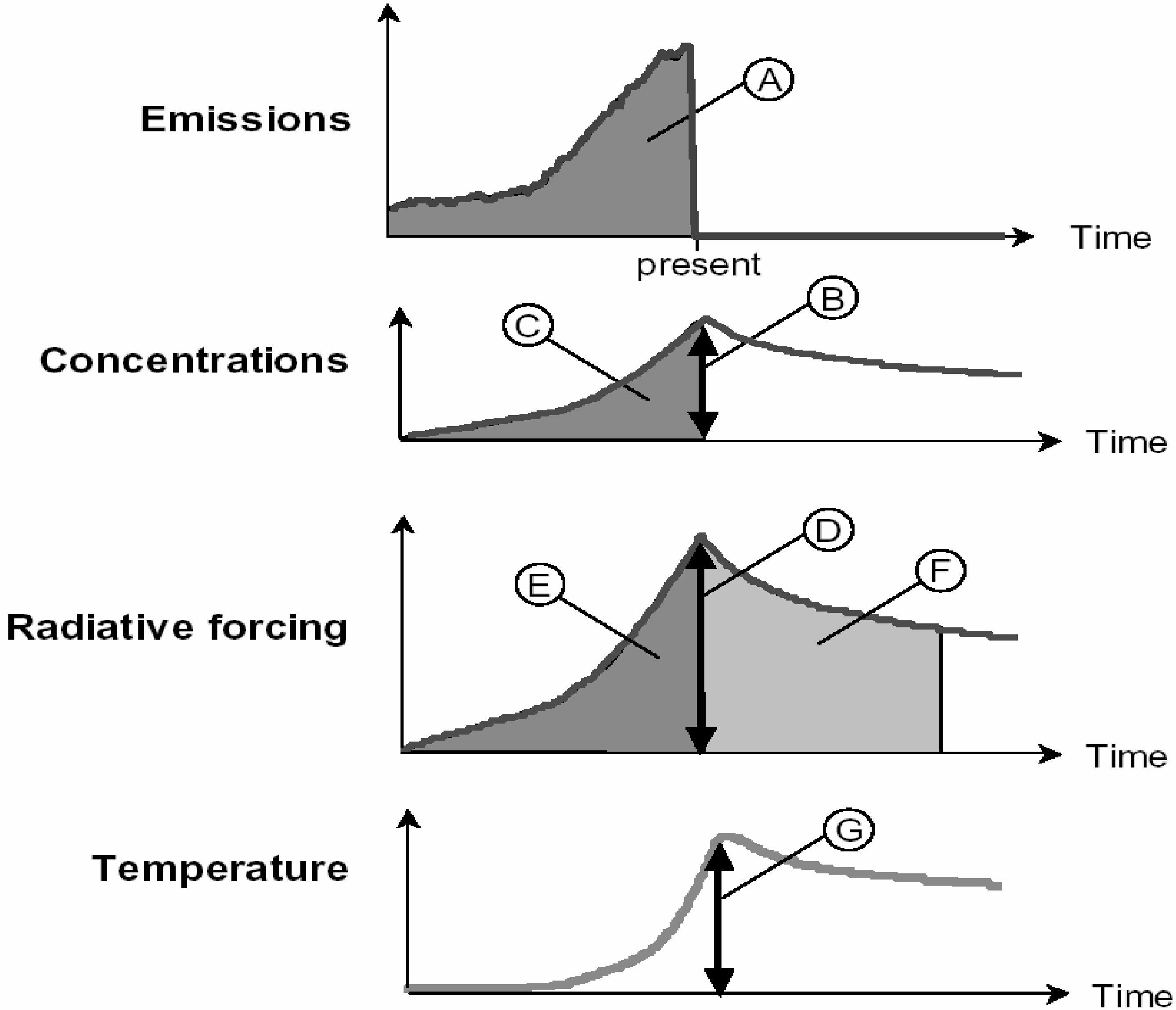


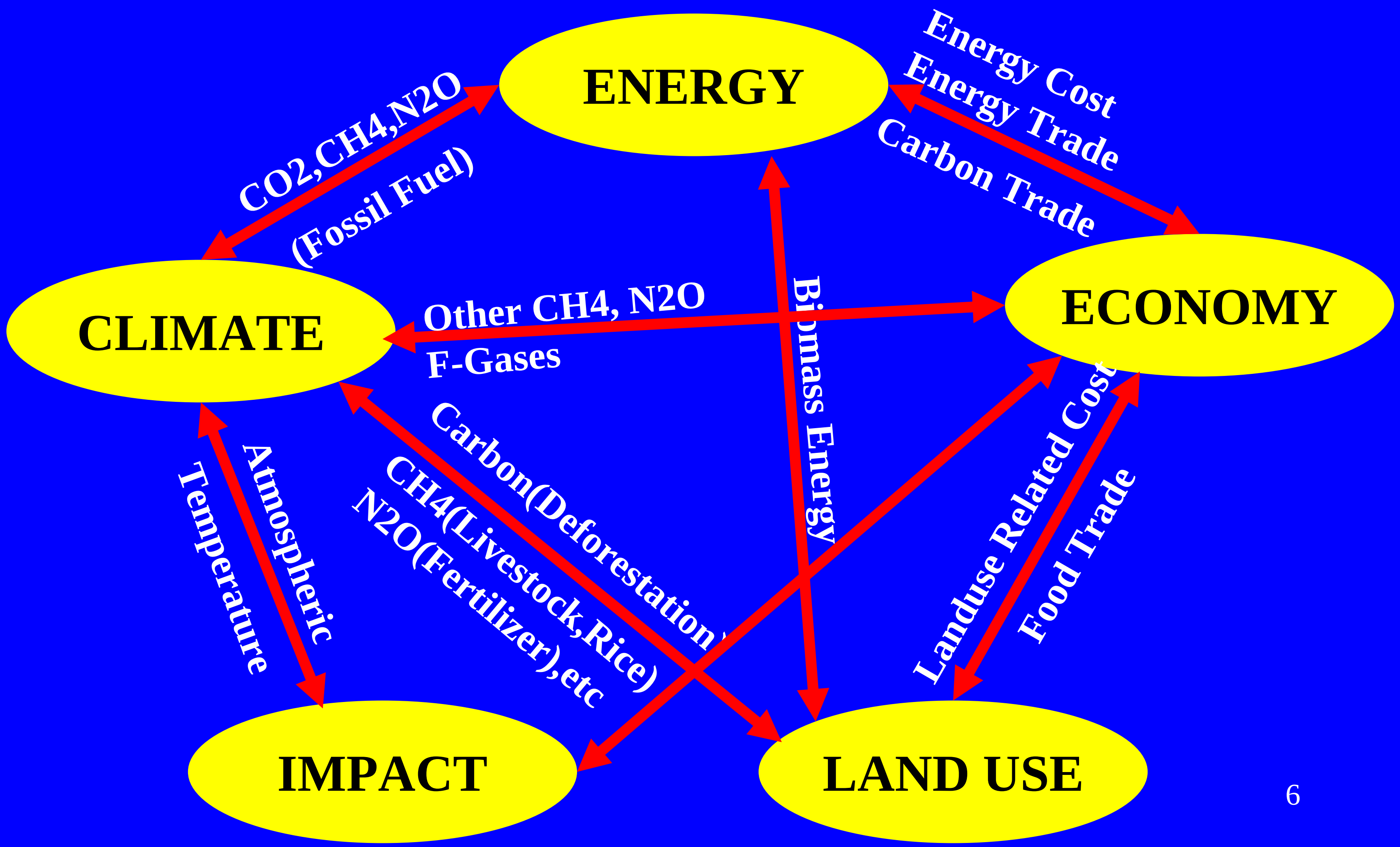
Figure 2. Indicators for attribution to climate change (adapted from ECOFYS)

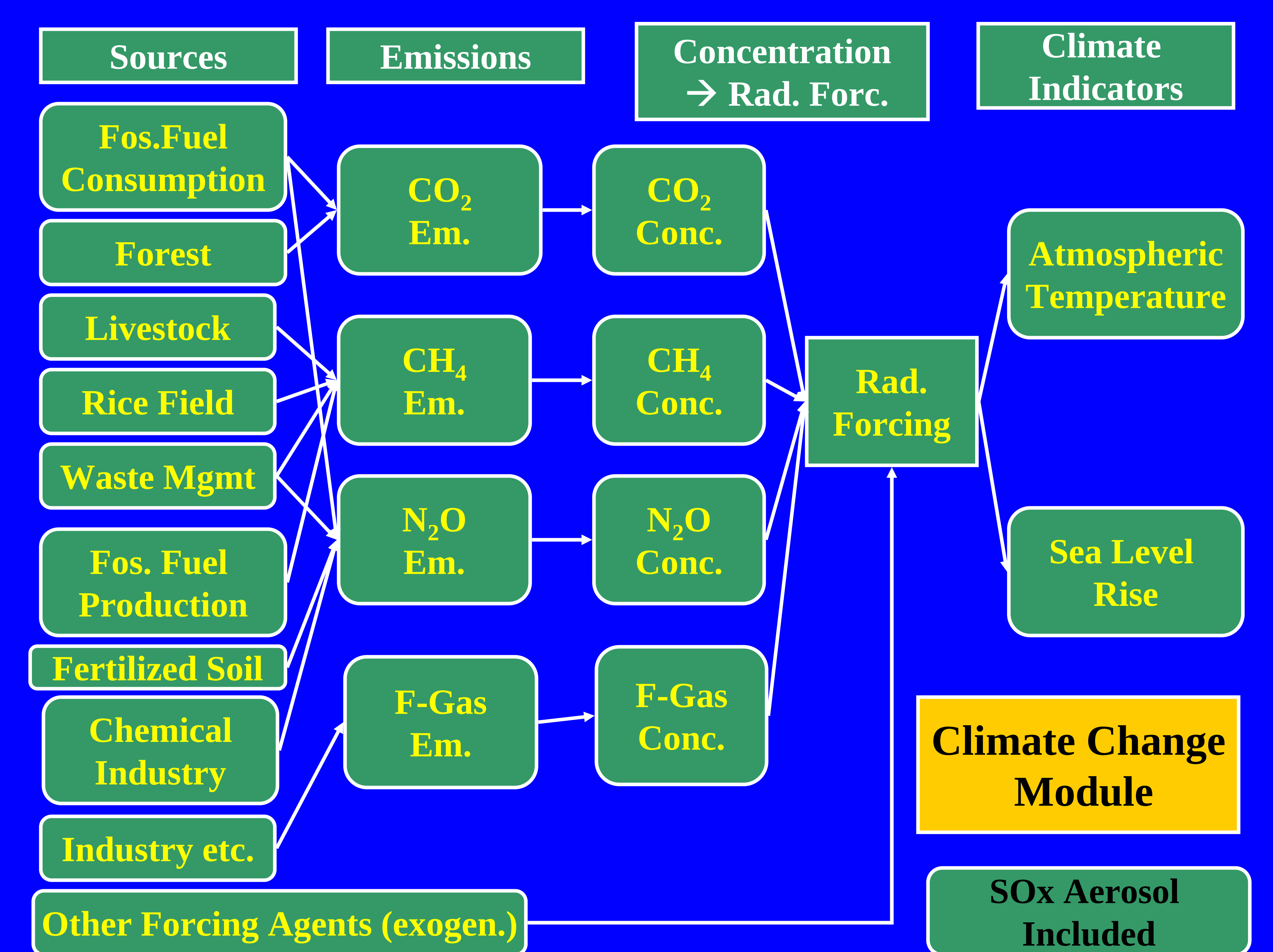
Source ： FCCC/SBSTA/2002/INF.14

3.GRAPE Model

5 Modules

Long-term (-2100), 10 global regions




Sources
Emissions
Concentration → Rad. Forc.
Climate Indicators
Fos.Fuel Consumption
Forest
Livestock
Rice Field
Waste Mgmt
Fos. Fuel Production
Fertilized Soil
Chemical Industry
Industry etc.
Other Forcing Agents (exogen.)
CO_2 Em.
CH_4 Em.
N_2O Em.
F-Gas Em.
CO_2 Conc.
CH_4 Conc.
N_2O Conc.
F-Gas Conc.
Rad. Forcing
Atmospheric Temperature
Sea Level Rise
Climate Change Module
SOx Aerosol Included

F-Gas Characteristics (IPCC WGI TAR)

	conc.(#1) (ppt)	emis.(#2) (Gg/yr)	life (years)	GWP(100yr)	rad. eff. (W/m2/ppb)
HFC23	14	～7Gg	260	12000	0.16
HFC134a	7.5	～25Gg	13.8	1300	0.15
CF4	80	～15Gg	>50000	5700	0.08
SF6	4.2	～6Gg	3200	22000	0.52

(#1)1998 , (#2)late 1990s

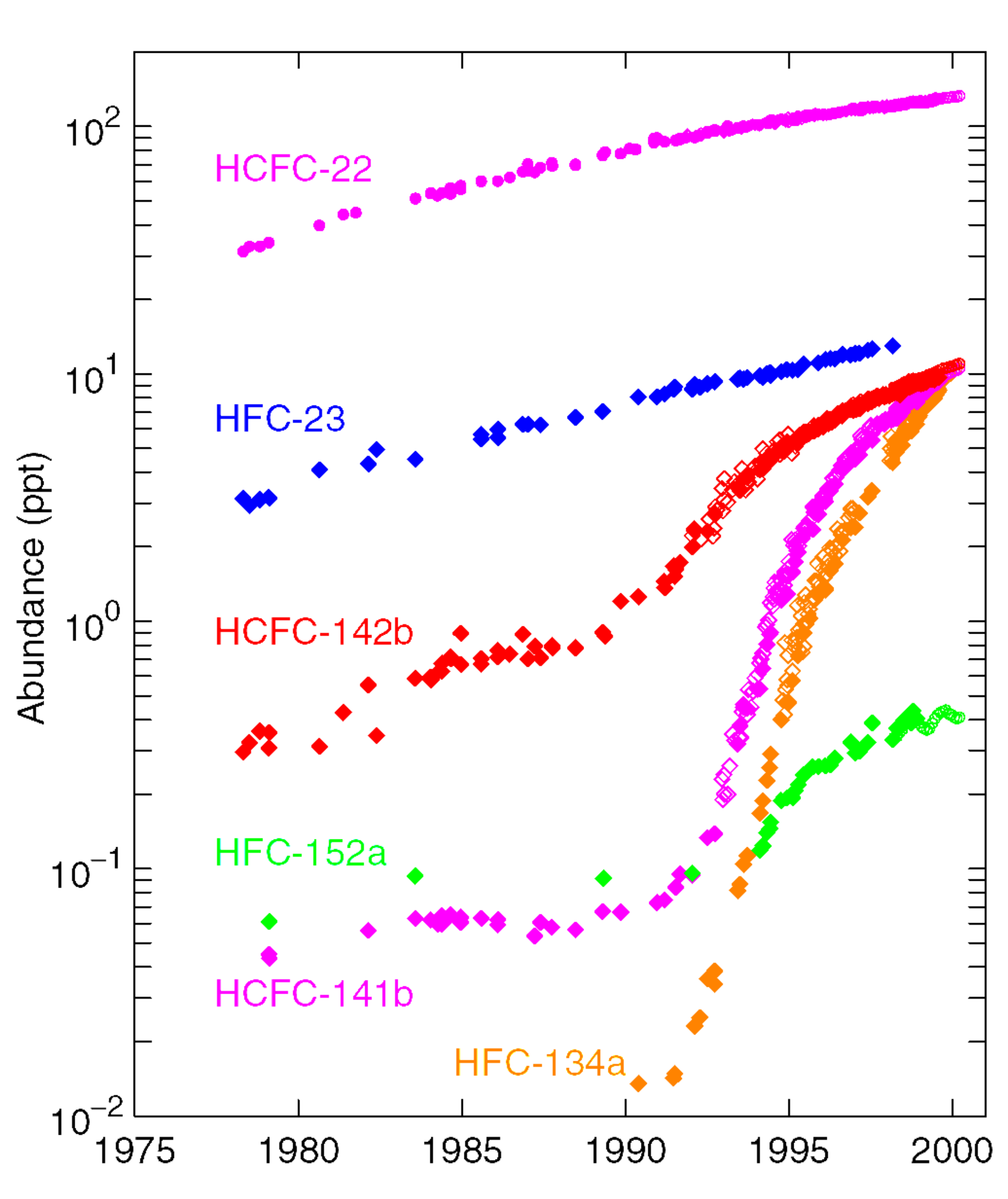
Concentration vs. Emission

- Lifetime

Radiative forcing vs. Concentration

- Radiative Efficiency

Atmospheric conc. of HFCs and HCFCs (IPCC WG1 TAR)



Atmospheric conc. of CF4 (IPCC WG1 TAR)

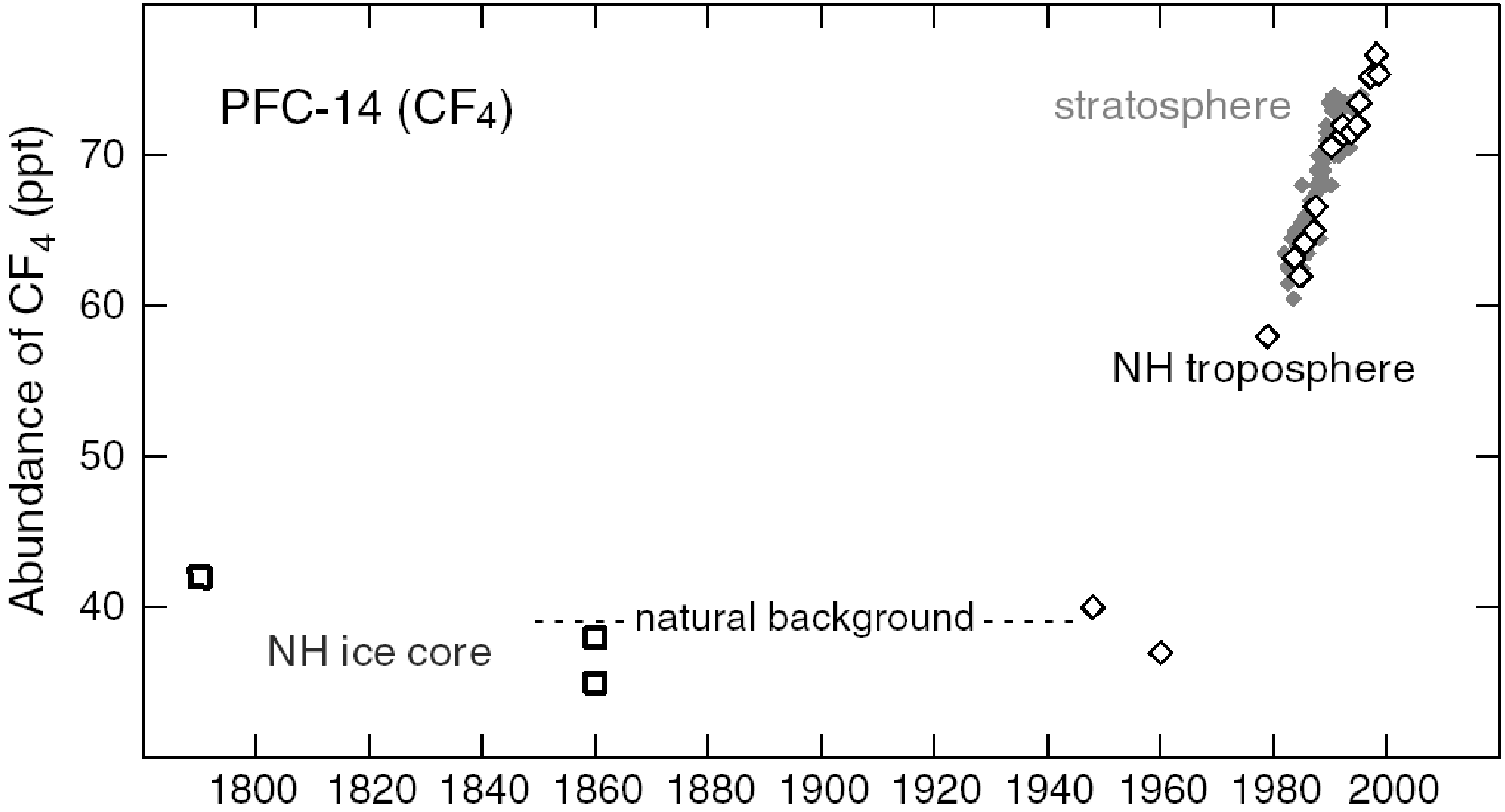


Figure 4.4: Abundance of CF_4 (ppt) over the last 200 years as measured in tropospheric air (open diamonds), stratospheric air (small filled diamonds), and ice cores (open squares) (Harnisch *et al.*, 1996; 1999).

Atmospheric conc. of SF6 (IPCC WG1 TAR)

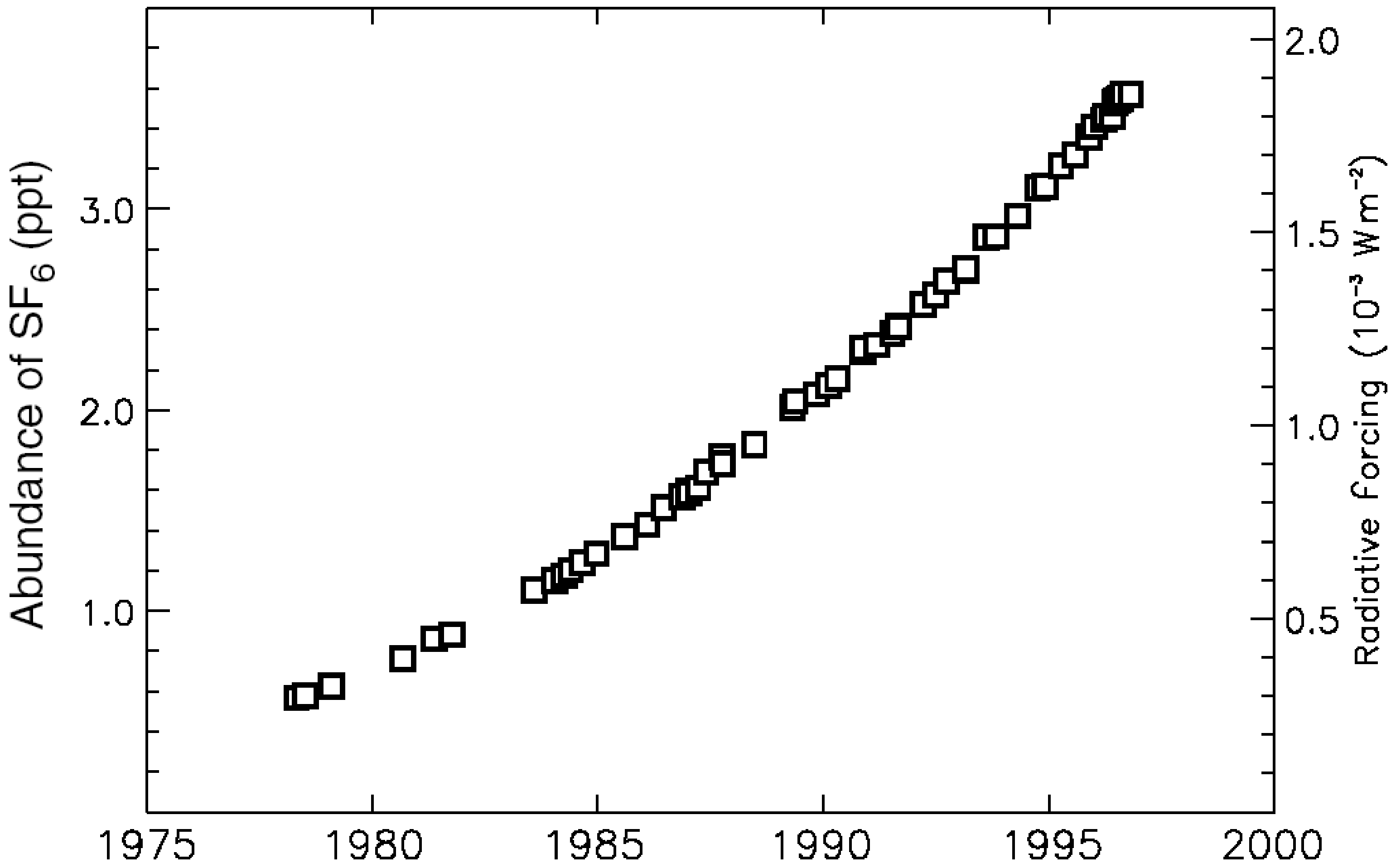
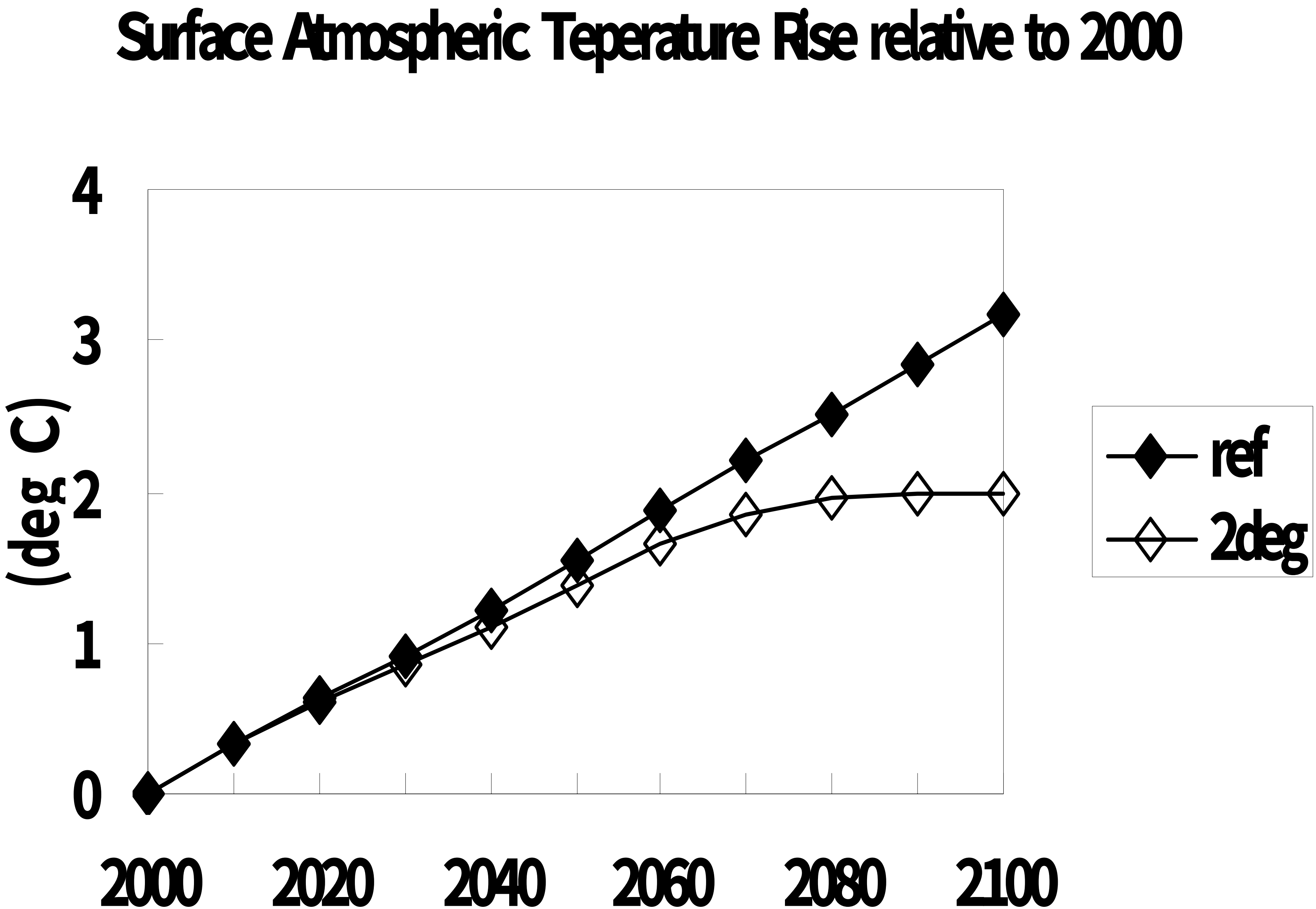


Figure 4.5: Abundance of SF_6 (ppt) measured at Cape Grim, Tasmania since 1978 (Maiss *et al.*, 1996; Maiss and Brenninkmeijer, 1998). Cape Grim values are about 3% lower than global averages.

4.GHG Mitigation under Climate Target
- Multigas and CO2 Sequestration

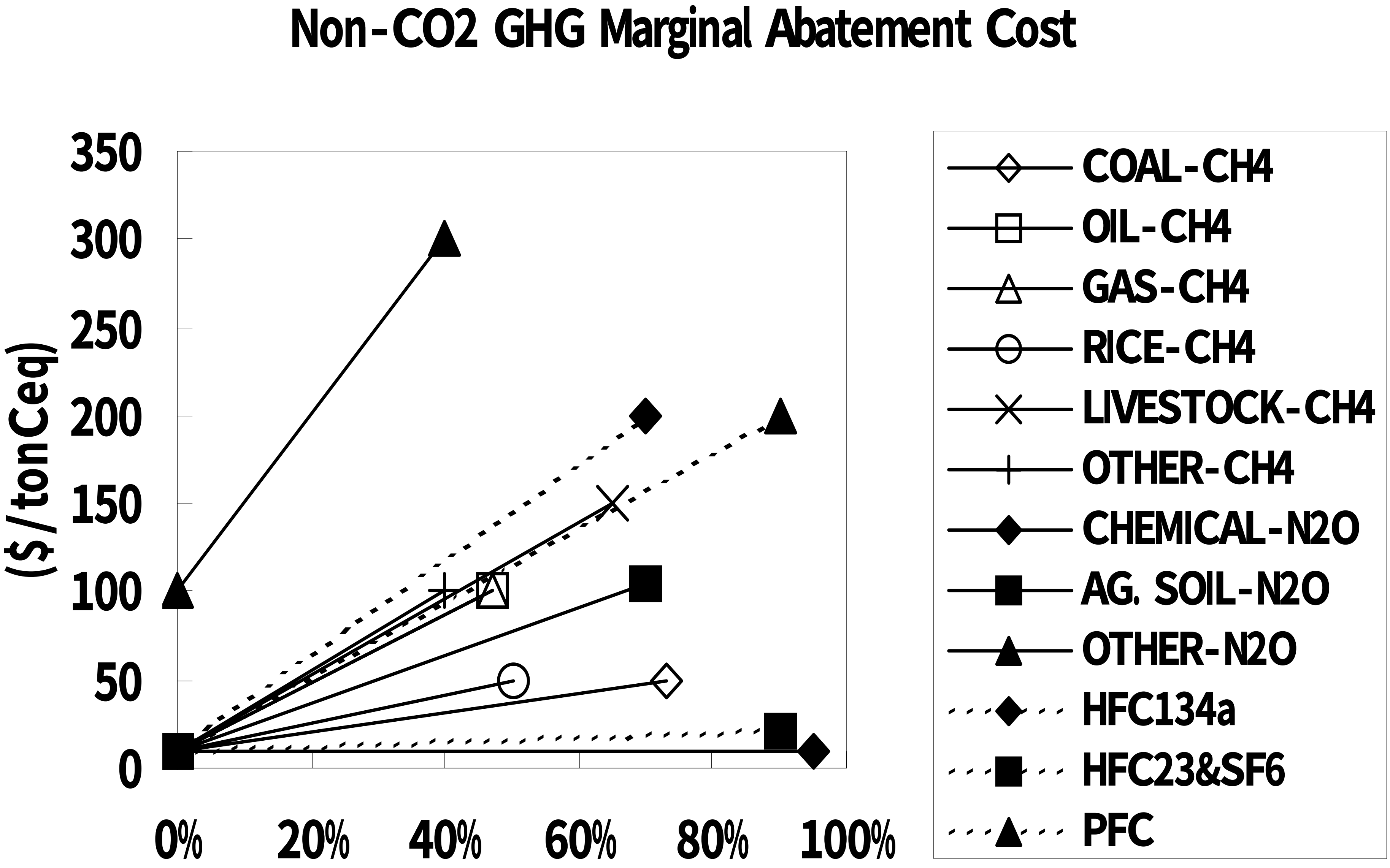
* Integrated climate indicators
  Radiative forcing, temperature, etc.

* Simulation cases
  Reference
    No climate policy
  2 deg
    Global average surface atmospheric temperature rise is controlled.
    (2 degC with relative to 2000)

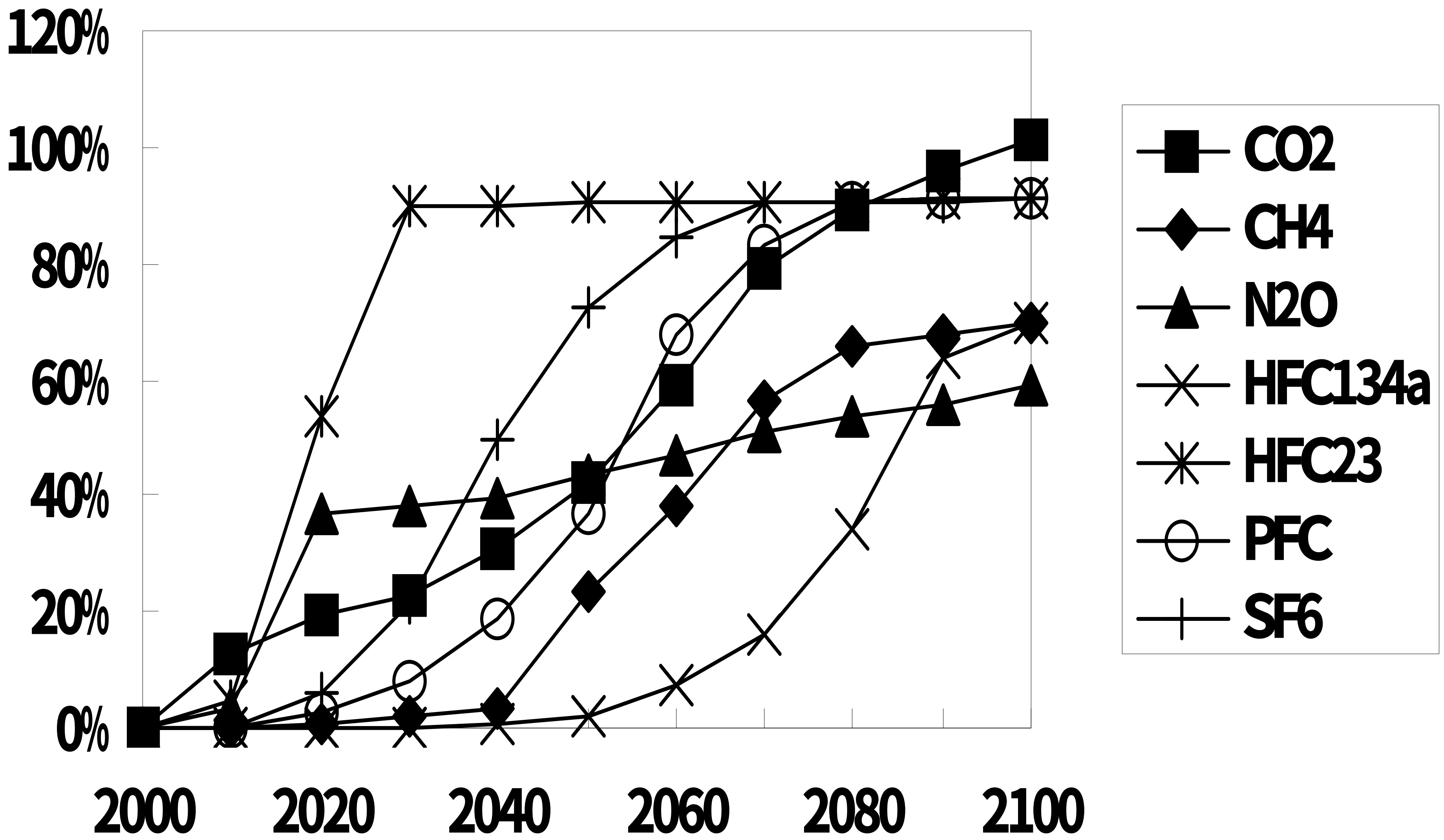


Surface Atmospheric Teperature Rise relative to 2000
4
3
2
1
0
(deg C)
2000
2020
2040
2060
2080
2100
ref
2deg

4.1 Multigas Mitigation Potential

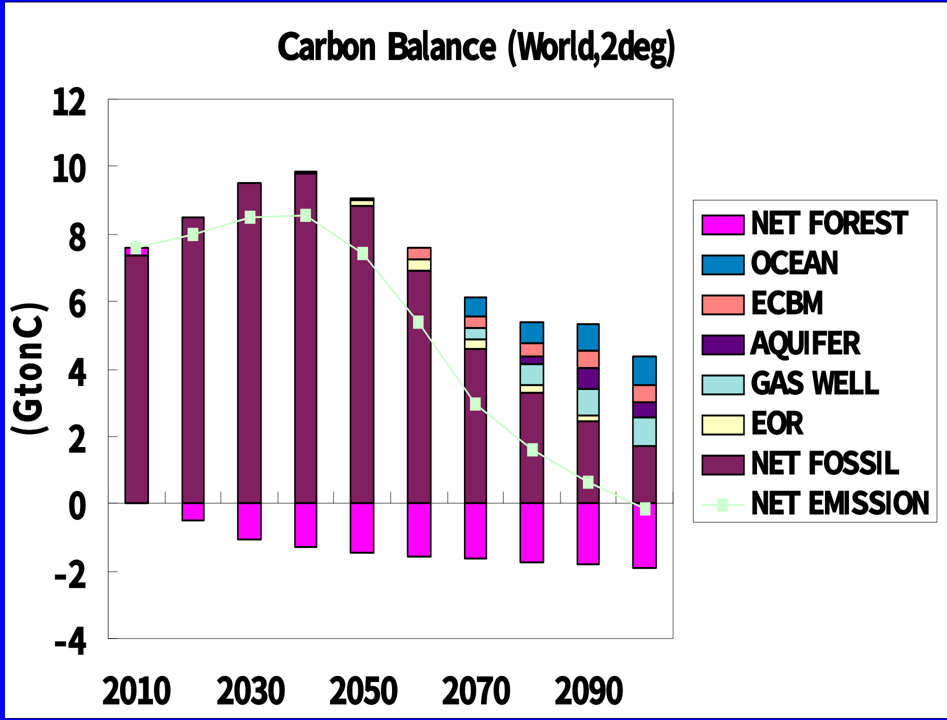


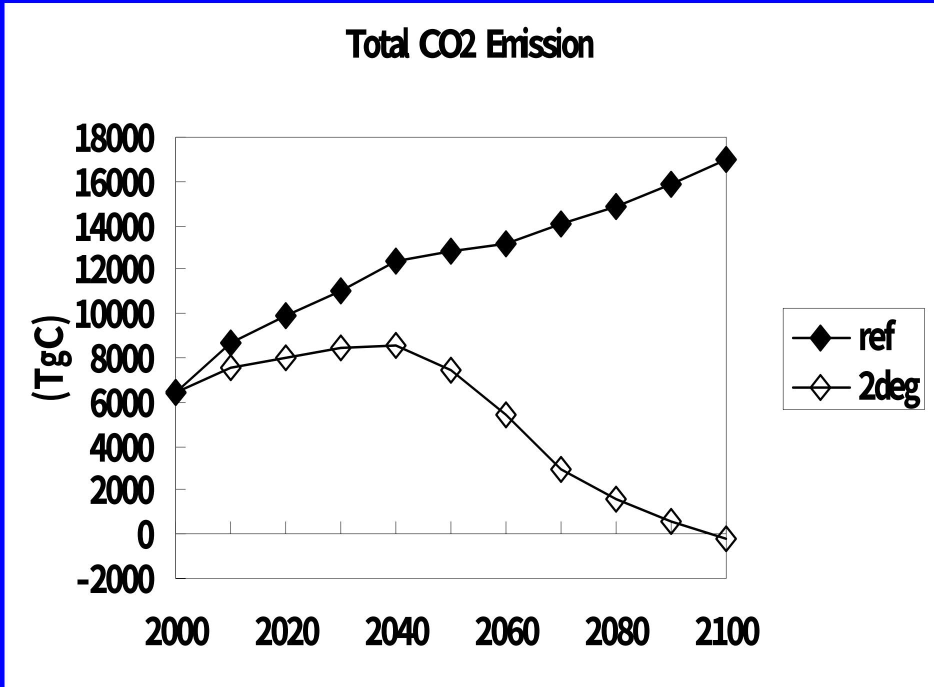
Global GHG Reduction Rate

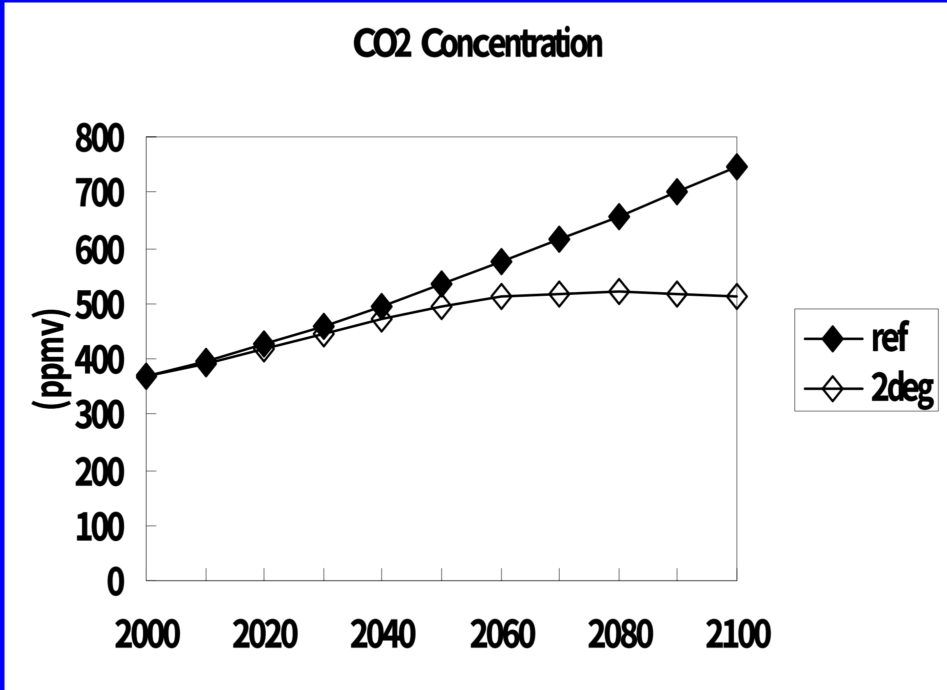


CO2

Emission and Concentration



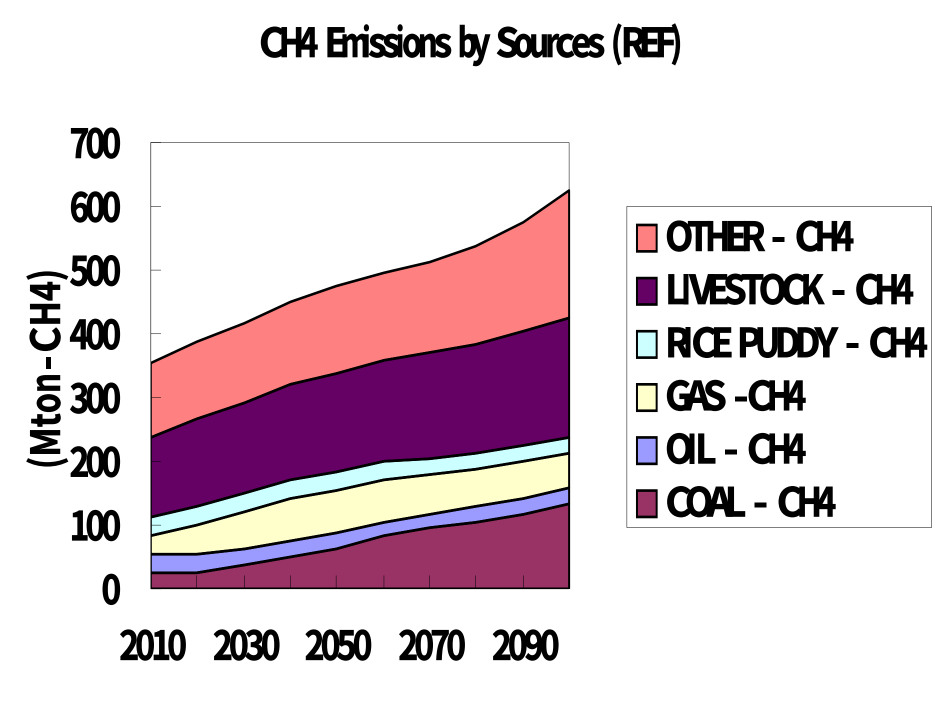


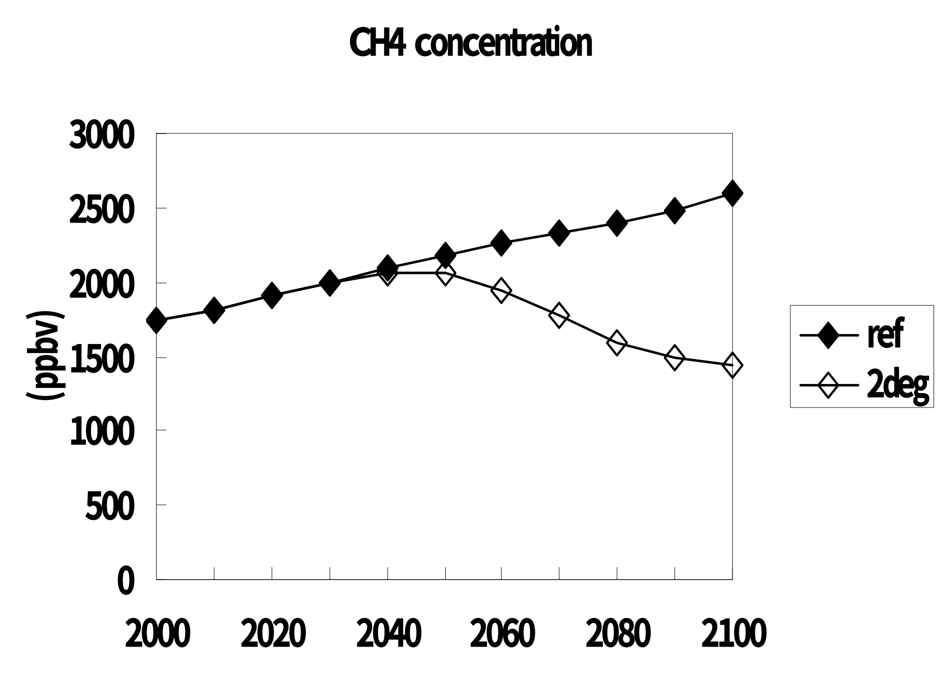


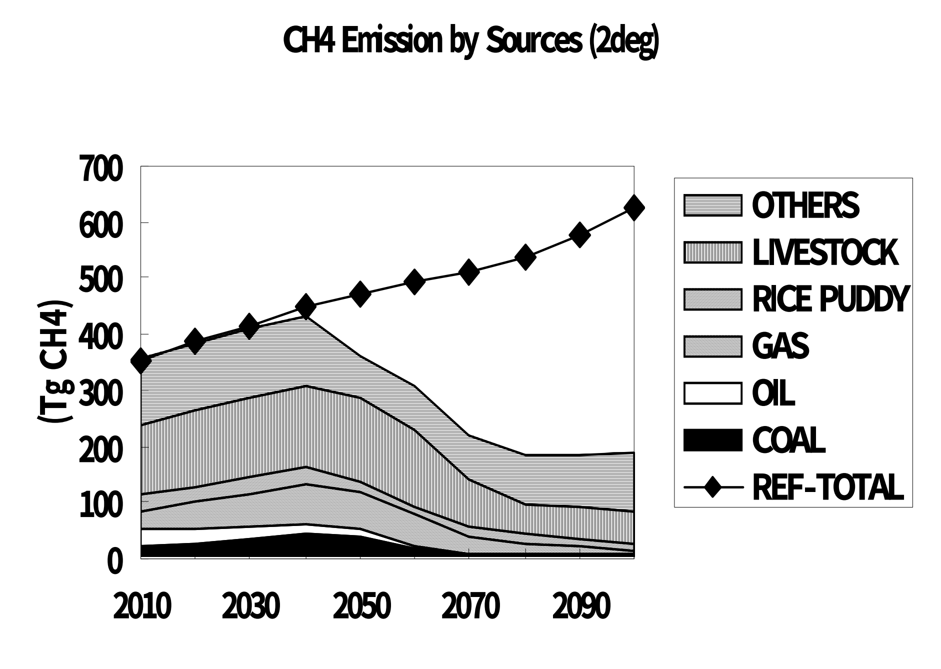
CH4

Emission and Concentration

Nat. Em. = 277(Tg)



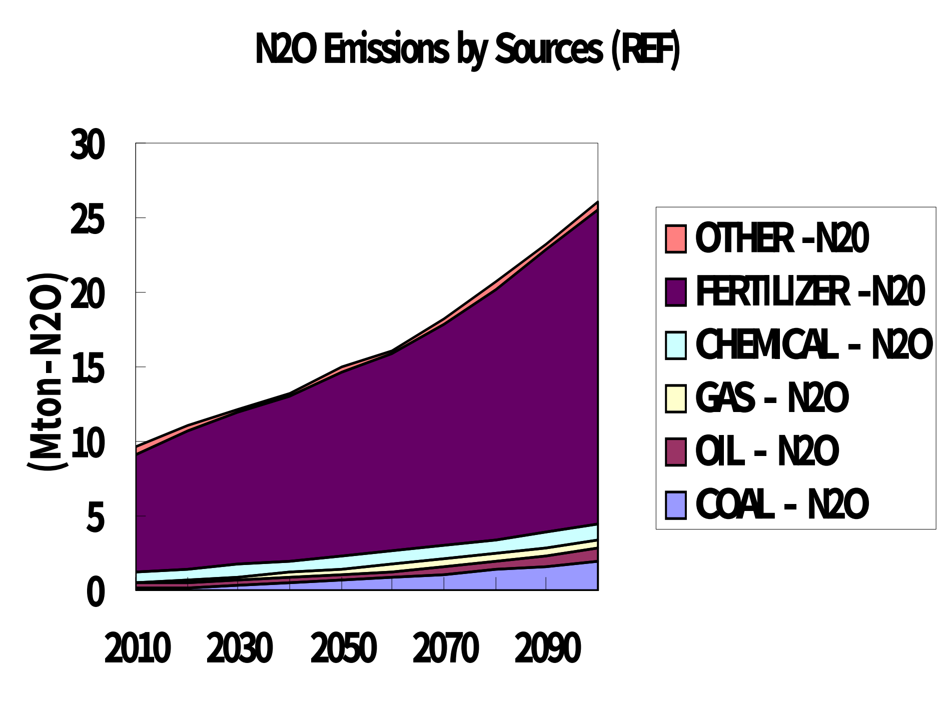


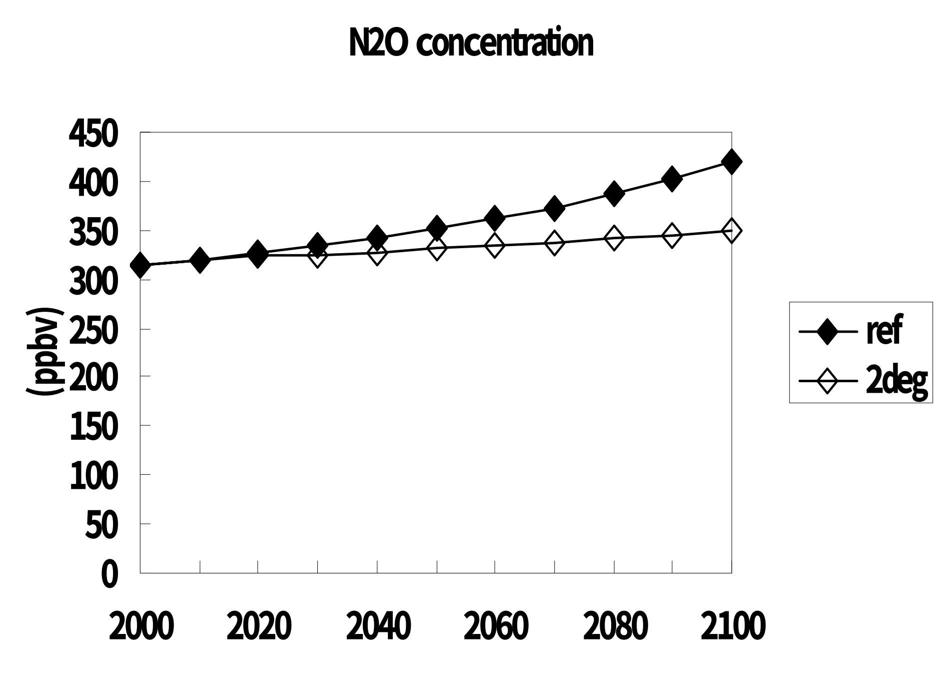


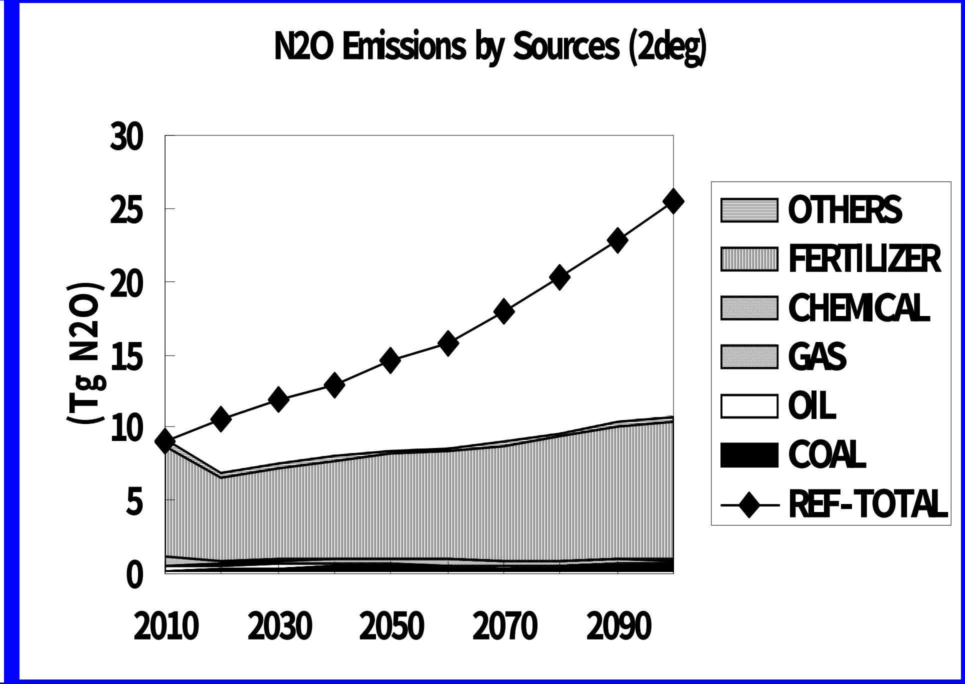
N2O

Emission and Concentration

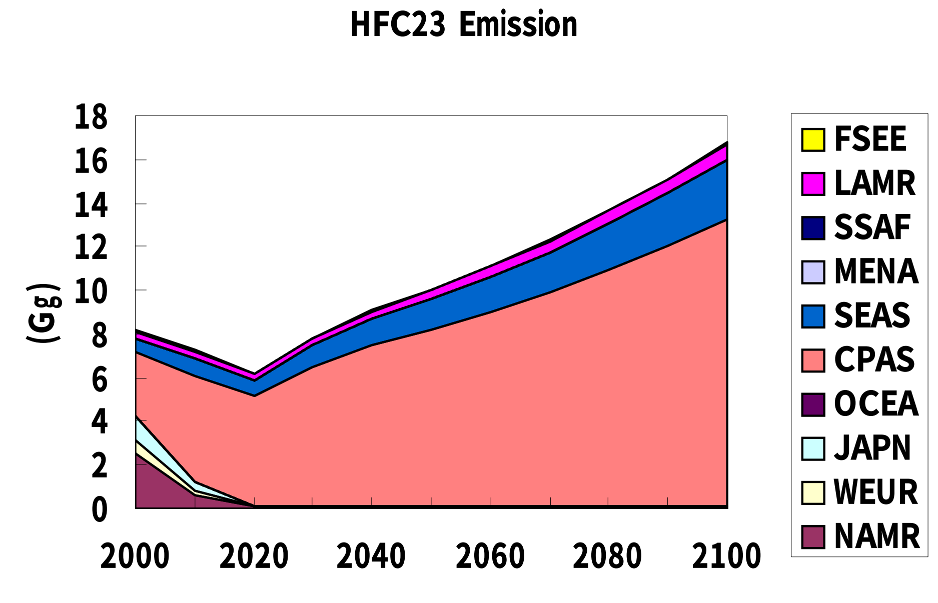
Nat. Em. = 15.7(Tg)

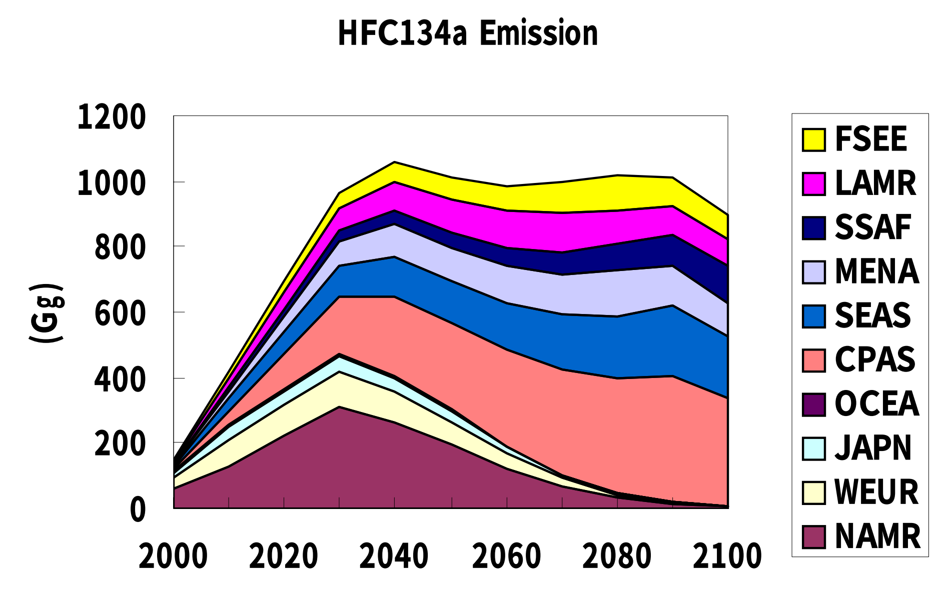


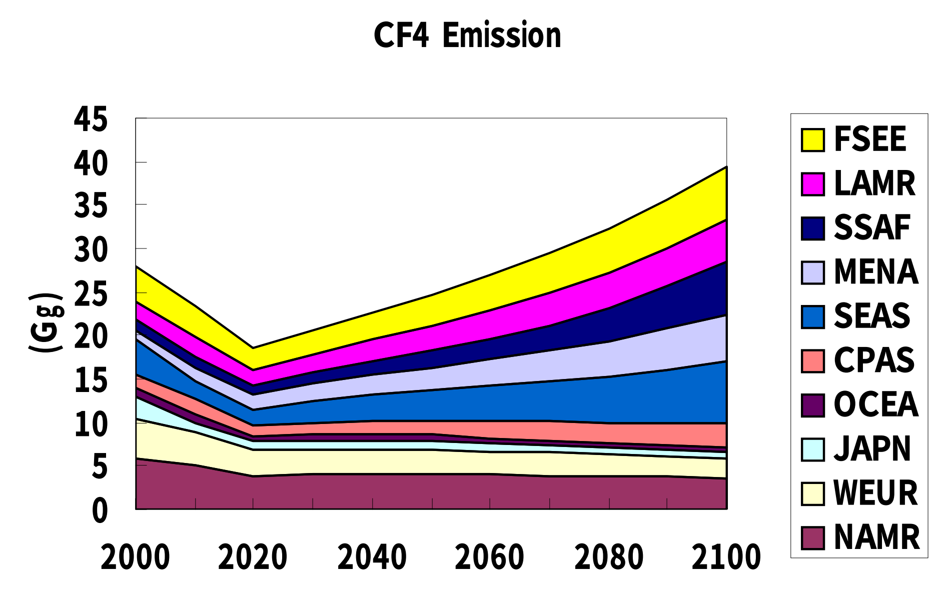


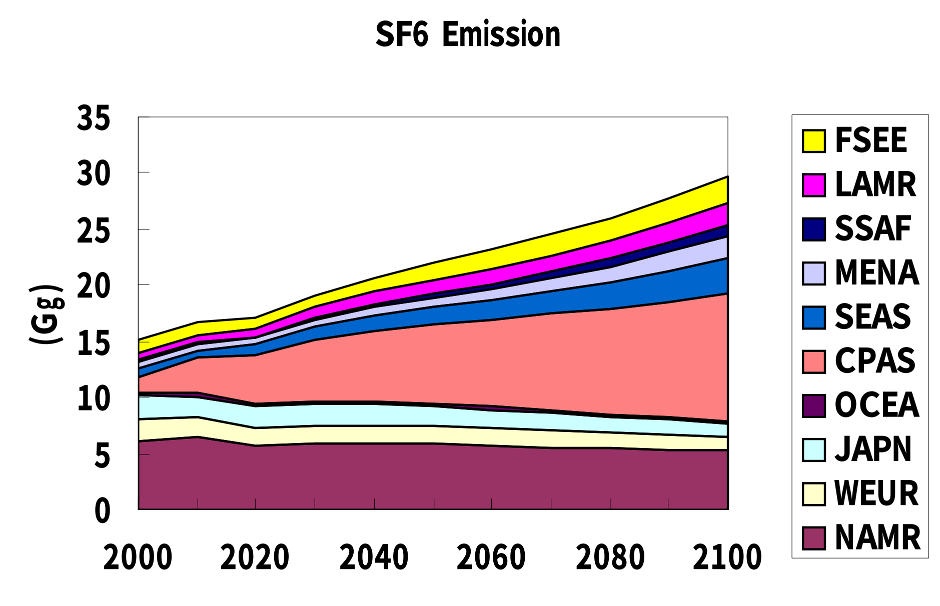


F-Gases Emission (REF)

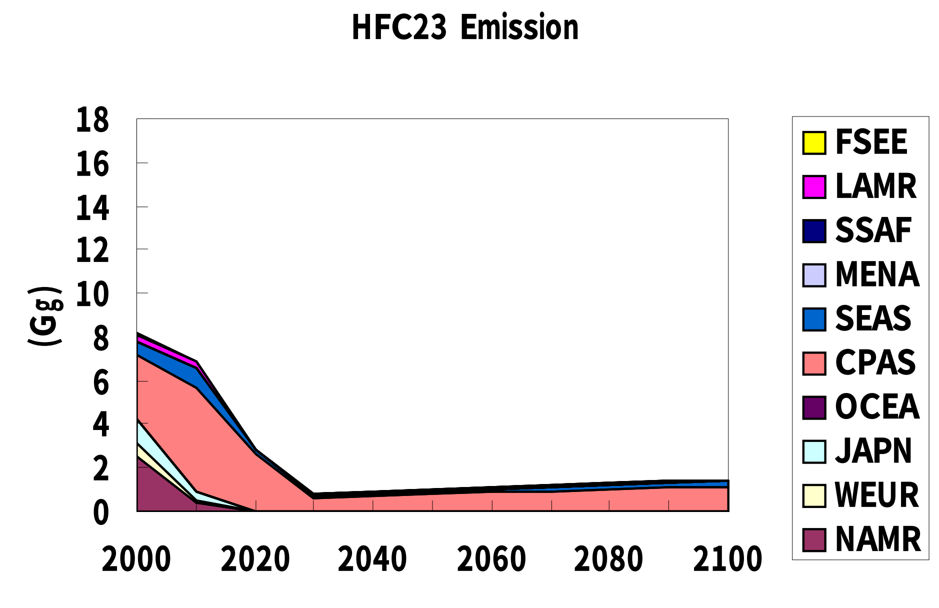


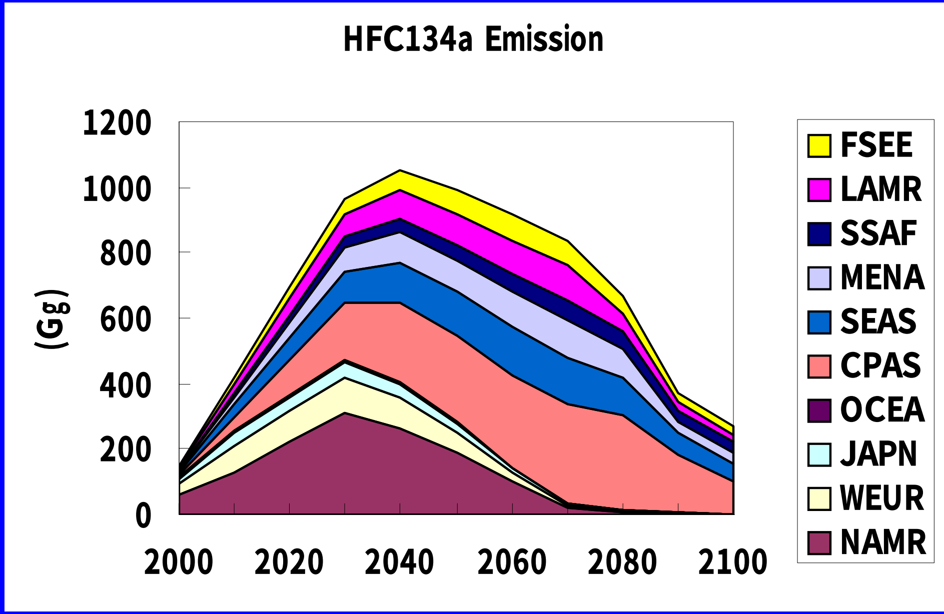


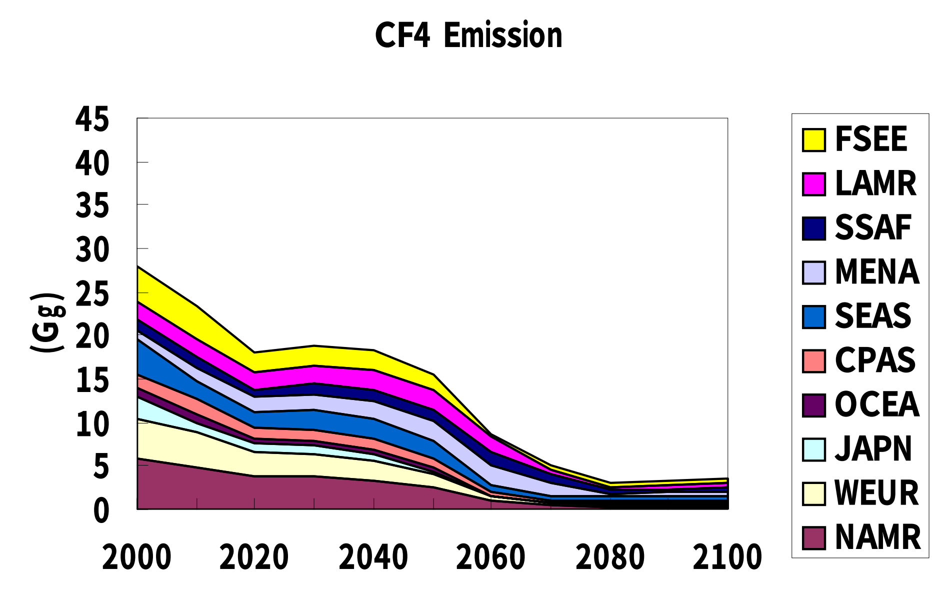


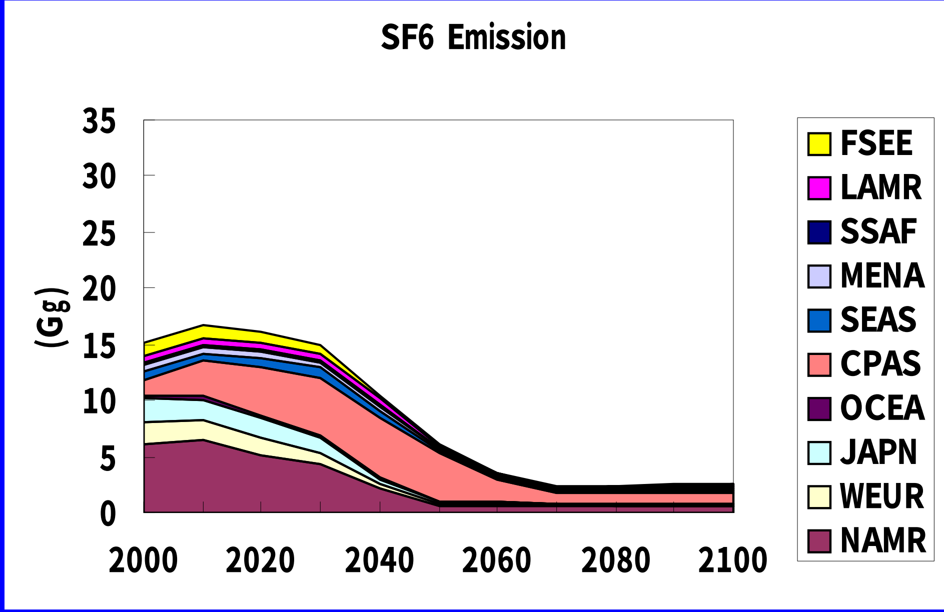


F-Gases Emission (2deg)

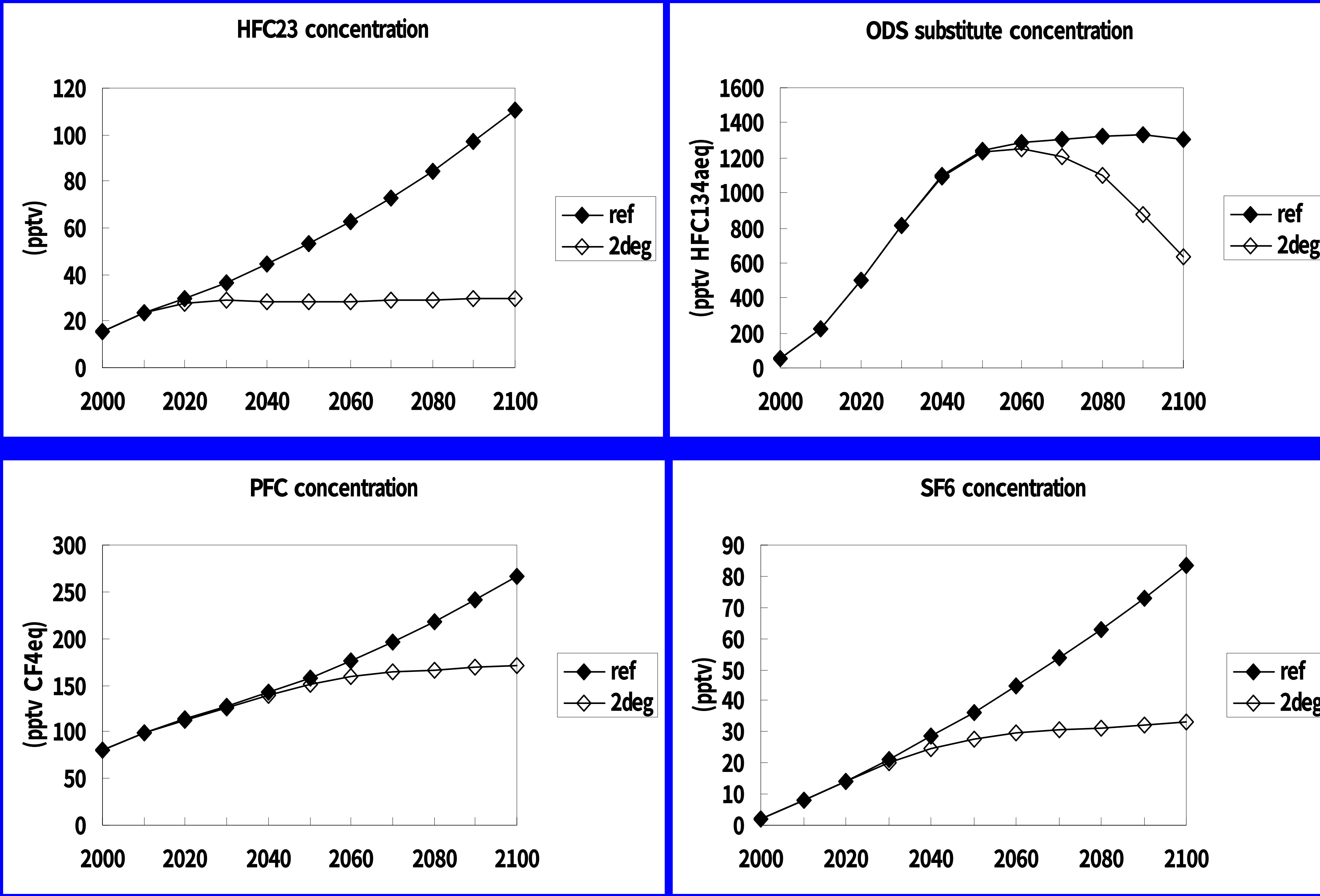








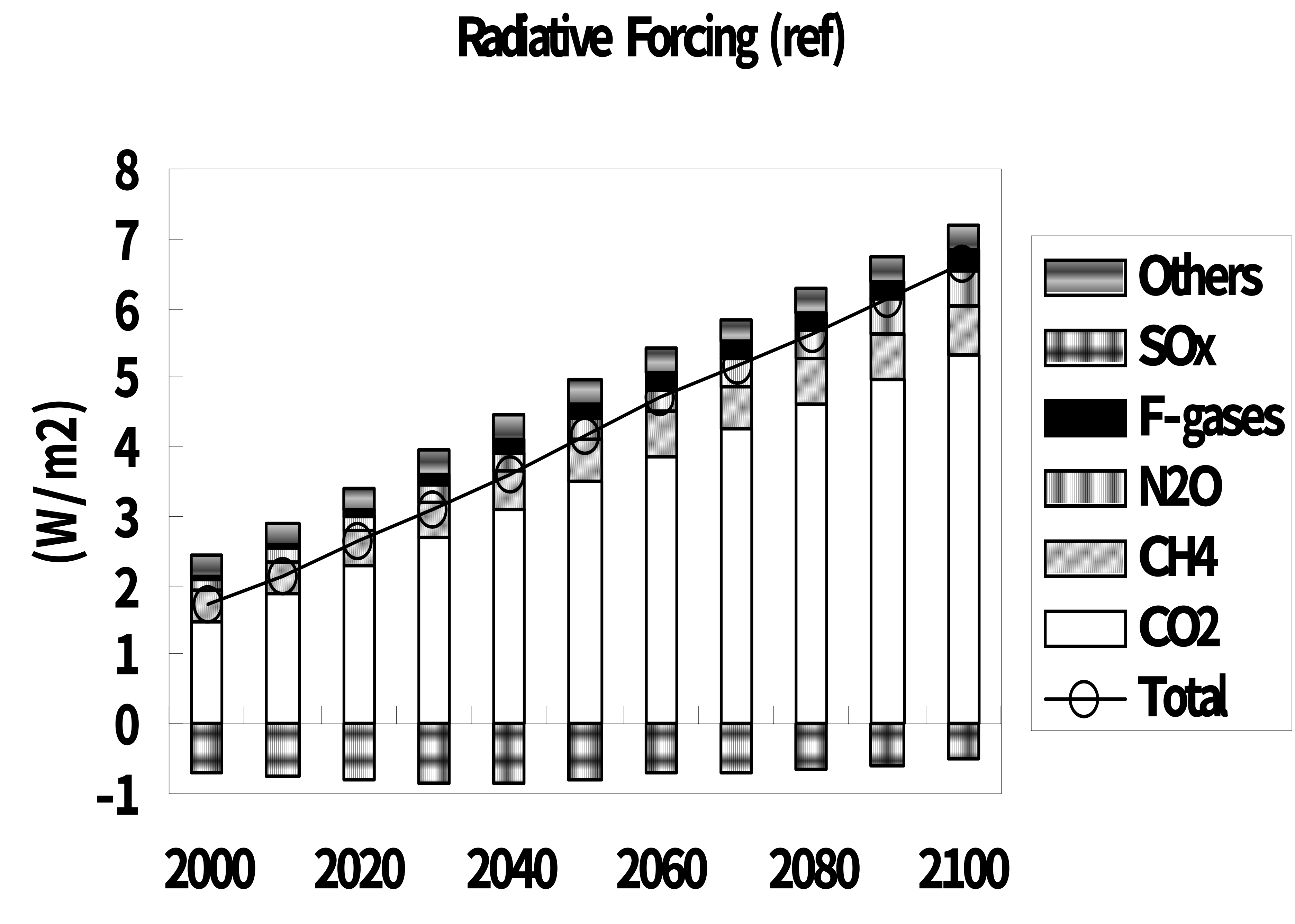
F-Gases Concentration



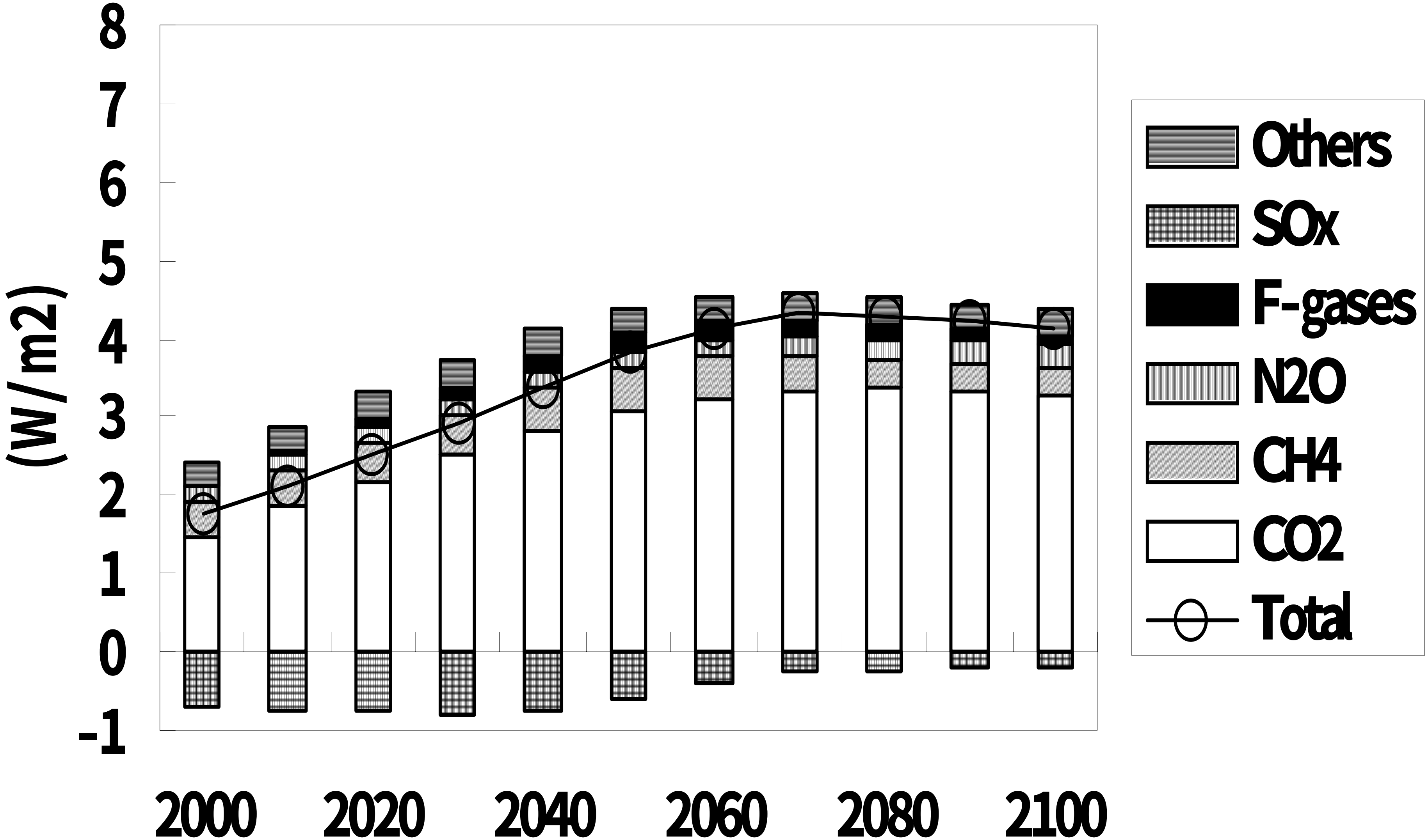
Concentration vs. Emissions - Summary

* Short-lived GHGs
  (CH_4, HFC134a, etc.)
  Mitigation efforts will affect concentration in a short period.

* Long-lived GHGs
  In spite of considerable reduction, the concentration will keep almost the same level in the long run.


Radiative Forcing (ref)
8
7
6
5
4
3
2
1
0
-1
(W/m2)
2000
2020
2040
2060
2080
2100
Others
SOx
F-gases
N2O
CH4
CO2
Total

Radiative Forcing (2deg)

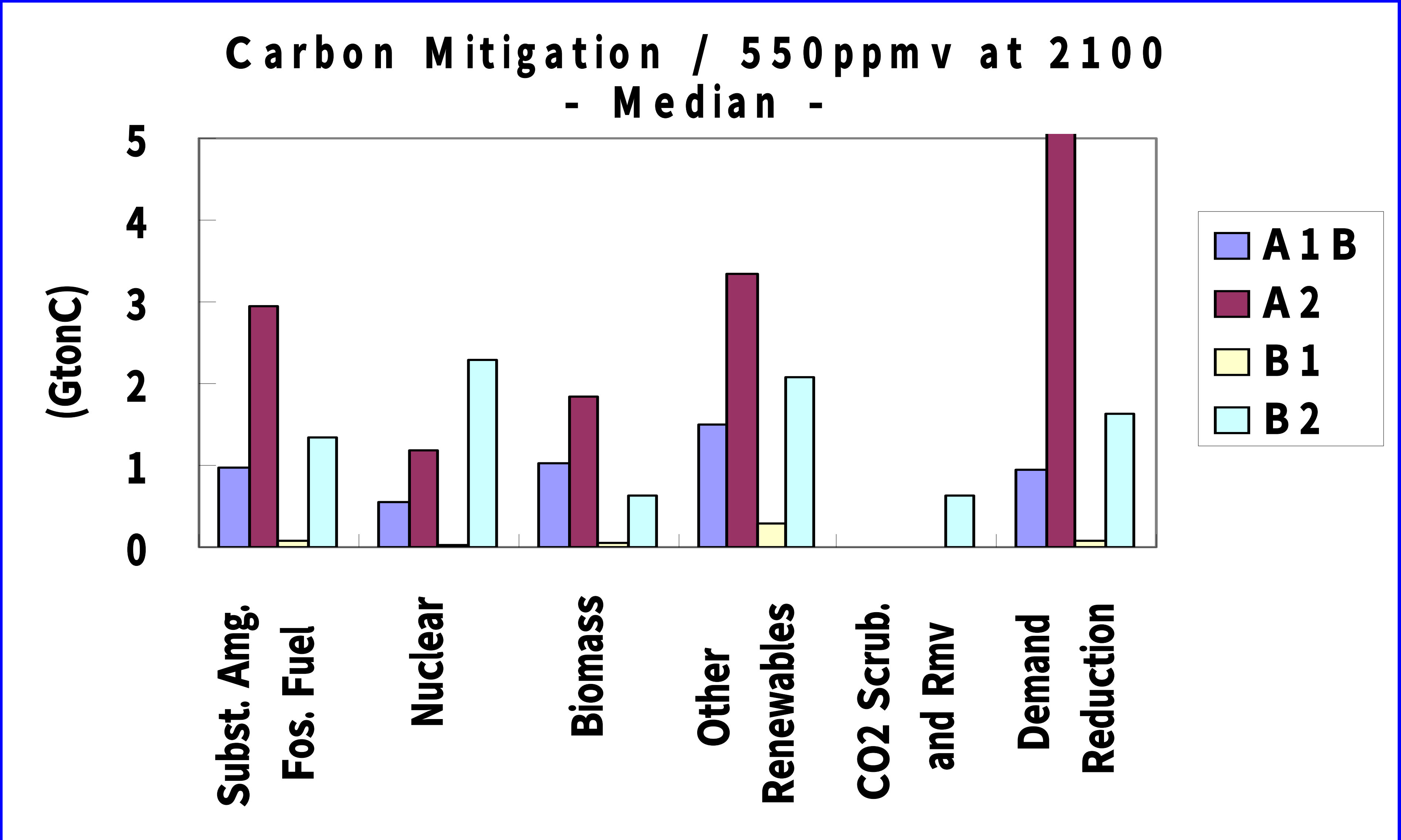


4.2 CO_2 Sequestration (Engineering Sink)

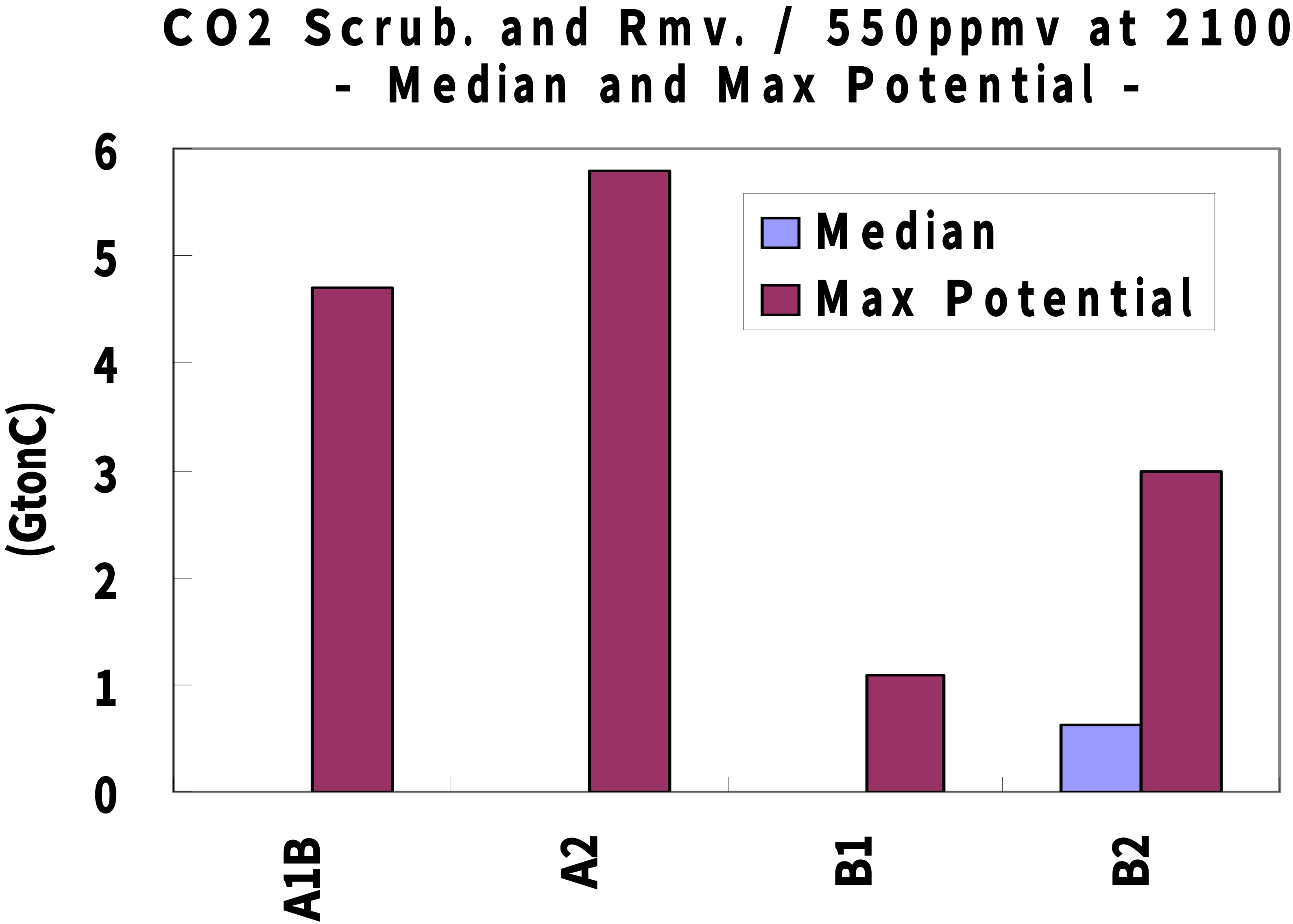
UNFCCC and IPCC concern on CO_2 sequestration (policy and science)

* Policy
  GHG inventories and national communications
  GHG registry and Kyoto mechanism
* Science(IPCC)
  Fourth assessment report
  Sequestration special report

IPCC WG3 TAR – CO2 mitigation potential (Mitigation from different baselines)



IPCC WG3 TAR (cont.) Scrub. & Removal - Max. potential could be large.



CO2 sequestration options

Geologic - EOR, Aquifer,
Dep.Gas Well, ECBM

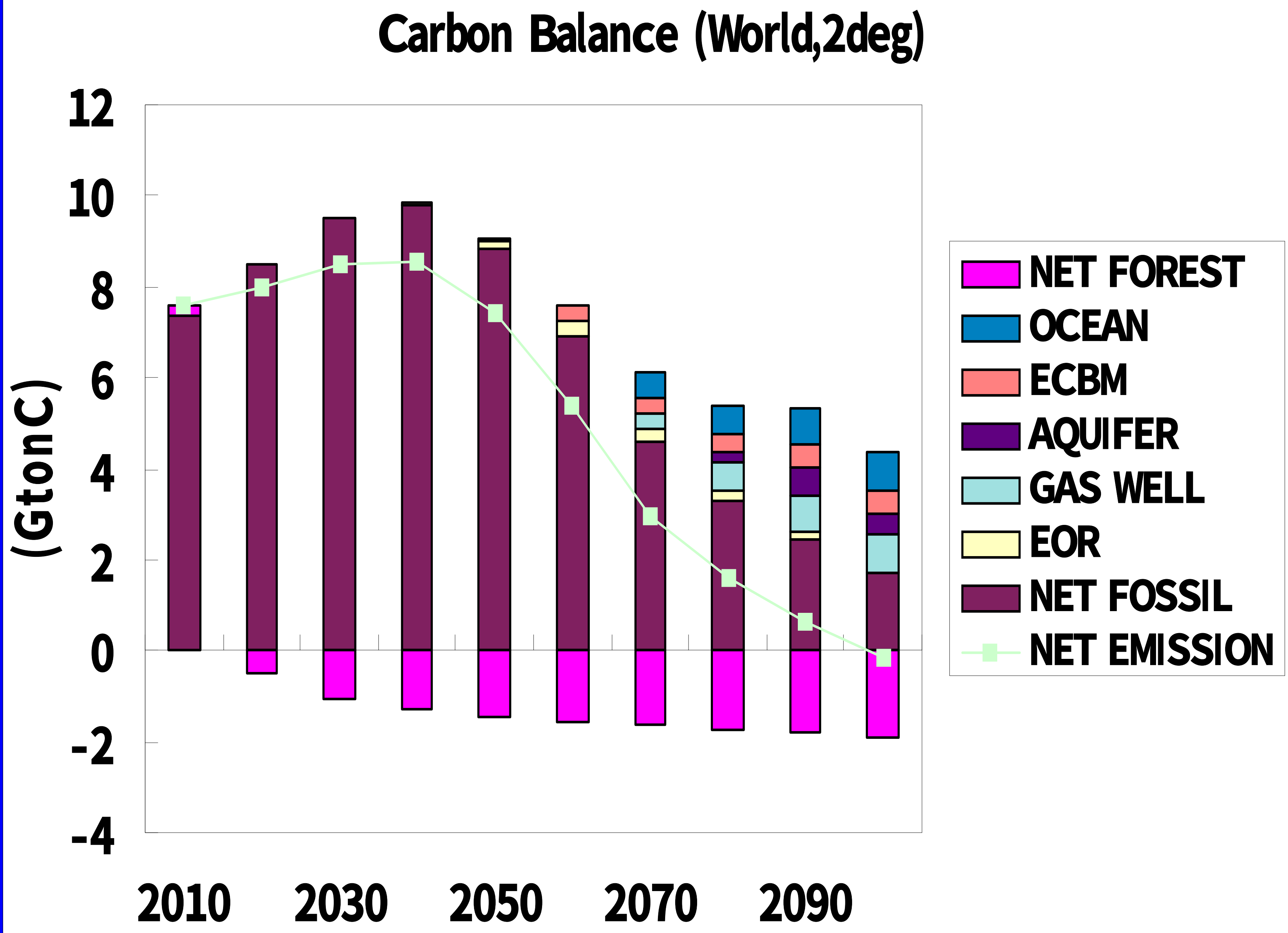
Ocean

Uncertainty of sequestration cost

Cutdown by tech. progress?

Rising by high SMV cost?

(Safety, monitoring & verification)



Carbon Balance (World,2deg)
12
10
8
6
4
2
0
-2
-4
(GtonC)
2010
2030
2050
2070
2090
NET FOREST
OCEAN
ECBM
AQUIFER
GAS WELL
EOR
NET FOSSIL
NET EMISSION

5.Discussion and Summary

(1) Co-benefit of CO_2 mitigation in energy sector is not small.

- Lessening the dependency of fossil resources in the energy system will be helpful to the reduction of CH_4 and N_2O.
- Including NonCO_2 GHG abatement measures in the energy sector would relax climate impacts.

(2) Additional nonCO2-GHG abatement efforts are required in the agriculture sector.

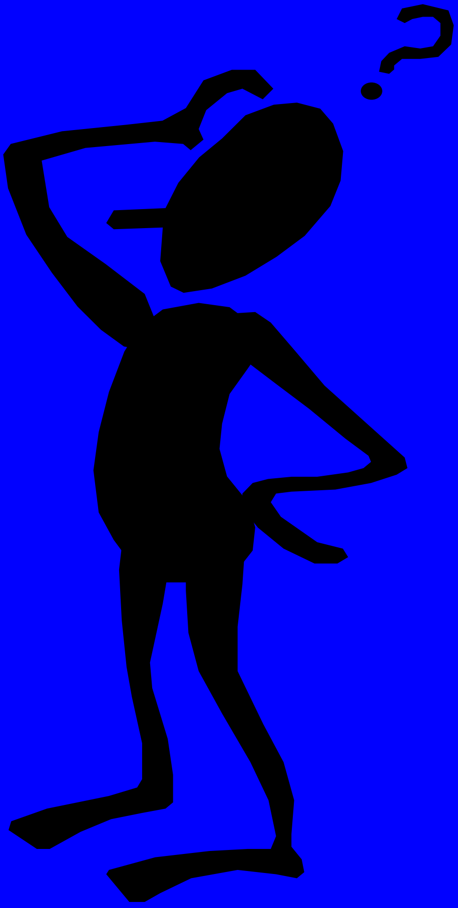
- In the energy sector climate policy, there are alternatives to satisfy demand (some options are costly).
- On the contrary, in the agriculture sector, we can hardly imagine substitutes or conservations.
- Additional nonCO2-GHG abatement is vital under the high transaction cost.
- Uncertainty in crop yield (fertilizer vs. gene tech, etc.)

(3) Determinant factors of GHG abatement technologies introduction

- Economics
  - pure cost
  - transaction cost
    - (especially if it is distributed source)
- Technology
  - existence and on-site know-how
- Benefit of mitigation
  - Recognition and public outreach
  - Additional benefit by mitigation
    - energy recovery (Gas, Oil)
    - local environmental factors

(4) Uncertainty

- Technology
  - abatement options
    - availability, cost, etc.
- Nature
  - climate dynamics
- Socioeconomic
  - climate policy
  - GHG intensive human activities
- Others



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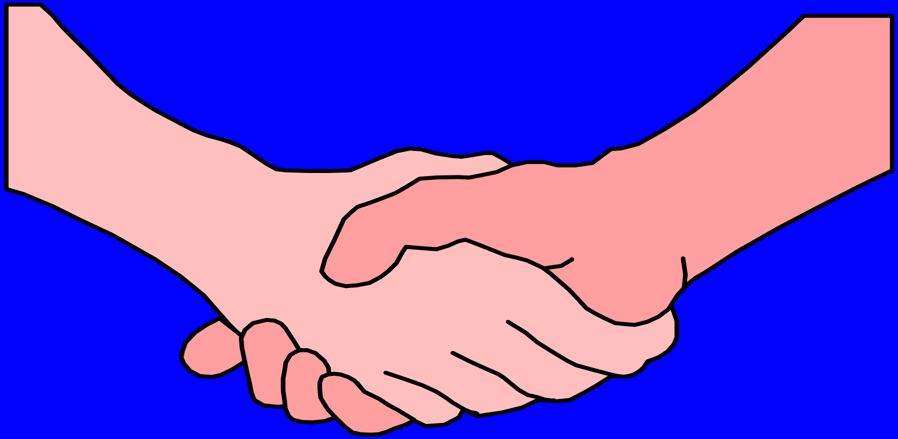
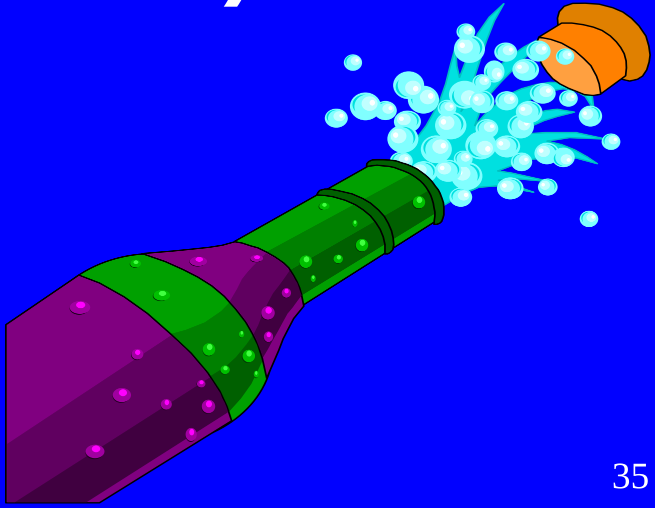
System Research Center (SRC), Japan

GRAPE team members hope that ..

GRAPE (Global Relationship Assessment to Protect the Environment) will mature to be

WINE (World Instrument to Negotiate for the Environmental issues)





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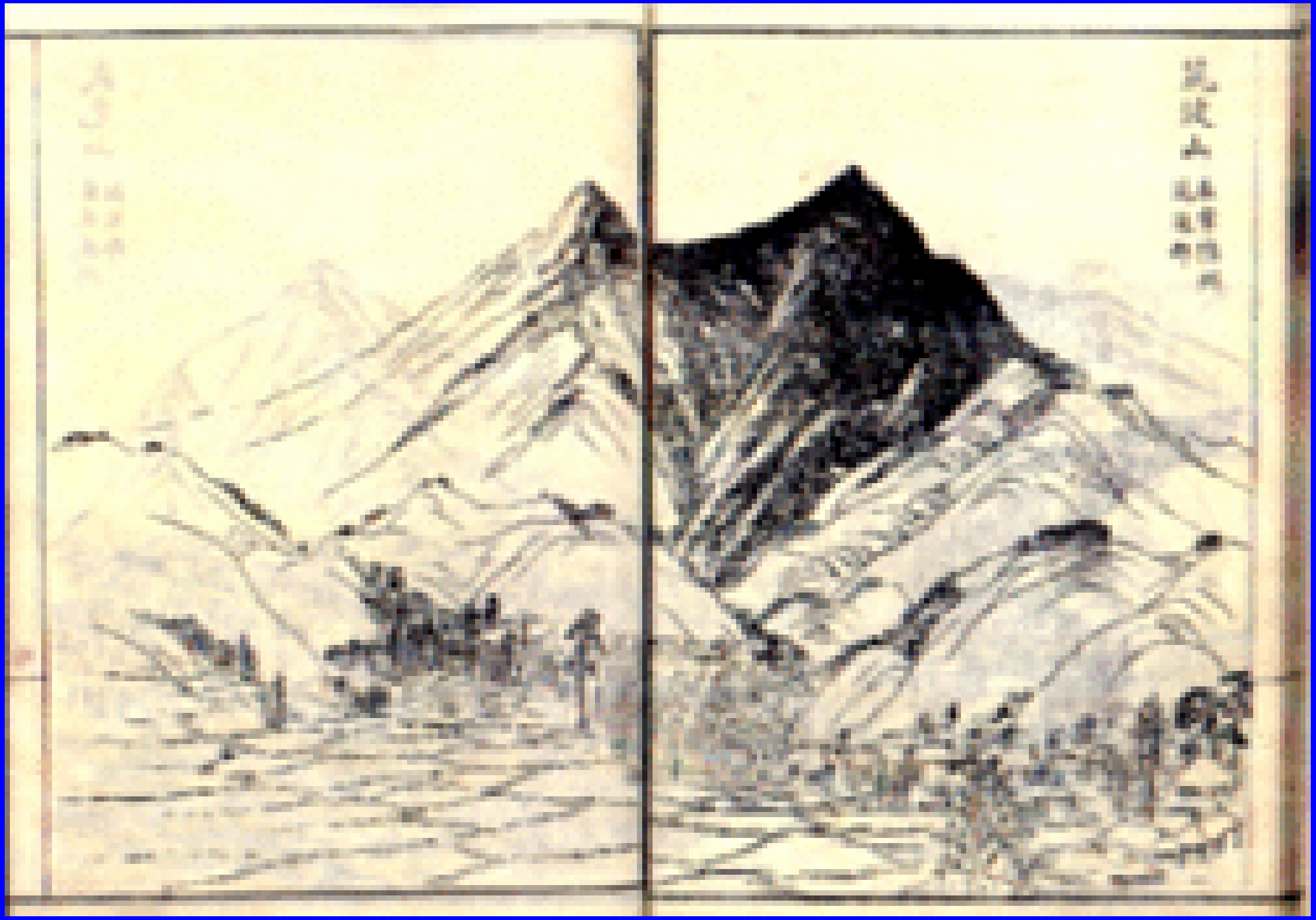

Twin peaks of Mt. Tsukuba

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