August 31, 2007

Stabilization of CO2 Concentrations

Systems Analysis Group
Research Institute of Innovative Technology for the Earth (RITE)

Introduction

- Article 2, 'Objective' in The United Nations Framework Convention on Climate Change (UNFCCC), sets a goal of achieving stabilization of greenhouse gas concentrations, but not the specific level.
- To tackle the global warming, long-term efforts are crucial and also development/diffusion of advanced energy-saving/decarbonization technologies and transforming the social systems are required.
- It is sharing the global specific long-term target that would make by when and what technology is required to be developed clear. It is a long-term target agreement that would make strategic technology development/diffusion and social system changes possible.
- Once we decide a long-term target, the road map for short-, medium-term emission reduction naturally could be narrowed down. Also it would help an agreement on short, medium-term action plans.

Article 2 of the United Nations Framework Convention on Climate Change, OBJECTIVE

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystem to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in sustainable manner.

What target would confront to this ‘ultimate objective’?
How could it be approached ?

International Trends in Long-term Stabilization（1/3）

EU (January, 2007)

- Ultra-long-term target: limiting global warming to 2 Celsius
- Mid and long-term target:

  - 50% GHG emission reduction by 2050 based on 1990 levels. Given the differences between developed and developing countries, 80% reduction by 2050 by developed countries.

  - Independently 20% reduction by 2020. 30% reduction, depending on other countries' targets

Japan (May, 2007): "Cool Earth 50"

- Long-term target: Cutting global GHG emissions by half by 2050
- Principles:
  - Participation of major emitters, including US, China and India
  - Flexible and diverse framework, with due to considerations to the circumstances of each country
  - Compatibility between environmental protection and economic growth
- Launching a national campaign for achieving the target

  - Review of the target achievement plan, enhancing the reduction measures in municipalities and major business entities, launching a national campaign

International Trends in Long-term Stabilization (2/3)

The United States (May, 2007)

- **Long-term target: Consensus of about 15 major emitters, including China and India, by the end of 2008**

- **Mid-term target: Setup of mid-term target, with due to considerations to the circumstances of each country**

- **Action plan:**

  - Sectoral working group (sharing clean technologies and best practices)

  - Stimulating development investments of technologies for clean energy

  - Elimination of tariff barriers on environmental technologies

International Trends in Long-term Stabilization (3/3)

G8 Summit Heiligendamm (June 6-8, 2007)

- Commitment to share challenges in tackling climate change for all countries
- Commitment to approach an optimal combination of energy security and effective climate protection
- Commitment to take urgent and concerted action to stabilize green house gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system
- In the process involving all major emitters, we will seriously consider the decisions made by the European Union, Canada and Japan which include at least a halving of global emissions by 2050.
- Commitment to the United Nations Framework Convention on Climate Change (UNFCCC) and to its objective with our common but differentiated responsibilities and respective capabilities
- We will call for emerging economies to reduce carbon intensity.
- We have agreed that the UN climate process is the appropriate for negotiating future global action on climate change. It is vital that the major emitting countries agree on a detailed contribution for a new global agreement under the UNFCCC by the end of 2008.

Future International Negotiations for Long-term Stabilization

An international conference against global warming hosted by the United States

- **Invited countries: EU, France, Germany, Italy, England, Japan, China, Canada, India, Brazil, Korea, Mexico, Russia, Australia, Indonesia, South Africa, and United Nations**

- **Scheduled to discuss the following themes in Post-Kyoto Protocol framework**

  - Long-term global target

  - Mid-term target and strategy by country

  - Sectoral approach

  - Acceleration of technology development and deployment

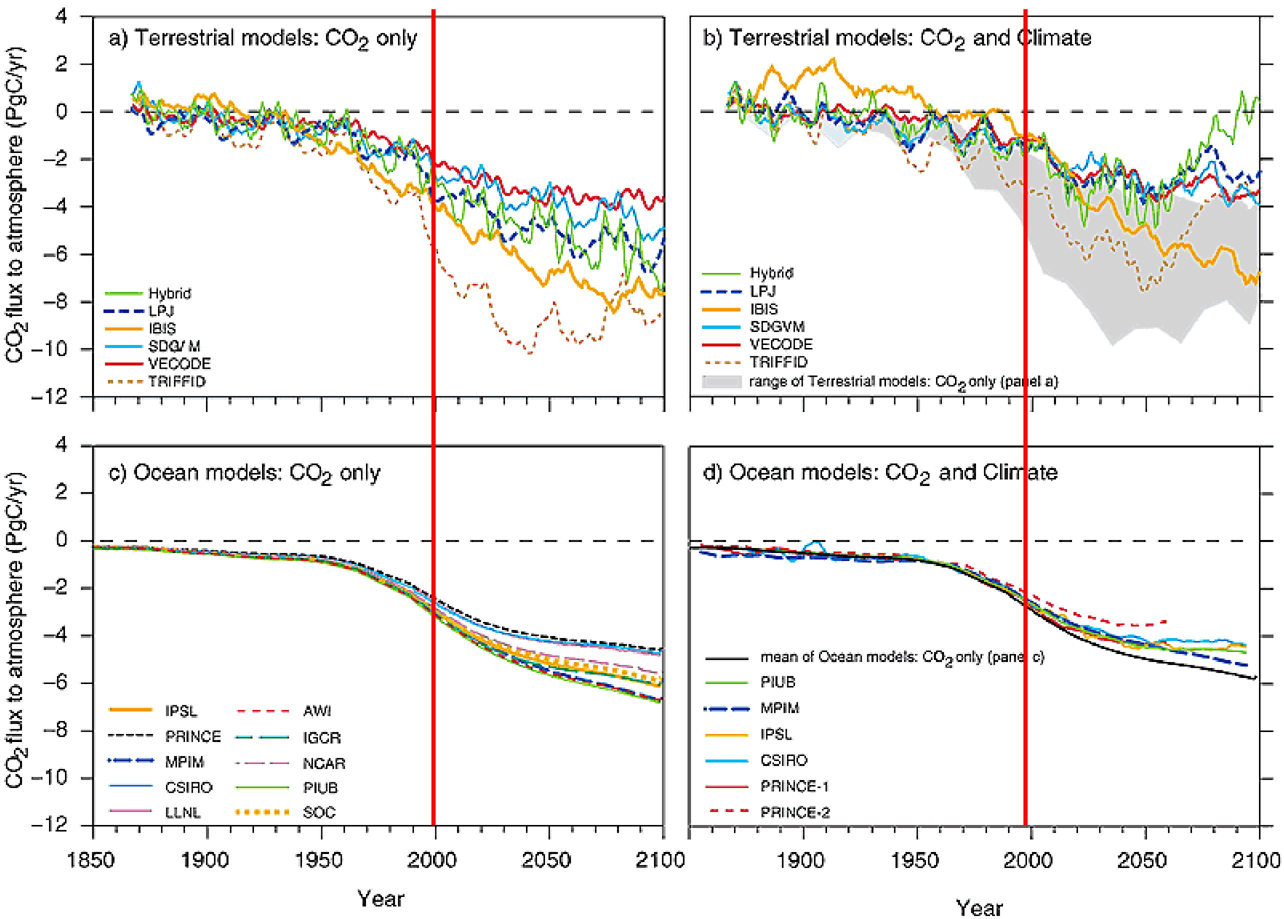
- **The first meeting: September 27-28, 2007**

The Background for the EU 2℃ Target

- Council of the Europe Union in 1996: Global mean temperature increases of up to 2℃ relative to pre-industrial levels, below 550 ppm CO_2 concentrations
- No scientific backgrounds for the target can be found. It is inferred from the doubled CO_2 concentration relative to pre-industrial levels that 550 ppm was set as a benchmark in analyses
- Based on a climate sensitivity of 2.5℃, SOx was once said to have a good cooling effect, so that SOx 0.5℃ cooling could keep 2℃ even in 550ppm CO_2 concentration.
- After that, Non-CO_2 GHG was learnt to have a good green house gas effect.
- Along with this, a new concept, equivalent CO_2 concentration emerged. Originally, 550 ppm should have been the concentration of only CO_2, but 550 ppm equivalent CO_2 concentration has been crucial to hold that 550 ppm equates to 2℃ (Environment Minister's Council, 2005).
- On the other hand, as SOx emissions have been notably reduced, the cooling effect is assessed less than -0.5 ℃ in the future.
- With the climate sensitivity upward-adjusted to 3 ℃, hereupon 2 ℃≒350 ppm (CO_2 only) is common.

Cool Earth 50: The background for halving relative to the current level

- Cool Earth 50 proposes that cutting by half from the current level is crucial to curb the GHG emissions to the same level as the capacity of natural sinks, which is scientifically incorrect.
- The capacity of natural sinks varies depending on the CO2 concentrations. The higher the concentrations are, the larger capacity of natural sinks is, and the lower concentrations, the smaller capacity.
- This is why natural sinks cannot be the background for cutting by half from the current level

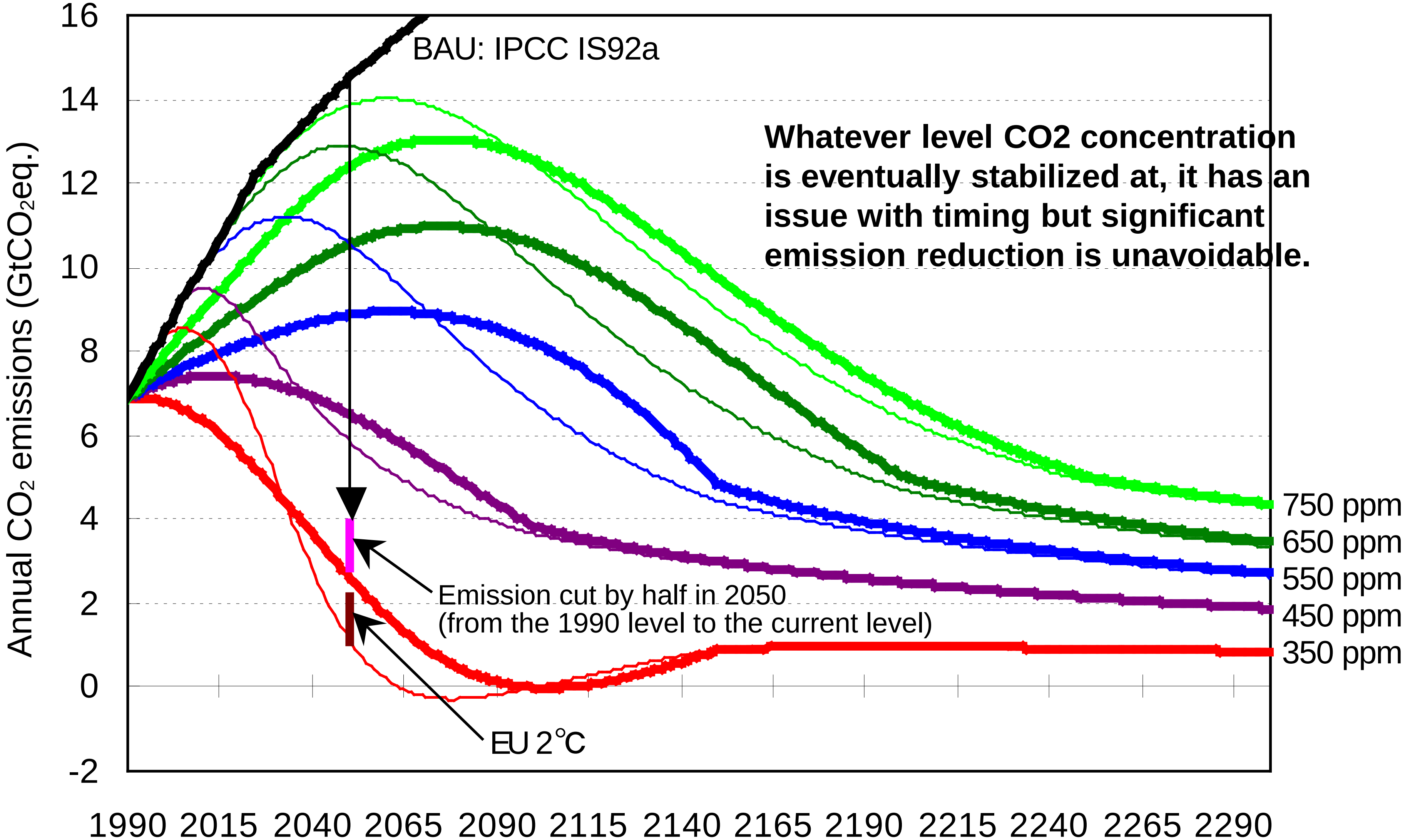


Projections of anthropogenic CO2 uptake by process-based models run with IPCC IS92a (-: net uptake, +: net emission)

the left panels: CO2 only
the right panels: CO2 plus simulated climate change

Source) IPCC WG1 TAR

The Targets of EU, Japan from the Viewpoint of Atmospheric CO2 Concentration Stabilization



Note) bold solid line: IPCC WG1; thin solid line: WRE (Wigley, Richels, Edmonds)

CO2 concentration stabilization is an issue which could not be well agreed. Here, we discuss what level is legitimated for concentration stability and agreeable on a global scale from the scientific perspective

What level is scientifically legitimated for CO_2 concentration stability?

The Ultimate Goal of RITE PHOENIX Project

- We basically have to approach this issue with CBA (cost-benefit analysis) to utilize limited resources effectively and to pursue global optimality
- But, we have to consider the specific points of global warming.
  - Intersectoral integrations of warming impacts: Based on CBA, wide-ranging impacts of global warming have to be all converted into money, which would be impossible.
  - Interregional damage integrations: CBA aggregates interregional global warming damage costs converted into the monetary value and calculated. Damages in small island states, for example, do not cost a bundle to the whole world, which could not be passed undetected for some people.
  - Intertemporal integrations: Aggregate warming damage costs of each time point are calculated with money conversion. Most of the costs are aggregated using an expedient parameter such as discount rates but the burdens on future generations can be seen in many distinctive ways.
  - Uncertainty
- Risk and risk perception have to be considered separately

* PHOENIX: Pathways toward Harmony Of Environment, Natural resources and Industry complex

PHOENIX Quantitative Assessments –Warming Impacts and Mitigation-

- Global warming impacts and mitigation are assessed by emission pathways.
- Assessed emission pathways:

  Reference case (BAU)

  Stabilization of atmospheric CO_2 concentration

  (650ppm, 550ppm, 450ppm)

*population and economic growth are in IPCC SRES B2, including sensitivity analysis of A1FI

- Quantitative assessment of warming impacts

  Impact of sea level rise on coast, on water resources, agricultural crops, on health, on land ecosystems,

Assessment Procedures for RITE PHOENIX Project

Scientific analyses/ assessment

A. The world total_2100_S550 reference scenario

<Assessments of global warming impacts>

1) sea level rise/impacts on coasts
2) impacts on crops 3) impacts on health 4) terrestrial ecosystems
5) THC disruption

<Assessments of mitigation costs>

-System cost increases calculated by an energy system model

C. By region_2050, 2100, 2150_S650, S550, S450 reference scenarios

<Assessments of global warming impacts>

-impact events (e.g. WAIS, extreme weather, mountain glacier, arctic sea ice, etc.), in addition to the five items in the left box

<Assessments of mitigation costs>

- value-added changes by region and industry, in addition to cost increases

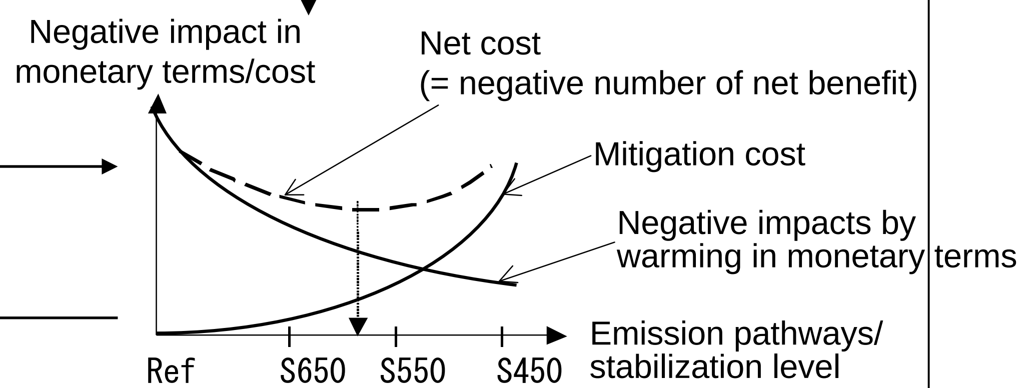
B. S650 and S450 reference scenarios, assessing the same items as the A above

Expert judges

EJ: the first step

Q1. pairwise comparisons of relative importance of mitigation of global warming impacts (5 items)

Q2. Health impacts on worth avoiding health (in monetary terms)



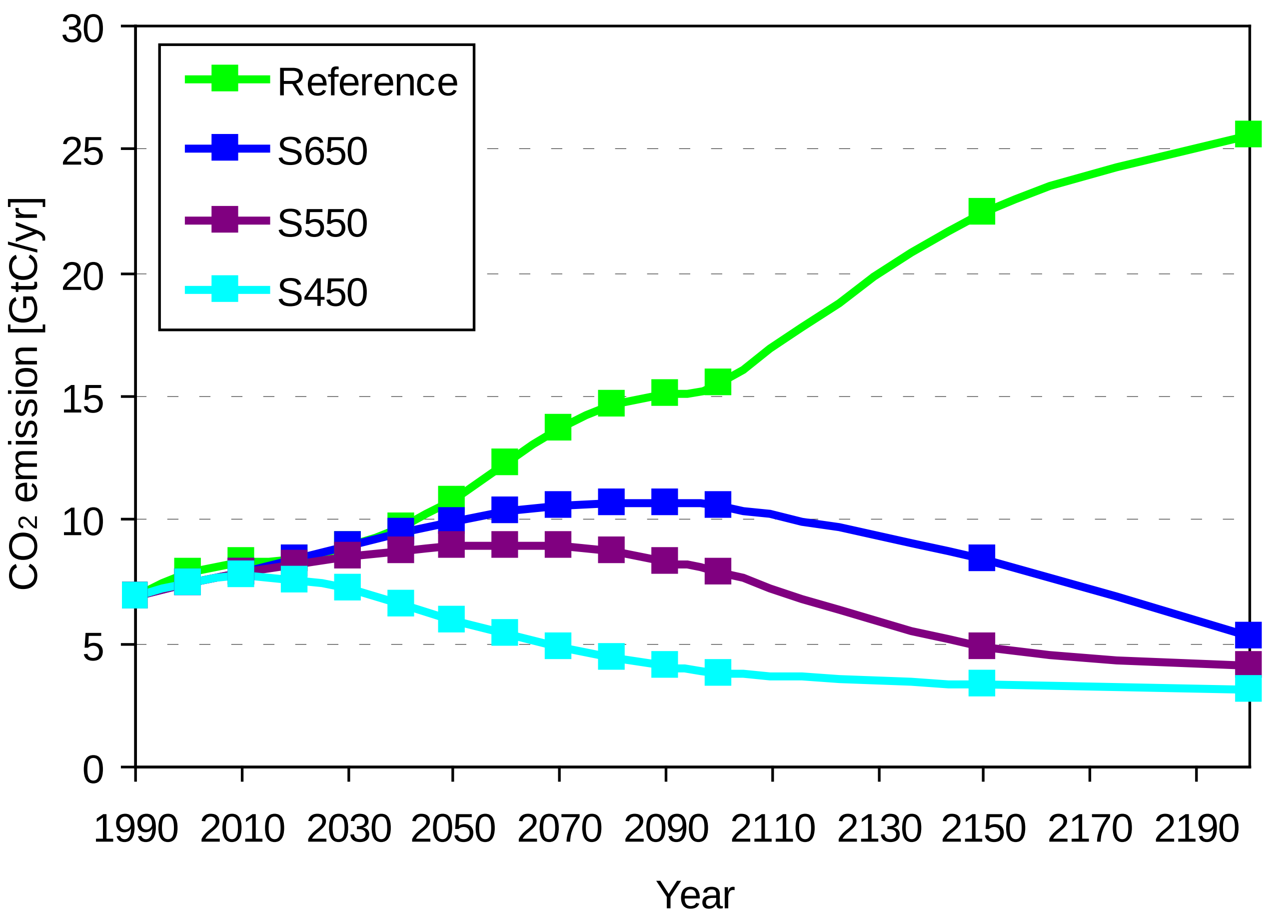
The stabilization level when the total cost is minimum (the maximum total benefit) is calculated

EJ: the second step

Q1. The most desirable stabilization level is considered comprehensively
Q2. The reasons why Q1 was answered
Q3. The emphasized items when Q1 was answered

Aggregating, analyzing and summarizing responses

CO2 Emission Paths for the Estimation

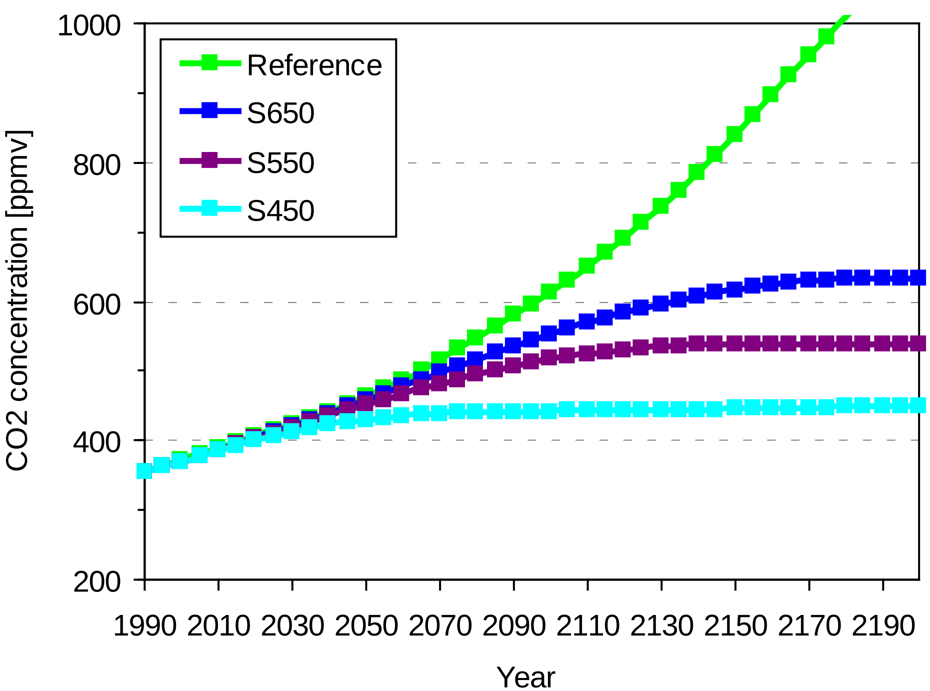


Reference: Based on SRES B2, the emission path is derived from DNE21, considering resources restrictions by 2200. The original technical parameters of DNE21 are adjusted to be relatively close to the SRES B2 emission path.

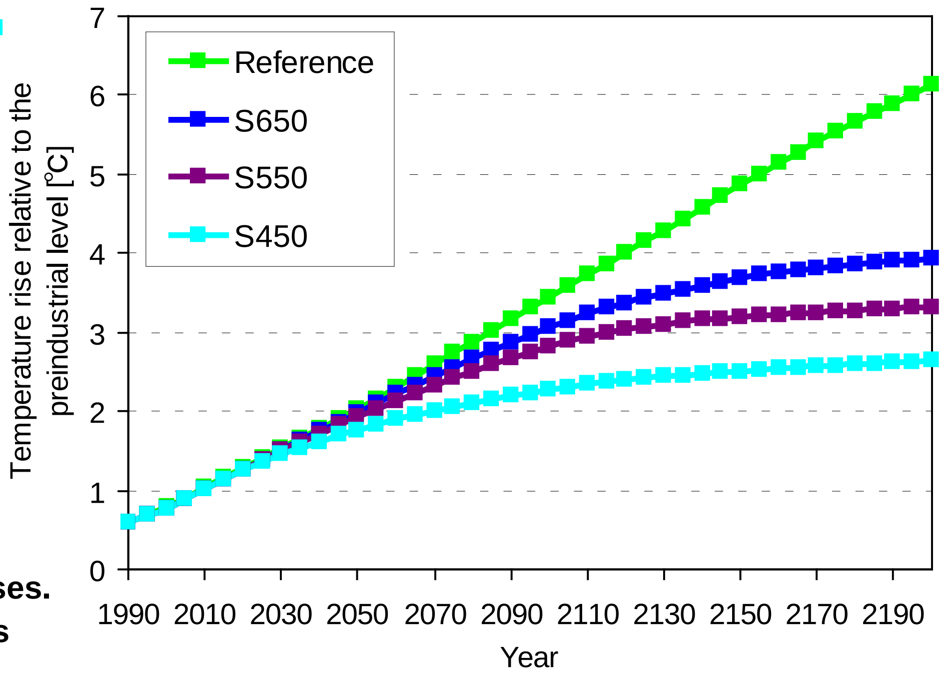
Concentration stabilization paths (S650, 550, 450): modified concentration stabilization paths of IPCC WGI to be consistent with the latest statistics

CO2 Concentration and Global Mean Temperature Rise

CO2 concentration (CO2 only)

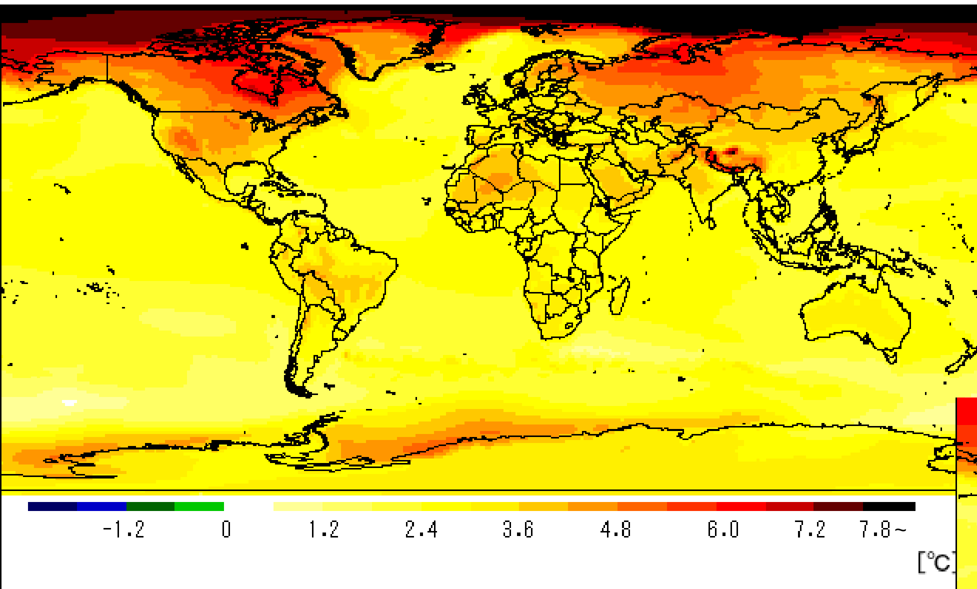


Global mean temperature rise

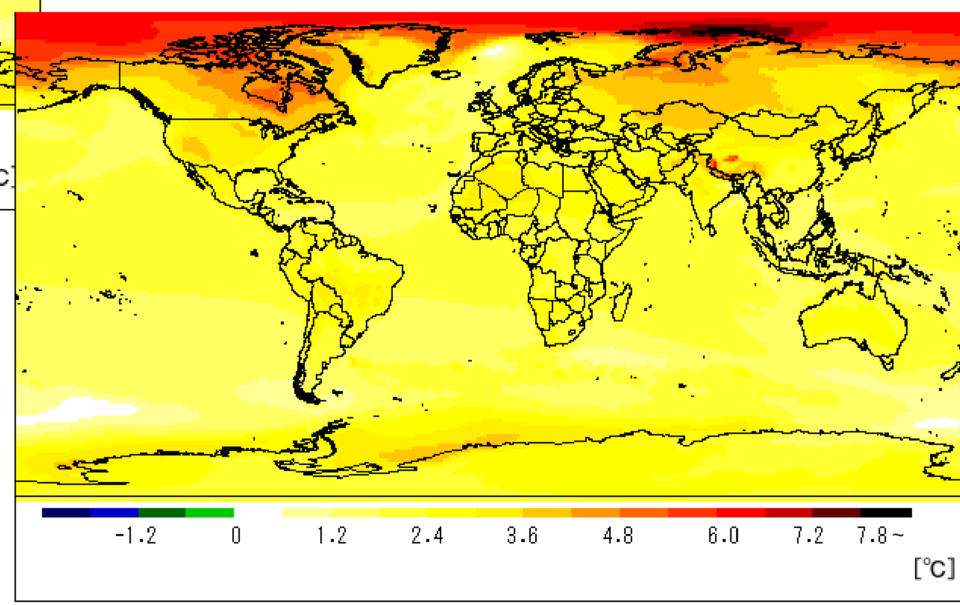


Non-CO2 GHGs is assumed based on SRES B2, in all the cases.
Equilibrium climate sensitivity is estimated 3 degrees celsius

Assessment of Global Warming Impacts by Concentration Stability Level
- Geographical Distribution of Temperature Rise (relative to 1990) –



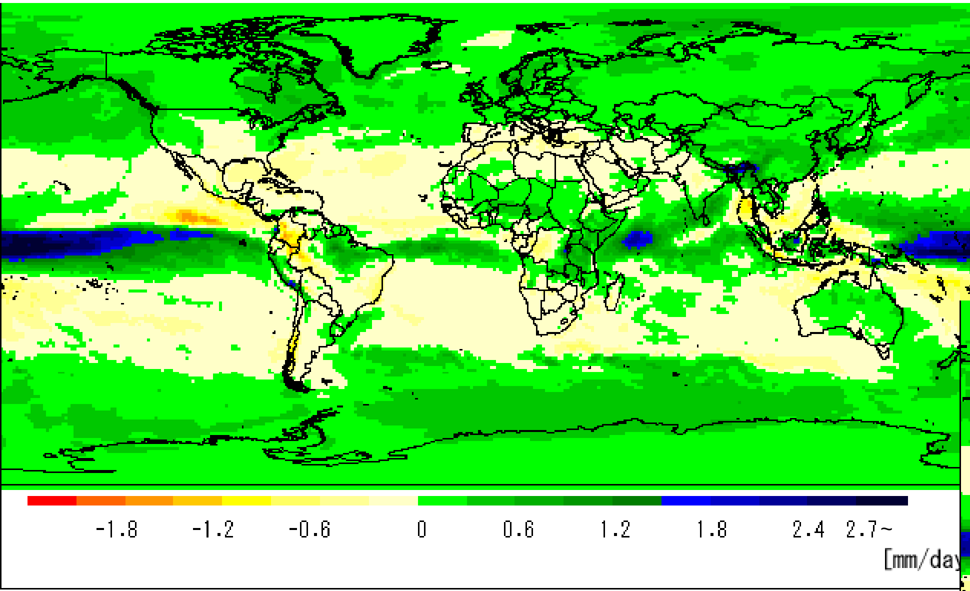
Reference case; 2100



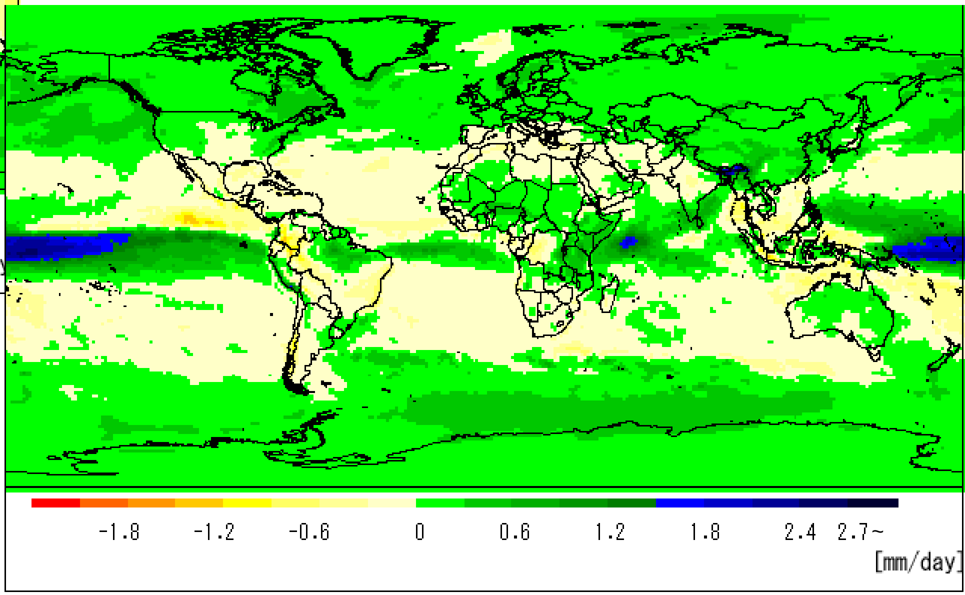
550 ppm stabilization case; 2100

- **Significant temperature rise can be seen in the arctic region.**
- **At 550 ppm stabilization level, the temperature rise is inhibited substantially, but significant temperature rise is inevitable around the Arctic.**

Assessment of Global Warming Impacts by Concentration Stability Level
- Geographical Distribution of Precipitation Changes (relative to 1990) –



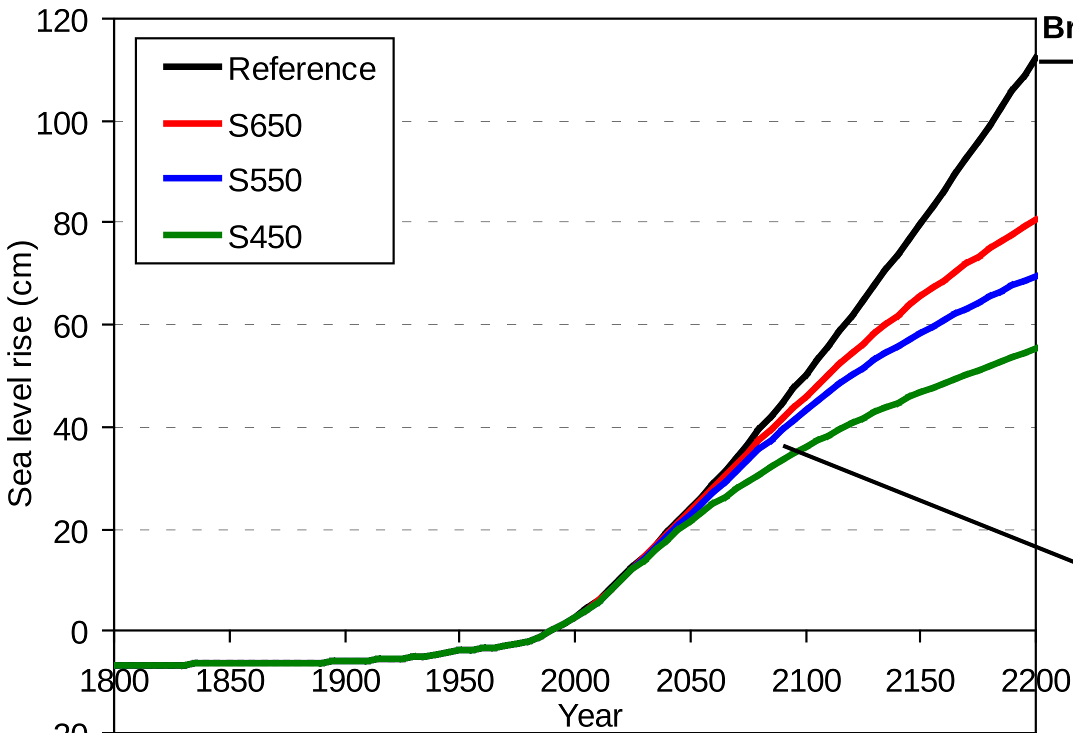
Reference case; 2100



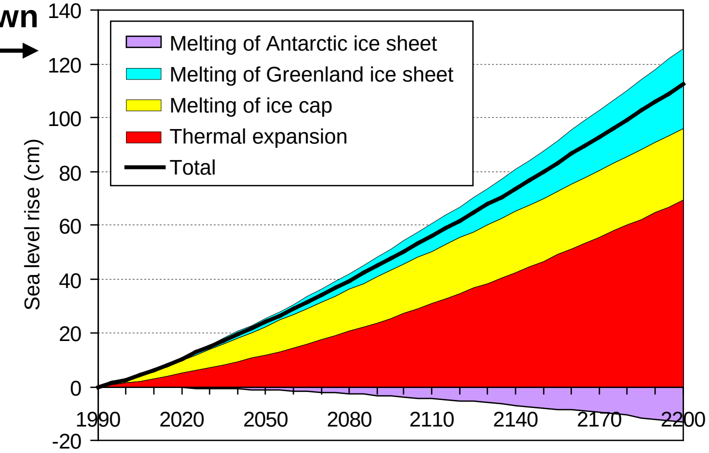
550 ppm stabilization case; 2100

- **The precipitation tends to increase largely in the equatorial region**
- **The impacts on precipitation changes are not so large between emissions scenarios, but overall, the precipitation tends grow larger in the reference case**

Assessment of Global Warming Impacts by Concentration Stability Level - Sea level Rise -



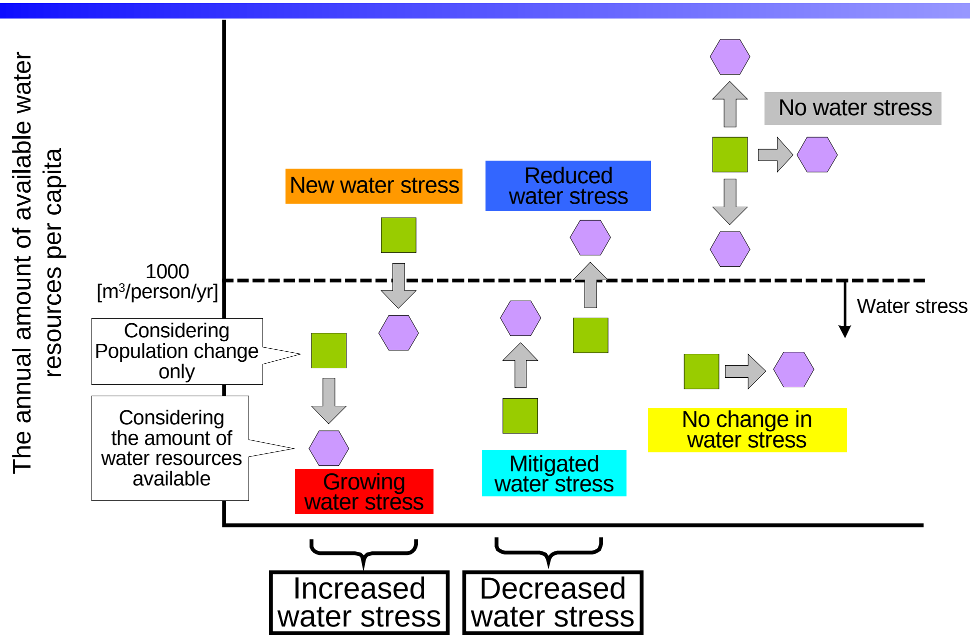
Breakdown



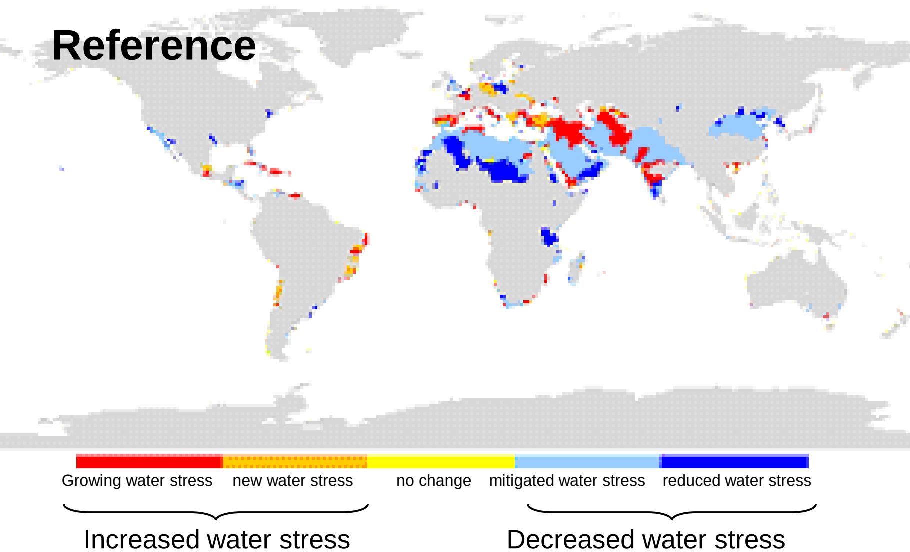
10 million people were flooded by storm waves in the year of 1990 and about 90 million people are estimated to be flooded in 2080 in case of the 38cm sea level rise, even considering the enhancement of protective

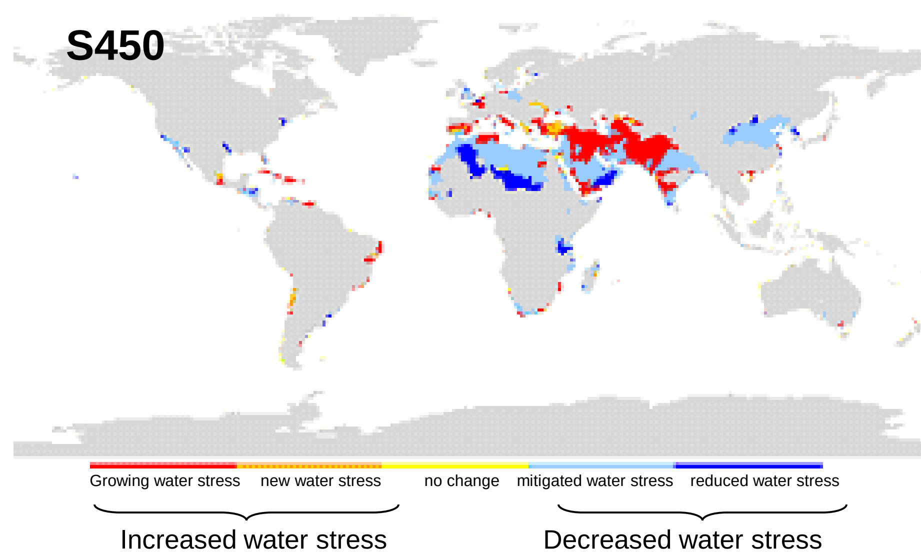
- **In the Reference case without any measures for emission reductions, the sea level is estimated to rise about 110cm in 2200 relative to 1990. In case of 650ppm stabilization, 80cm rise is estimated and in case of 450ppm about 55cm rise.**
- **However, even if the concentration is stabilized, the sea level will continue to rise after 2200.**

Assessment of Global Warming Impacts by Concentration Stability Level - Water Resources (1/2) -

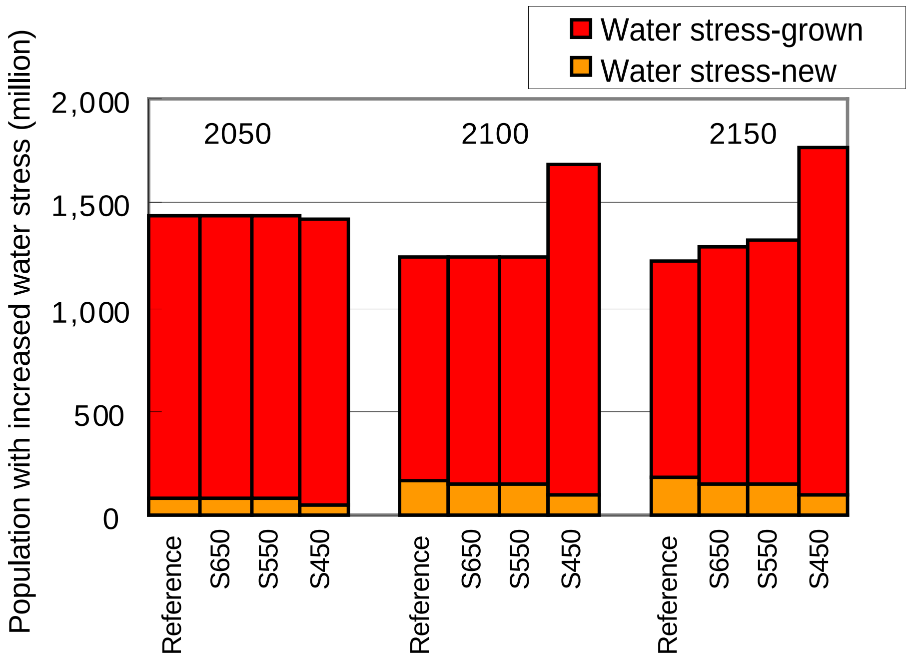


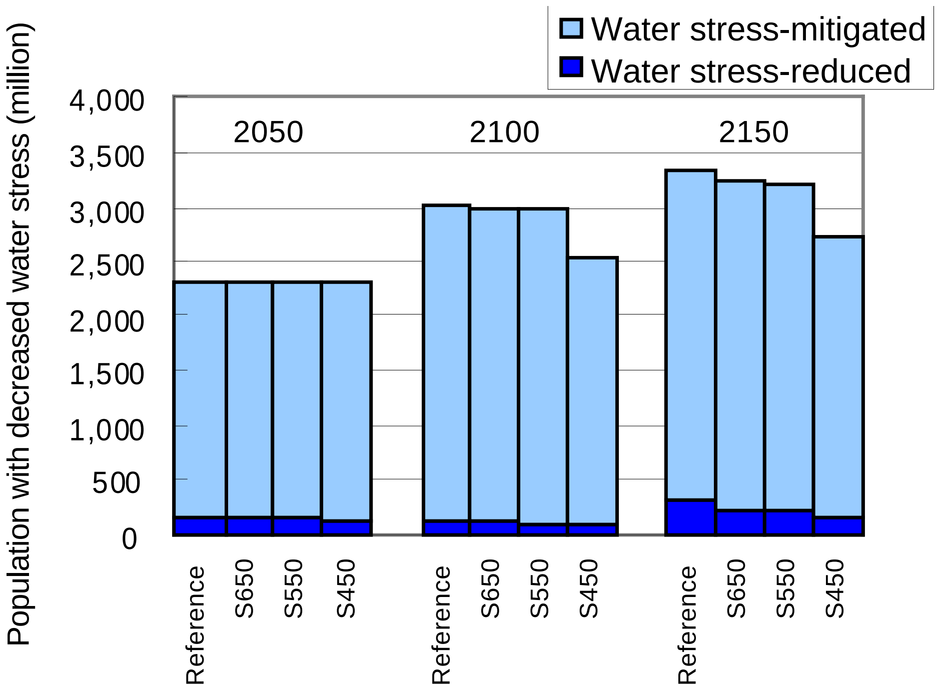
- Water stress is assessed based on water resources abundance, 1000m3 per capita, per year, which is often used as one of criteria.
- As global warming makes some parts in North Africa and East Asia have more precipitation, water stress is mitigated.
- In contrast, some parts in Europe, Mediterranean coast, South Asia and South America have increased water stress.





Assessment of Global Warming Impacts by Concentration Stability Level - Water Resources (2/2) -

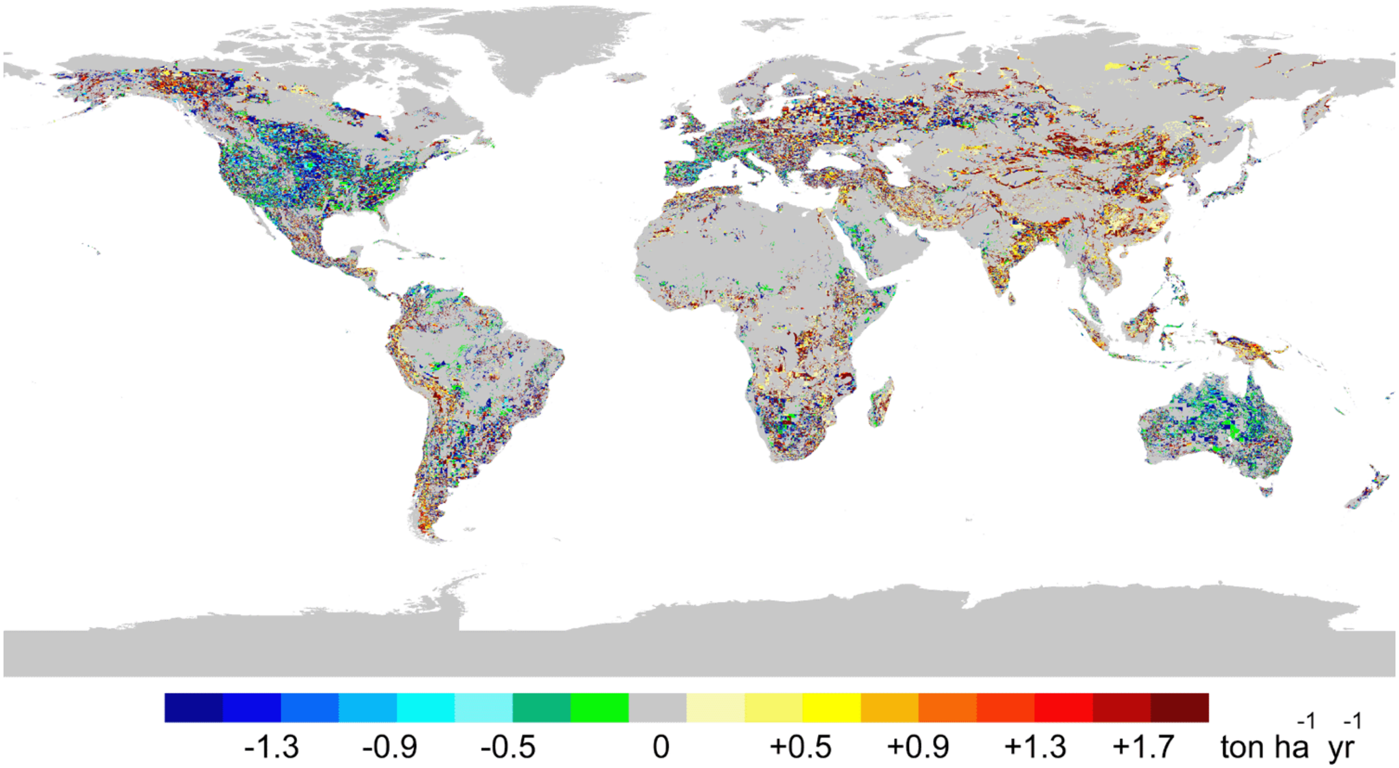




- **In terms of water resources, water stress tends to be mitigated, since the whole world has more precipitation, as global warming continues.**
- **However, it is required to implement appropriate water management in many cases, as rainfall sometimes tends to increase intensively.**

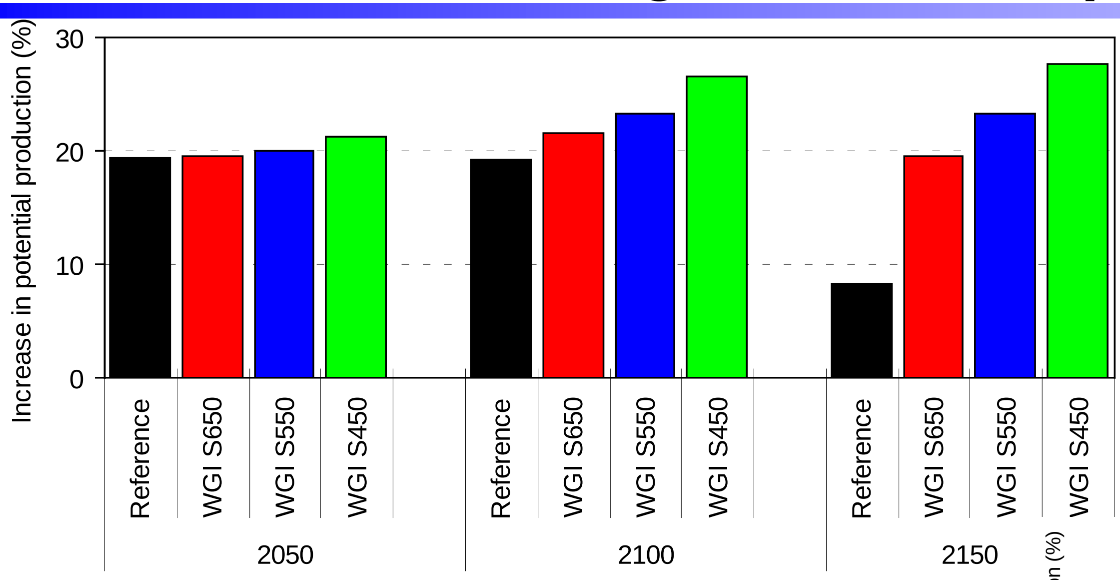
Assessment of Global Warming Impacts by Concentration Stability Level - Agricultural Crops (1/3) -

Changes in wheat productivity potentials in the reference case (relative to 1990)



- In future developing countries can expect improved productivity and a bit of global warming would benefit cold regions for wheat growth and increased productivity
- The United States, European Union and Australia have less productivity potentials.

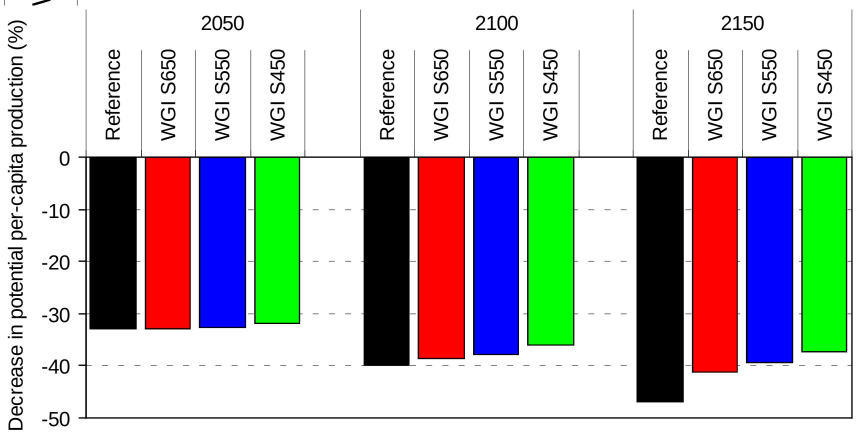
Assessment of Global Warming Impacts by Concentration Stability Level - Agricultural Crops (2/3) -



Wheat

Increase in potential production (relative to 1990)

Decrease in potential per-capita production (relative to 1990)



- **Mainly in developing countries, productivity improvement is expected, so the three concentration stability scenarios show improvement of wheat production potentials. However, only the reference scenario shows the substantial reduction of production potentials in 2150.**
- **Due to population growth, production potentials per capita in four scenarios in 2050, 2100, 2150 are lower than today, though production potentials increase.**

Assessment of Global Warming Impacts by Concentration Stability Level - Agricultural Crops (3/3) -

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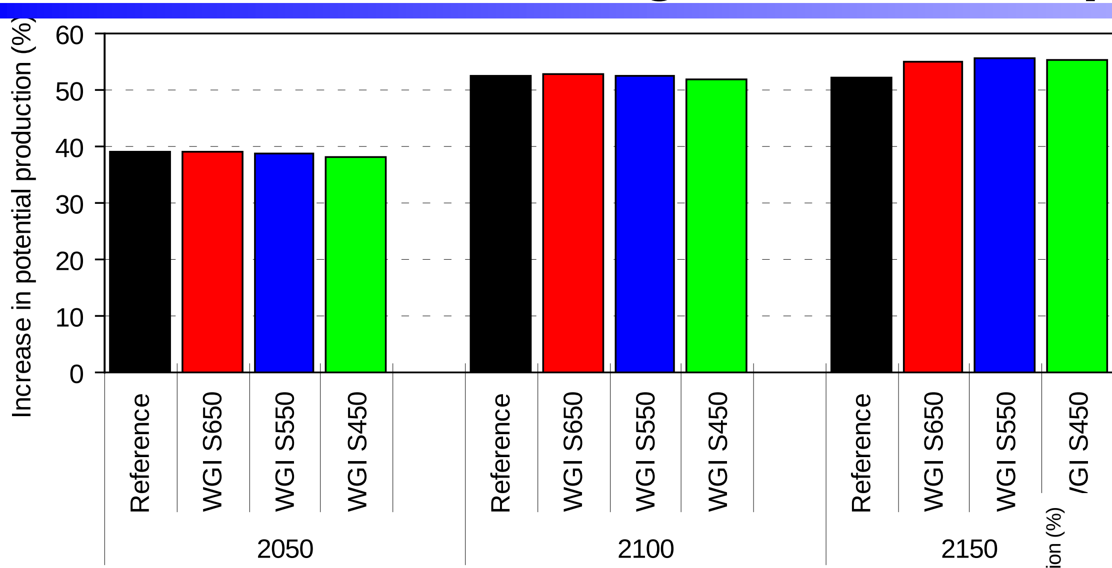
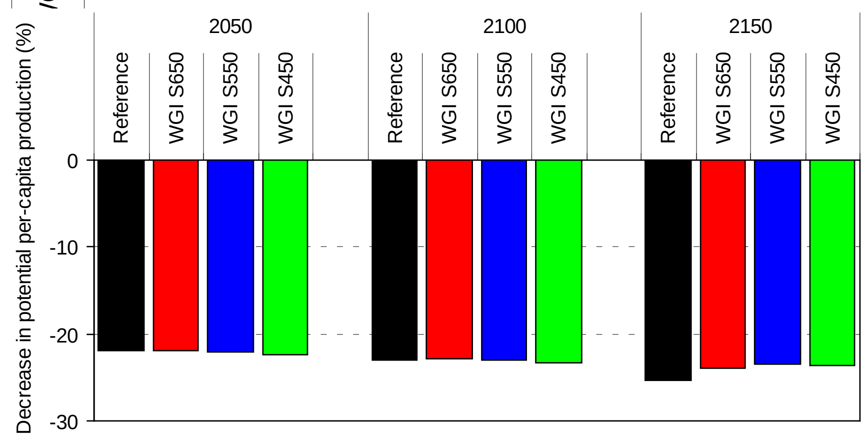


Rice

Increase in potential production (relative to 1990)

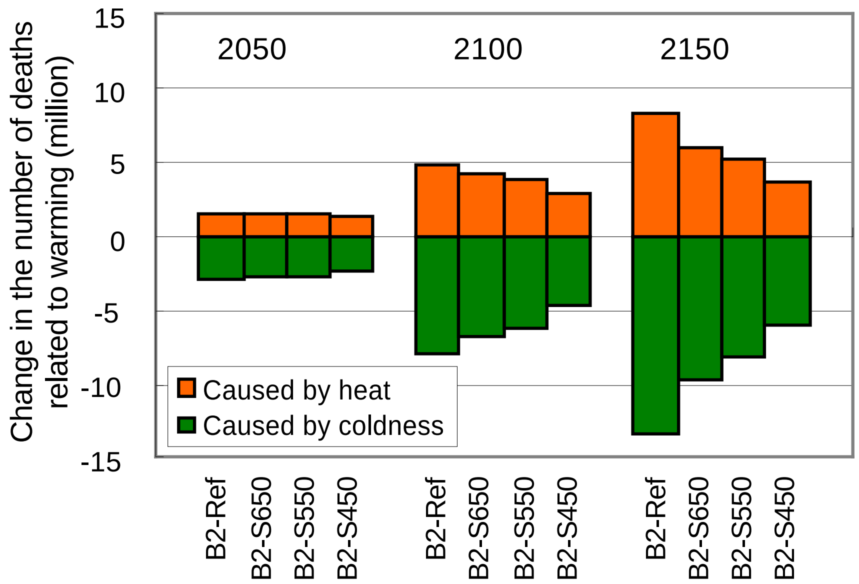
Decrease in potential per-capita production (relative to 1990)



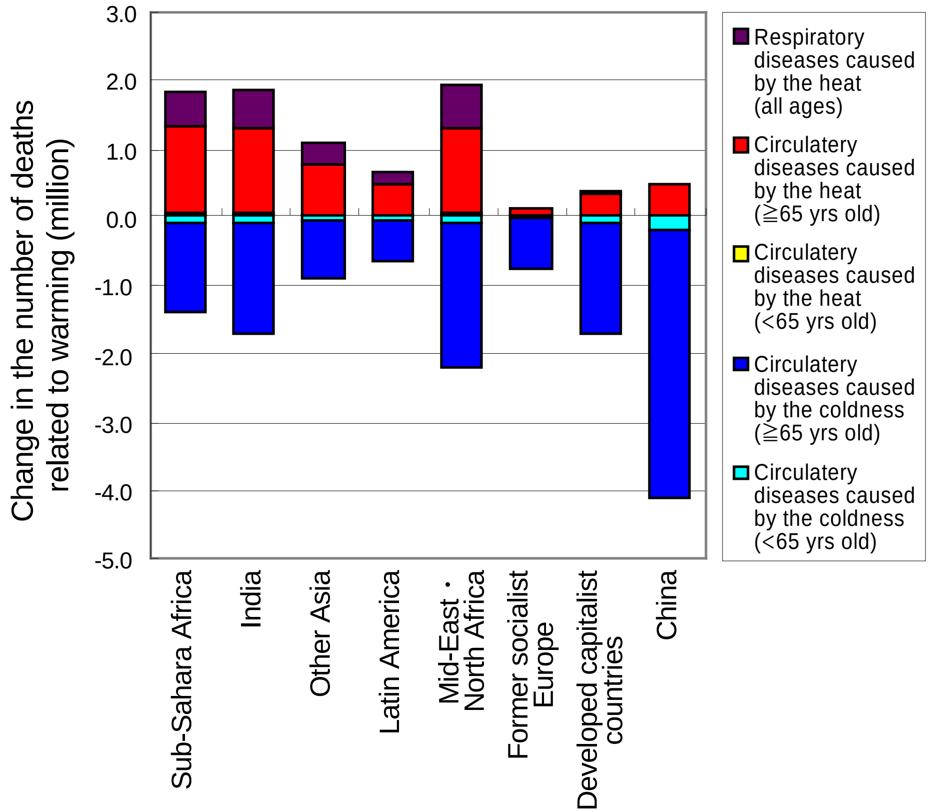
- **Even the reference scenario in 2150 shows less reduction of production potentials than wheat because rice grows in warmer climate, which should include consideration of breeding and changes of planting seasons. Such adaptation is required for the scenario.**
- **Due to population growth, as well as wheat scenarios, production potentials per capita in four scenarios for 2050, 2100 and 2150 are lower than today, though production potentials increase.**

Assessment of Global Warming Impacts by Concentration Stability Level - Health (heat stress (circulatory disease, respiratory disease)) -

Emission path (world)



The breakdown of the 2150 reference case



- Decrease in deaths caused by cold is expected to be larger than increase in deaths caused by heat.
- Less deaths in China and increase of net deaths in sub-Saharan Africa can be assumed in the 2150 reference case by region

Assessment of Global Warming Impacts by Concentration Stability Level - Health (malaria, dengue)-

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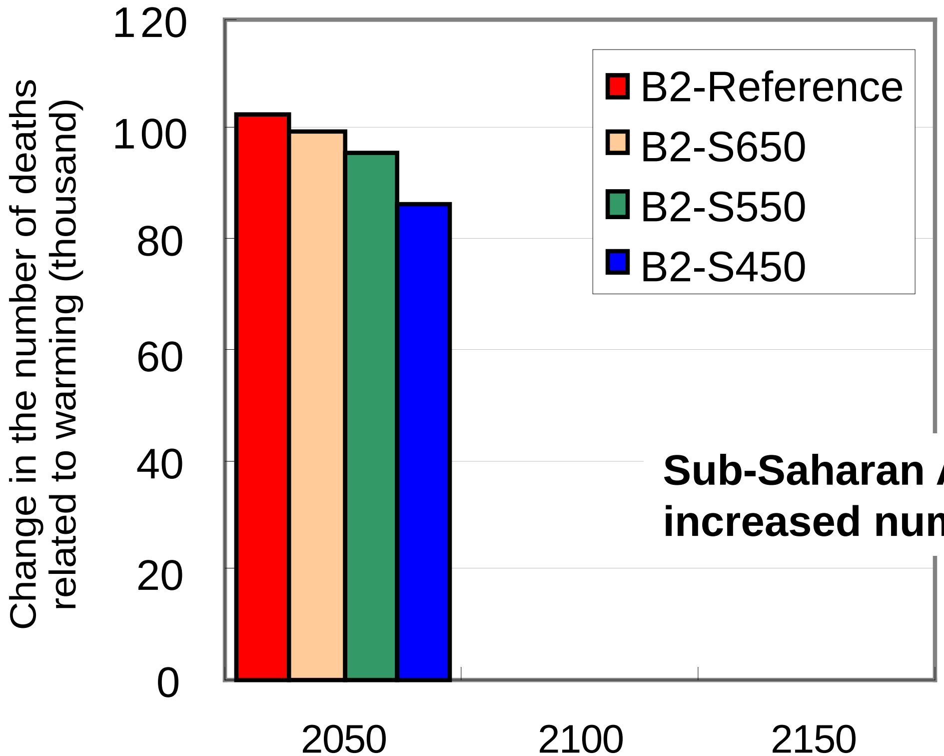
Increase in deaths from malaria and dengue caused by global warming

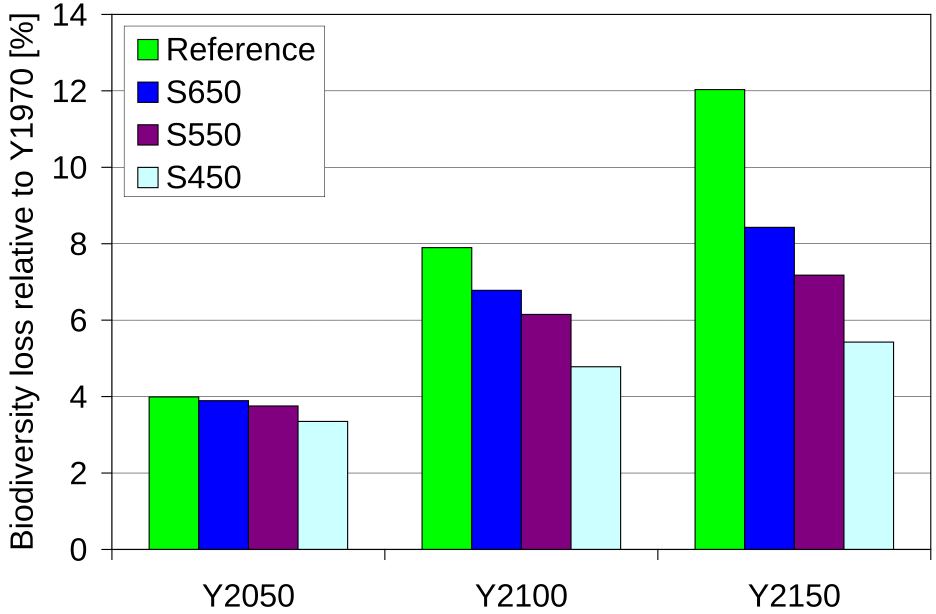


Sub-Saharan Africa is assumed to have increased number of death in 2050

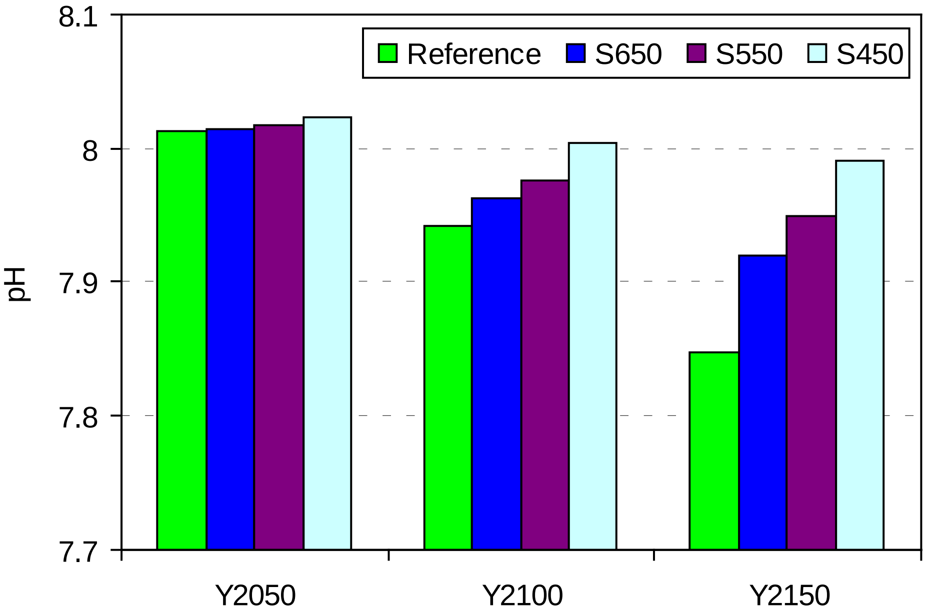
- **Stabilizing the low concentration level decreases a number of deaths**
- **However, the impacts are dominated by the level of economic growth, not by global warming. With the growth of GDP per capita, Asian regions are expected to be free from malaria and dengue, and also all scenarios show that sub-Saharan Africa is not expected to have increased deaths around 2100.**

Assessment of Global Warming Impacts by Concentration Stability Level - Terrestrial Ecosystems and Marine Acidification -

Terrestrial ecosystems: biodiversity loss

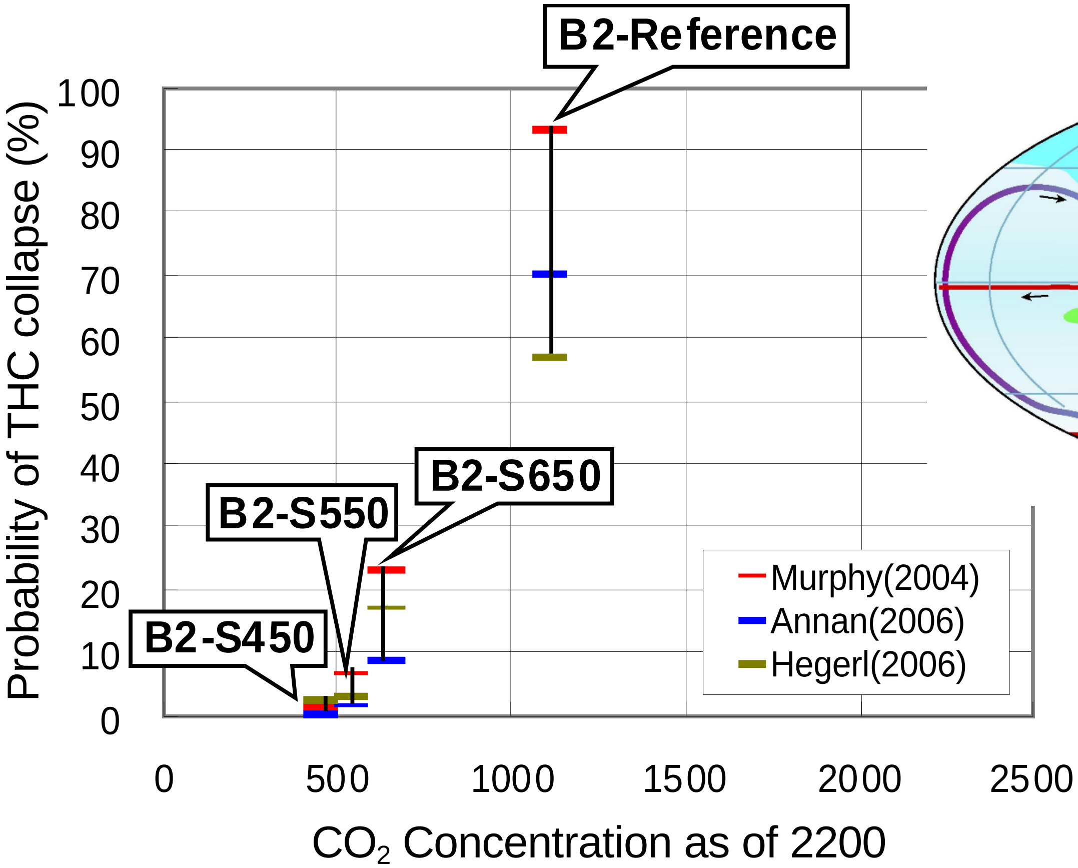


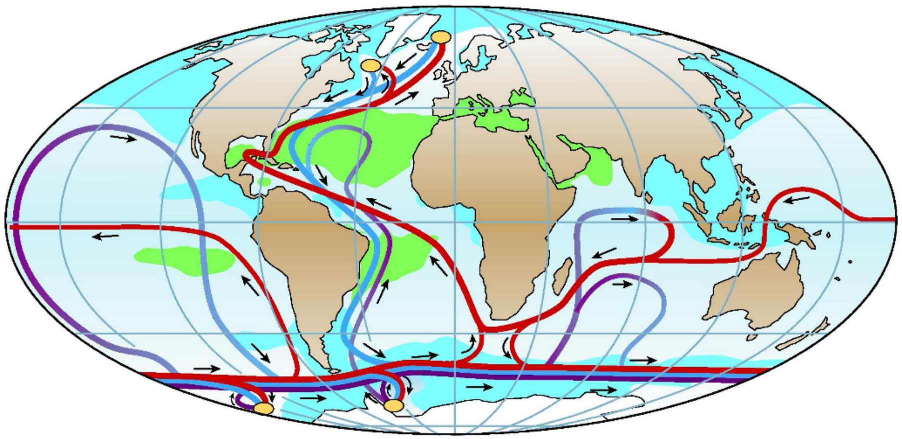
Ocean acidification



- **In 2150, the reference scenario shows that species might be reduced by 12% caused by global warming, but in the 450 ppm scenario they might be reduced by less than 6%. Meanwhile, in 2500, biodiversity loss in terrestrial ecosystems is assumed to be reduced by about 12% caused by factors other than global warming.**
- **With a CO2 concentrations in the atmosphere increased, oceans are more acidified. In scenarios for 2050 pHs in the water are similar, but among scenarios for 2150 pH 0.2 may result in difference**

Assessment of Global Warming Impacts by Concentration Stabilization Level
- the Probability of the Collapse of the Thermohaline Circulation (THC) -





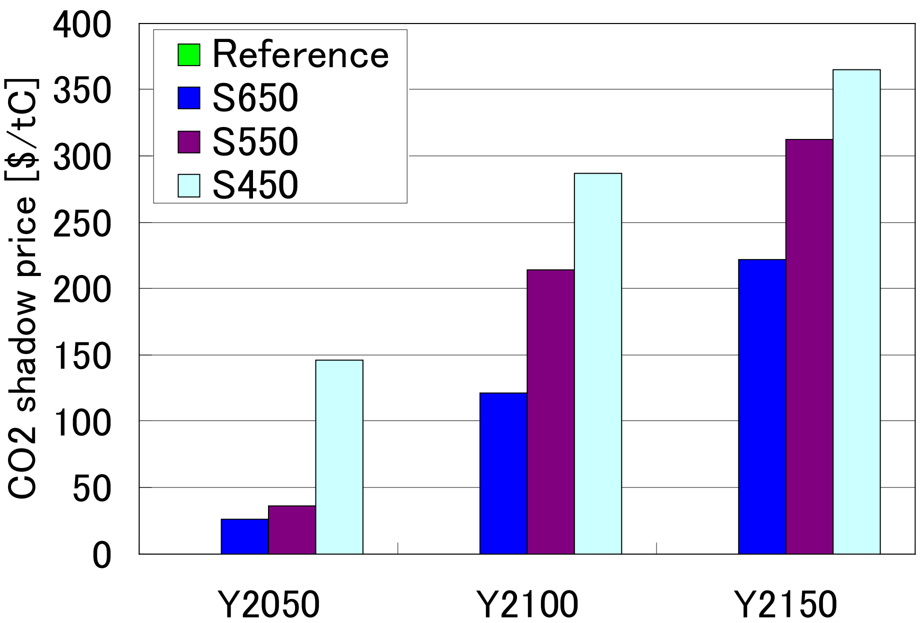
Source) S. Rahmstorf, *Nature*, 2002

- **The collapse of the thermohaline circulation may impact ocean ecosystems as drastically as unpredictable**
- **In the reference case without any measures to reduce CO2 emissions, the THC may collapse with 60-90% probability. But if stabilized at 650ppm, the THC may collapse with 10-20% probability, and at 450ppm the probability is less than 5%.**

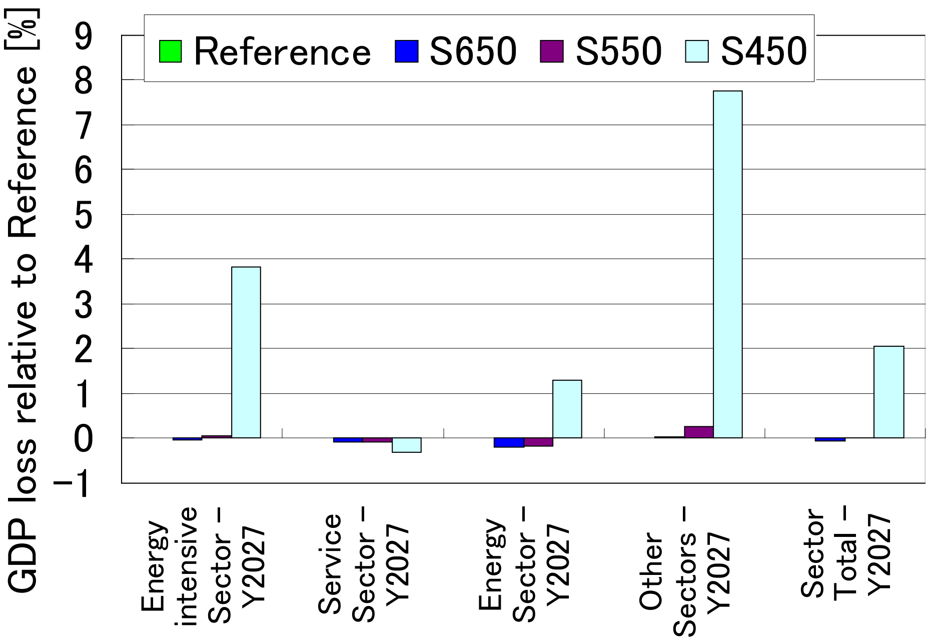
Assessment of Global Warming Impacts by Concentration Stability Level - Other Impacts-

- **The collapse of West Antarctic ice sheet (WAIS): If WAIS collapses, the sea level may rise about 4-6m but potential WAIS collapses in the 21 century is small.**
- **Forest: While rising CO2 concentration levels and global warming may increase forest potentials, forest fires and pest increase and damages may reduce the potentials.**
- **Fisheries: Plankton habitat changes or reductions may have effect on significant changes in fishing grounds.**
- **Tropical cyclones: Although tropical cyclones may form less frequently, strong tropical cyclones may have potential to form more frequently.**

Assessment of Mitigation of Global Warming by Concentration Stability Level (1/2)



Marginal abatement costs of global CO2 Emissions estimated by the DNE21 model. **(The ideal case to equalize the world marginal abate costs is assumed.)**

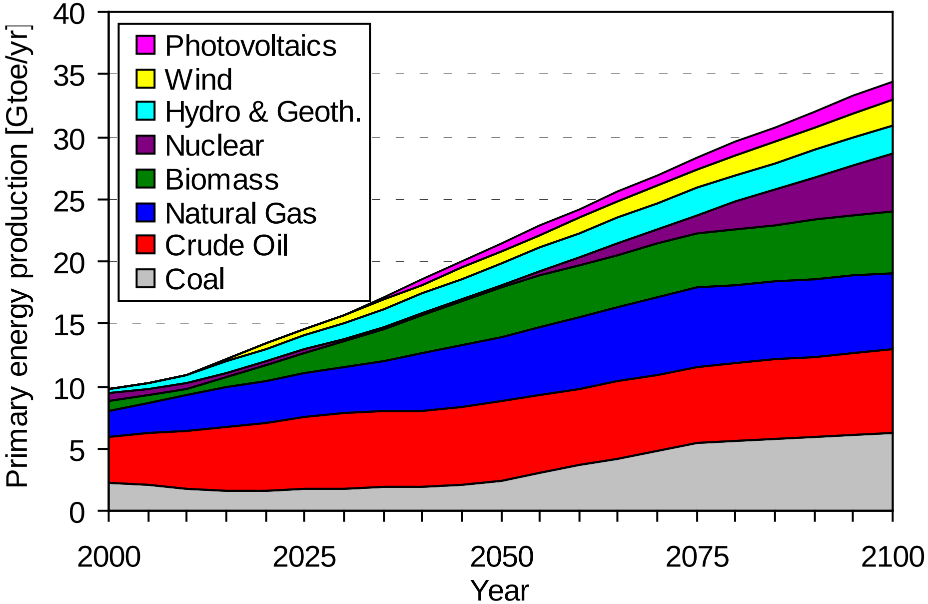


2027 sectoral value-added loss estimated by the DEARS model

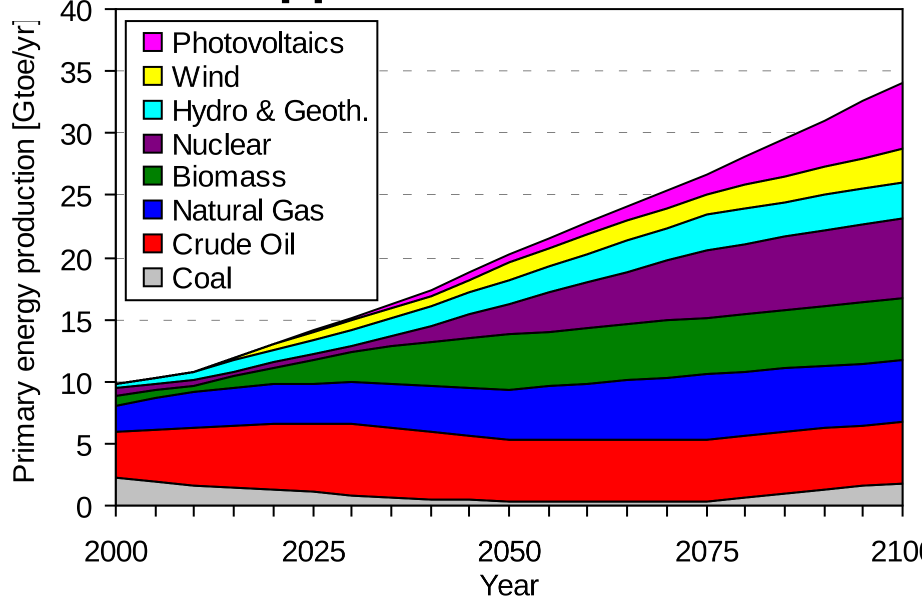
- **Especially in the 450 ppm stabilization case, the marginal abatement cost in 2050 is much higher than the other scenarios.**
- **The assessment by the DEARS model which divides sectors in details shows the rapid tendency toward the large value-added loss in the 450 ppm stabilization case.**

Assessment of Mitigation of Global Warming by Concentration Stability Level (2/2)

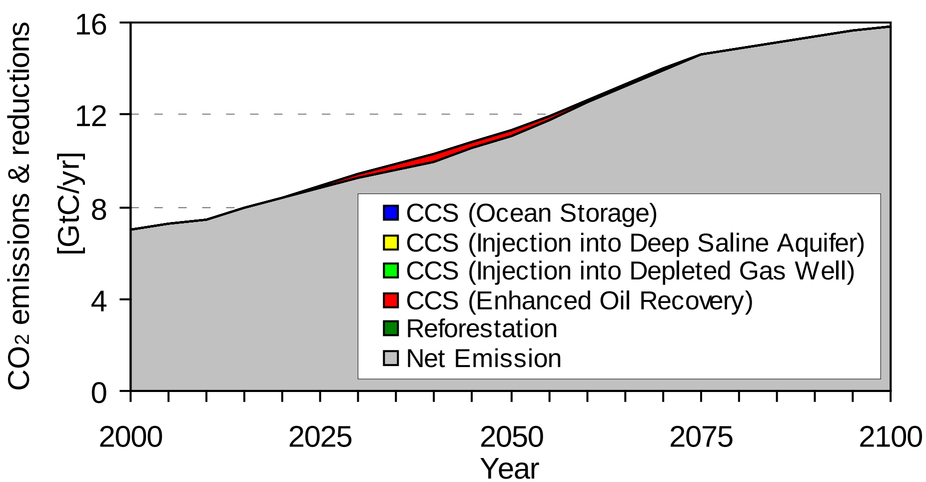
Reference case



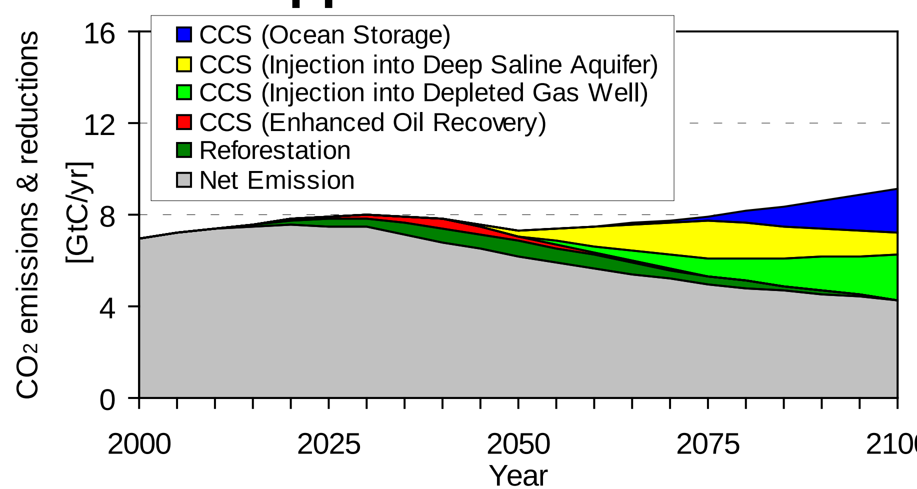
450 ppm stabilization case



Reference case



450 ppm stabilization case



Models Used for the Assessment of Mitigation Costs

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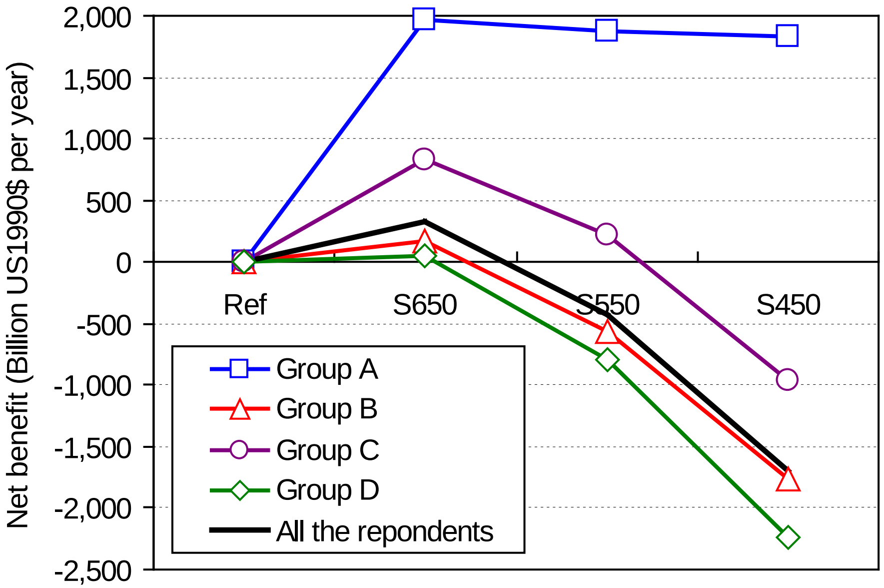
- **Super long-term assessment of the mitigation strategy (~2150): The DNE21 model**
  - The integrated model consists of the top-down economic module (only one sector of non-energy) and the bottom-up energy system module.
  - Optimized dynamic nonlinearity model (maximized consumption utility in the whole world)
  - Assessment period: ~2150
  - Regions: 10 divisions
- **Mid-term assessment of the mitigation strategy (~2150): The DEARS model**
  - The integrated model consists of the top-down economic module and the bottom-up energy system module.
  - Optimized dynamic nonlinearity model (maximized consumption utility in the whole world)
  - Assessment period: ~mid-21st century
  - Regions: 18 divisions
  - Non-energy industries: 18 industrial sectors
  - Energy industries: 7 sectors in the primary energy, 4 sectors in the second energy
  - The economic module specified industrial frameworks, based on the GTAP model and database
  - The simplified energy system module, based on the DNE21 model

DNE21: Dynamic New Earth 21
DEARS: Dynamic Energy-economic Analysis model with multi-Regions and multi-Sectors

Value Judgment by Specialists

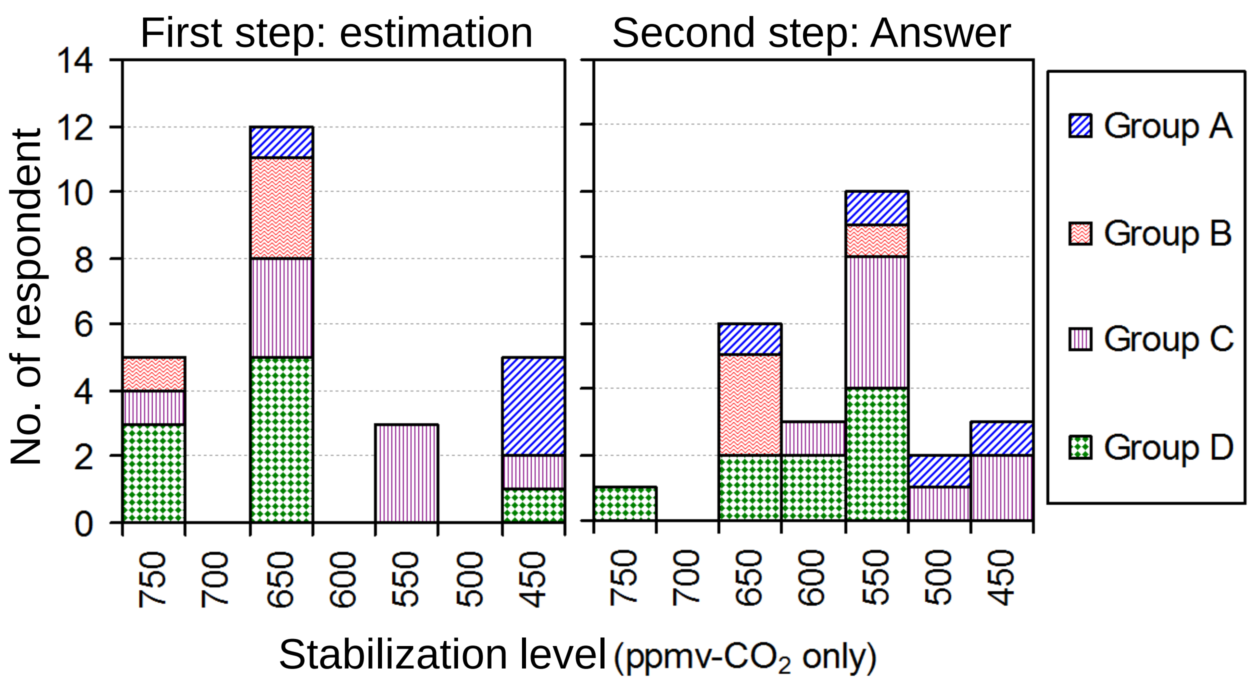


The first step（estimation results by CBA simple assessment）

It is estimated that the most groups of specialists assume around 650 ppmv (CO2 only) to be the recommended concentration stabilization level

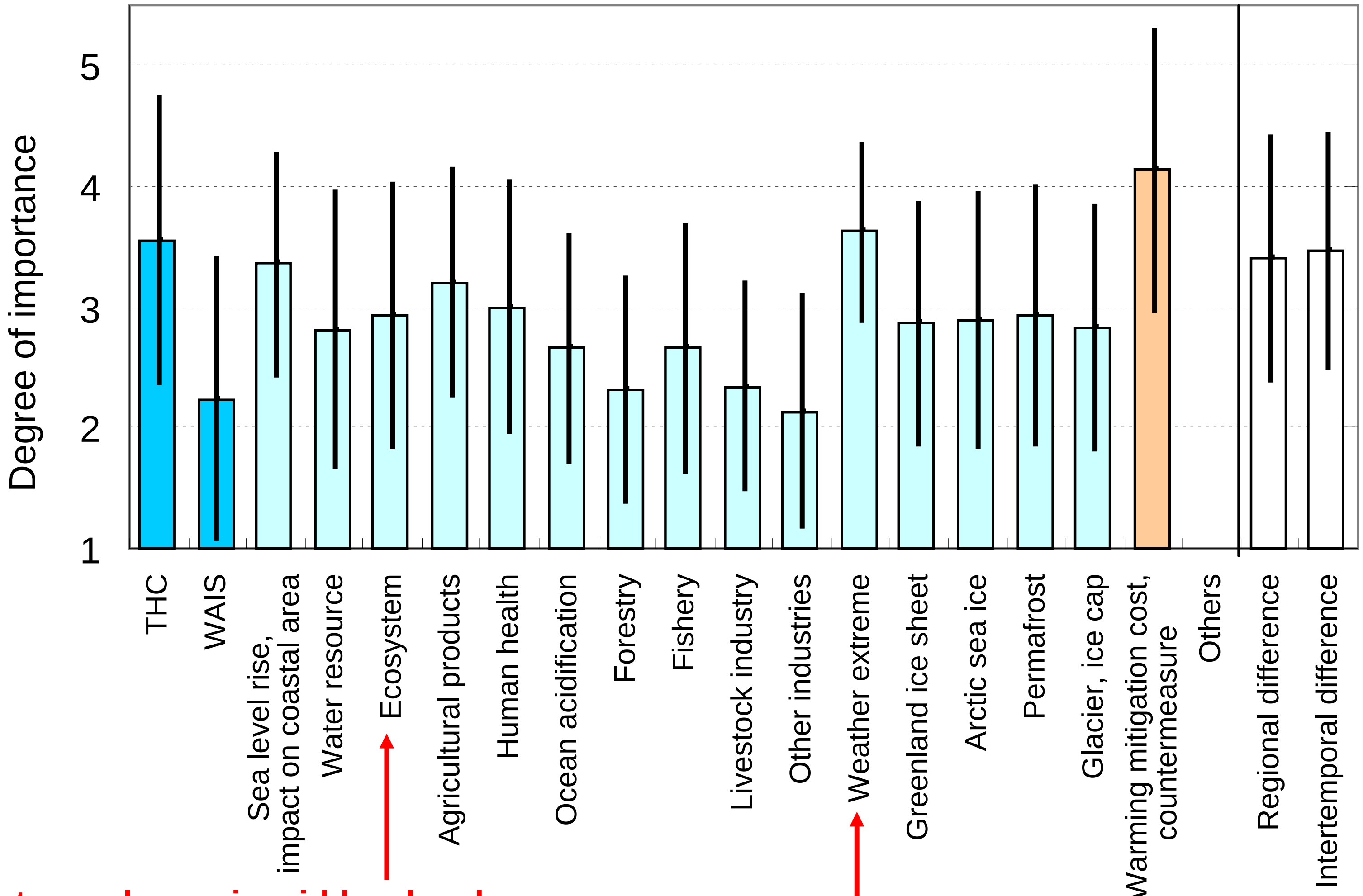
The result of the second step

A number of respondents judged around 550 ppmv (CO2 only) to be recommended in the second step where impacts except the above five, impacts every time point and regional differences are included.



A Domain Considered Important by Specialists and Contributing to the Recommended Concentration Stabilization Level

Importance degrees by domain



The importance degree is mid-level and has significant co-relation with the concentration stabilization level

Many considered the domain important but has no co-relation with the concentration stabilization level

Scientific Assessment of the Recent Climate Change

RITE Research Institute of Innovative Technology for the Earth

Stern Review (October, 2006, UK)

Urgent! Significant reductions

- The costs of damages from business-as-usual would be equivalent to at least 5% and up to 20% of GDP.
- The 450~550 ppmvCO2eq. path would well reduce catastrophic risks.
- The costs of removing the most risks, getting to 500~550 ppmvCO2eq. are around 1% of GDP per year. The costs are much lower than the path without taking actions.
- Early and deceive mitigations would have more advantages than the case without measures, economically.

IPCC the Fourth Assessment Report: Climate Change 2007（summary for policy makers, published February ~ April, 2007）

- Concentration rises due to anthropogenic activities.
- The temperature is more likely to rise than it has been estimated.
- Impacts of global warming are obvious facts.
- Impacts of global warming are more various than it has been thought.
- Presenting reduction potentials by sector and cost
- Presenting stabilization scenarios of only CO2 concentrations 350~790 ppmv (445～1130 ppmvCO2eq.)

Global warming is serious. There is a way for reduction, but preferable strategies in terms of impacts of global warming and mitigation costs are political issues

The Stern Review

- **The Stern Review on the Economics of Climate Change (known as the Stern Review) is released for the British government in October, 2006 by Sir Nicholas Stern.**

<The main conclusions>

- **The cost of BAU climate change would be equivalent to around 5%~20% of GDP.**
- **Stabilizing the concentration level between 450 and 550 ppmvCO2eq. would substantially reduce the worst impacts by climate change.**
- **The annual costs of stabilization at 500-550ppmvCO2eq. are estimated to be around 1% of GDP, which is manageable at much lower costs than BAU path.**
- **Stabilization at 450 ppmvCO2eq. is very difficult and costly.**
- **The earlier effective action is taken, the less costly it will be.**

The review does not state any defined concentration targets but can be interpreted as implicit suggestions to stabilize at 500~550 ppmvCO2eq. (The Stern review is almost consistent with EU policies, if cooling effect of SOx is considered, though in the review, the effect is not considered.)

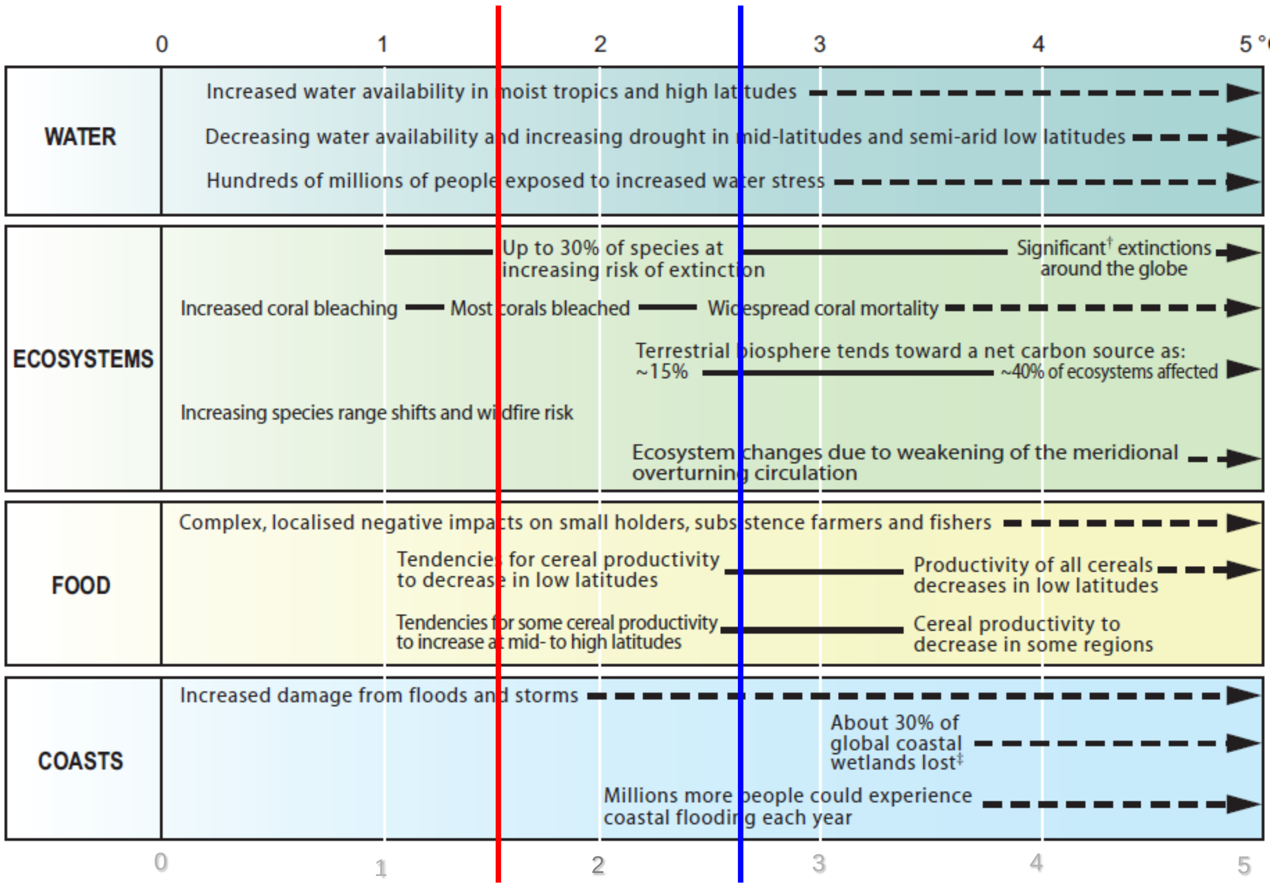
Comparison of the PHOENIX and the Stern Review

	The Stern Review	The PHOENIX
Approach to note the desired concentration stabilization level	Estimating mitigation costs for global warming (GDP loss) and damage costs from the impact of global warming under BAU scenarios. By comparing the two, the desirable concentration stabilization level is noted, which is not actually cost-benefit analysis, though cost benefit is partially considered.	Estimating benefits from reduced global warming and the cost for the reduction. Cost-benefit analyses based on weighted mitigation costs among various impacts by specialists. Taking into account of non-quantifiable impacts of global warming and intergenerational / regional equity, specialists made the final decision of the desirable concentration stabilization level based on the analyses.
Baseline scenario for assessments	~2100: **IPCC SRES A2** 2100-2200: the world population increase 0.6% p.a. (2100: 15 billions, 2200: 27 billions) <**A2** is used only for the global warming assessment. **Mitigation costs are based on B2**>	~2100：**IPCC SRES B2** (medium population and economic growth rate per capita) 2100-2200：the world population increase 0.6% p.a. (2100: 10 billions, 2200: 11 billions) <**B2 is used for the impacts of global warming and mitigation assessments consistently.**>
Monetizing the impacts of global warming	5% relative to GDP in 2200 for the market impacts, **20% for various aspects such as no-market impacts. Not evidence-based.**	Based on the sectoral impacts of global warming calculated using each index, specialists evaluated the impacts. **The derivation process is clear**.
Estimated mitigation costs	**Less than 1% relative to GDP for 500–550 ppmv-CO2eq.% stabilization until 2050.** 450 ppmv-CO2eq. stabilization is too costly and unrealistic.	**Less than 1% relative to GDP for 550 ppmv(CO2only). There could be more than 10% for 450 ppmv (CO2 only) relative to GDP.** To get it around, the introduction of innovative technologies to reduce CO2 emissions is crucial by 2030

IPCC The Fourth Assessment Report WG2

EU 2 ℃ target
（1.5℃ relative to 1990）

550 ppmv CO_2 only



Global mean annual temperature change relative to 1980-1999 (℃)

- Observational evidences show the significant impacts of global warming
- If the global mean temperature rises 2~3 ℃ relative 1990, net benefits could reduce 【2.5~3.5 ℃ rises relative to pre-industrial. Please let me note that the costs of measures are not included.】
- Corals are projected to be bleached or widespread mortality by 1~3℃ warming of surfaces waters

The PHOENIX and IPCC Fourth Assessment Report

EU proposal
The Stern Review?

The government proposal

The PHOENIX

	CO2 concentration (ppm)	CO2-eq concentration (ppm CO2eq)	Temperature rise after the industrial revolution	CO2 emission in 2050 (relative to 2000 %)	Reduction costs in 2050 (relative to GDP %)	Global warming damages (relative to GDP %)
I	350~400	445~490	2.0~2.4	-85~-50	less than +5.5	mixture of loss(-) /benefits(+)
II	400~440	490~535	2.4~2.8	-60~-30		
III	440~485	535~590	2.8~3.2	-30~+5	1.3 (-0~4)	In all the regions +
IV	485~570	590~710	3.2~4.0	+10~+60	0.5 (-1~2)	
V	570~660	710~855	4.0~4.9	+25~+85	—	1~5
VI	660~790	855~1130	4.9~6.1	+90~+140	—	—

Source: IPCC fourth assessment Report, WG2 & WG3
Note) When the sum of marginal abatement costs and damage costs is the minimum, the concentration would be ideal, considered in the cost-benefit analysis.

<reference: Stern estimate of damage impacts>

5~20% (8.6 temperature rise)

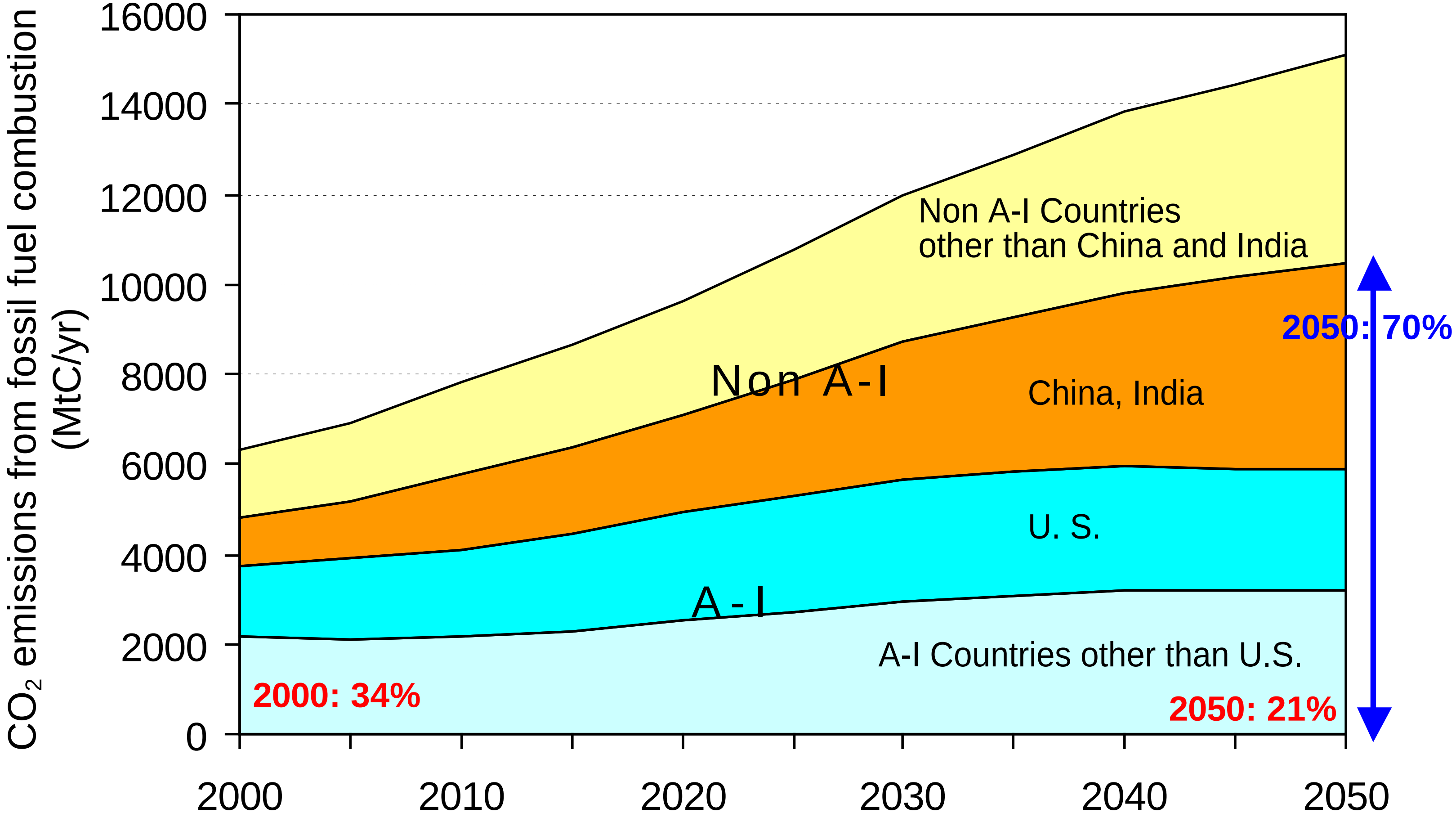
What is the stabilization level of CO_2 concentration ?

What is the realistic level the world could agree?

Emission sharing among developed and developing countries

- The article 3 of the United Nation Framework Convention on Climate Change states that the Parties should protect the climate system on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities and that the specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.
- The concrete meaning of 'differentiated responsibilities' is not clear, but developed countries should be required not only to provide financial assistance to developing countries but to set their own higher reduction targets.
- From the perspective of emission sharing among developed and developing countries, we should consider what meaning each level of concentration stabilization or the proposed long-term targets have.

Prospects for the future CO2 emissions

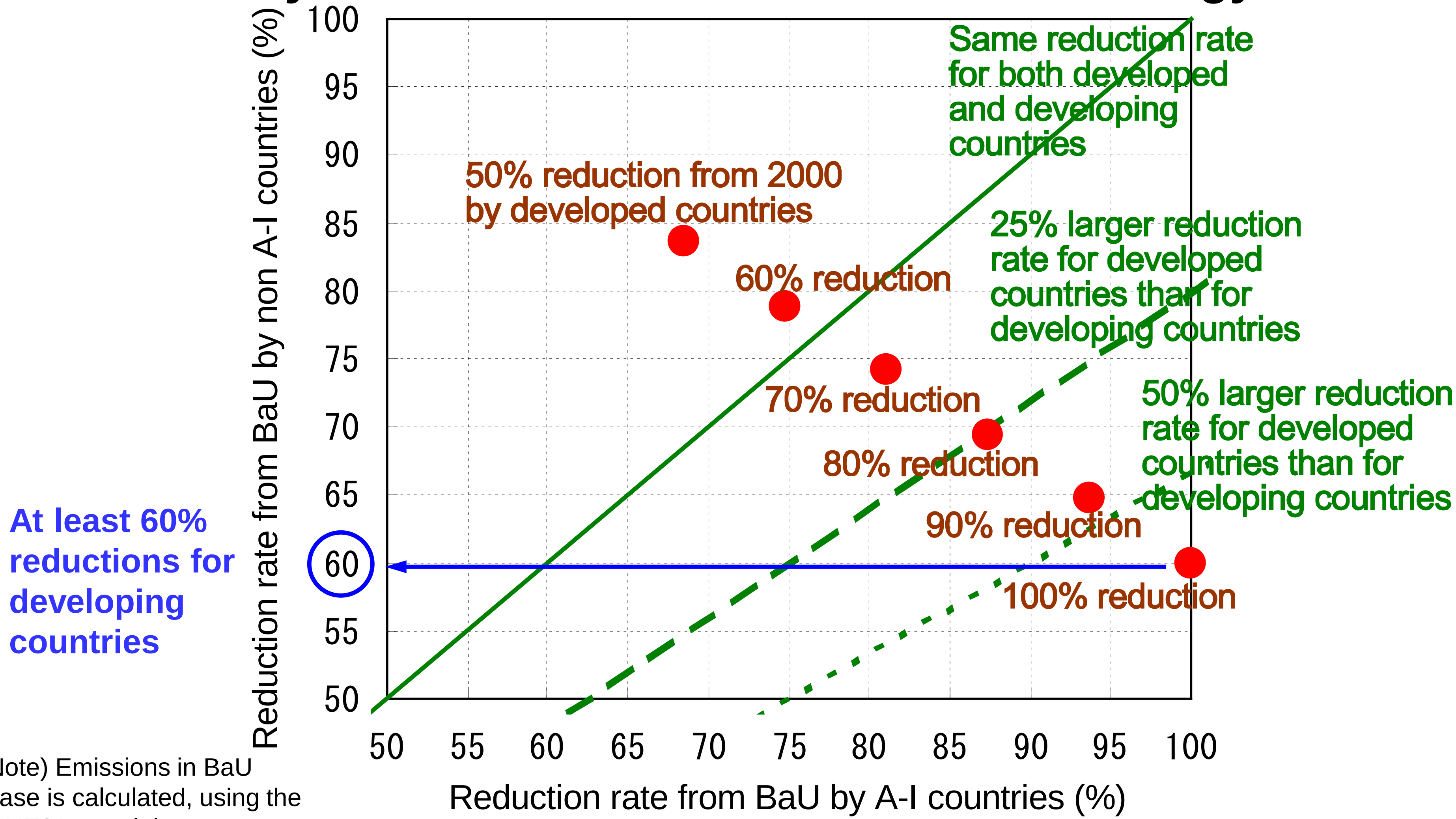


RITE, DNE21+ model

- **Developing countries especially have potential of significant emission increases in the future**
- **At least the framework is needed to substantively including the United States, China and India and also the target level is needed to facilitate participation of the developing countries in the framework.**

Meaning of Halving Global Emissions by 2050

Analyses of CO2 emissions related to energy

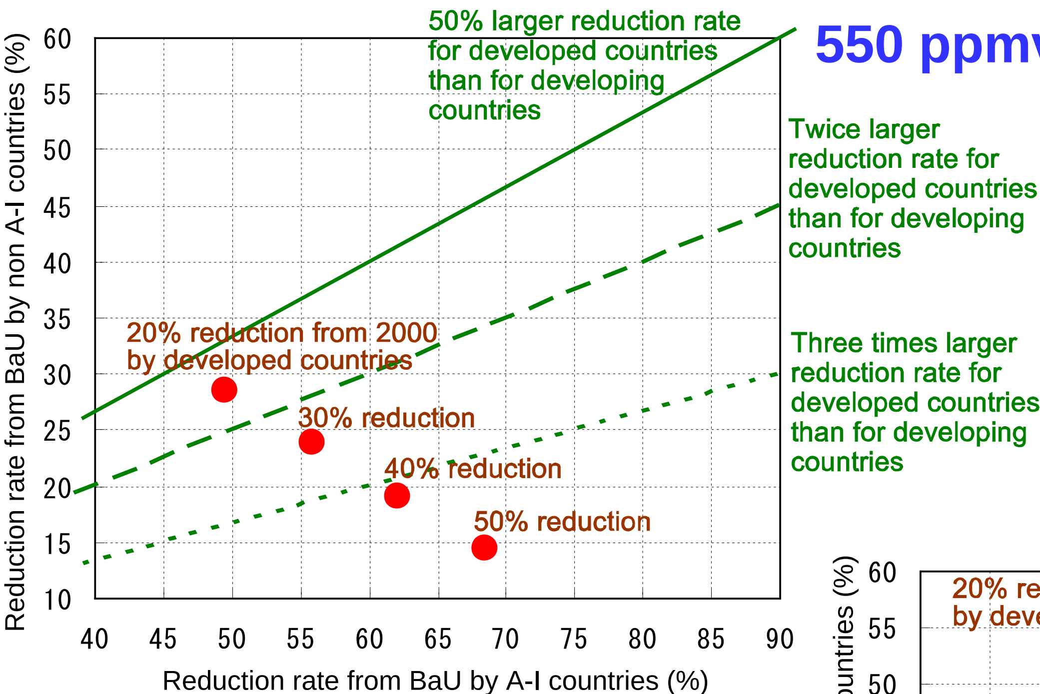


Note) Emissions in BaU case is calculated, using the DNE21+ model

- **The agreement of this target including developing countries seems to be very difficult.**

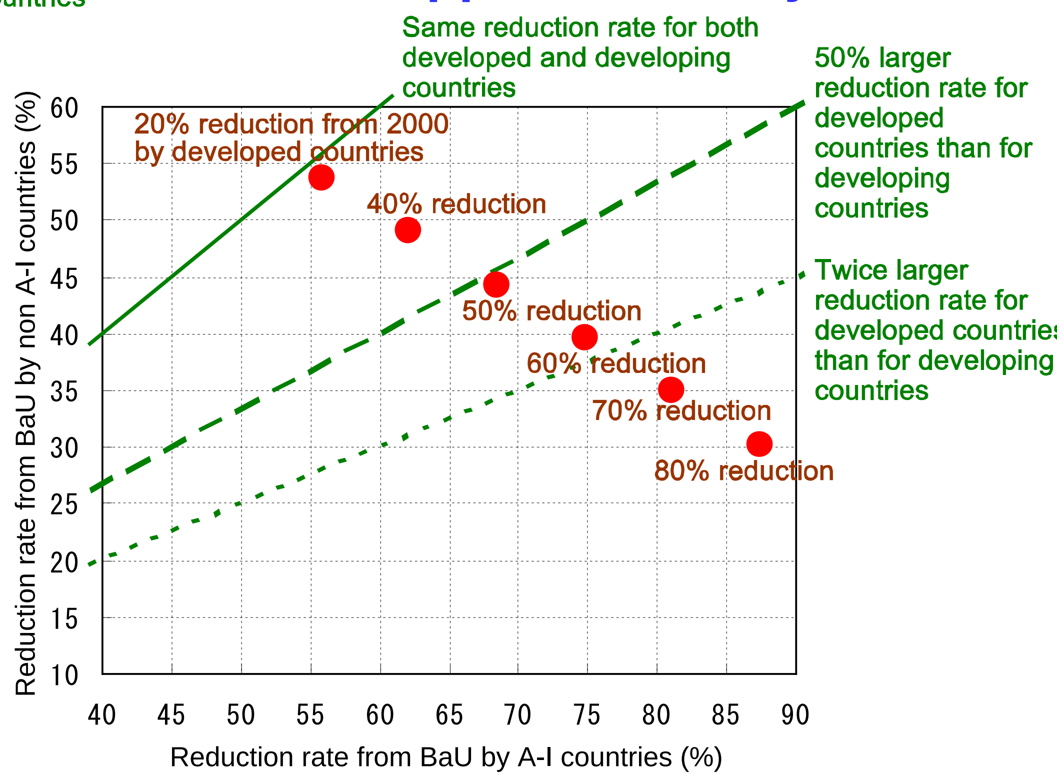
Reduction Rates for Developed and Developing Countries at each level of concentration stabilization

550 ppmv CO2 only

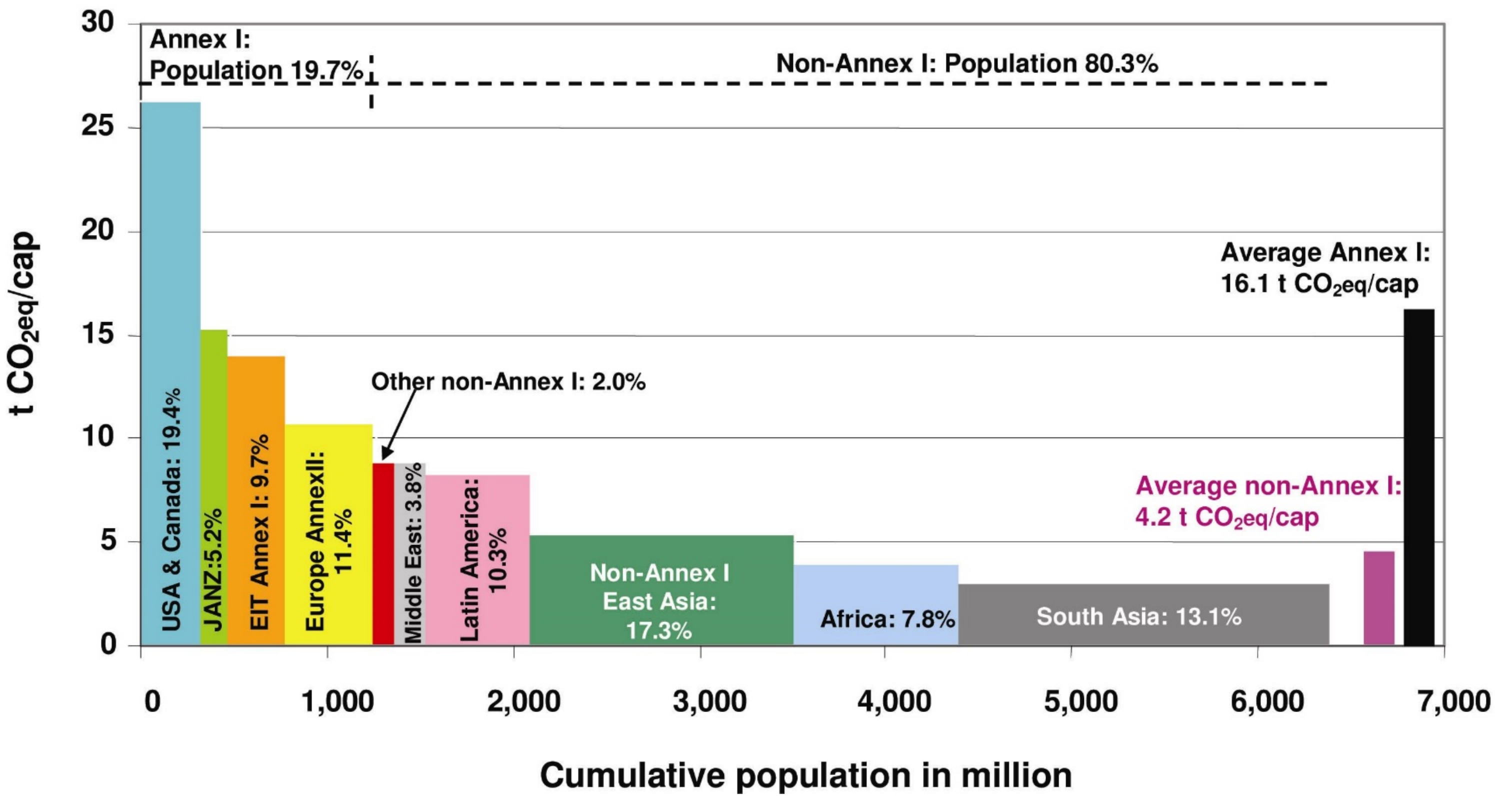


- This level may potentially lead to agreement including developing countries

450 ppmv CO2 only



Regional GHG Emissions per capita (2004)



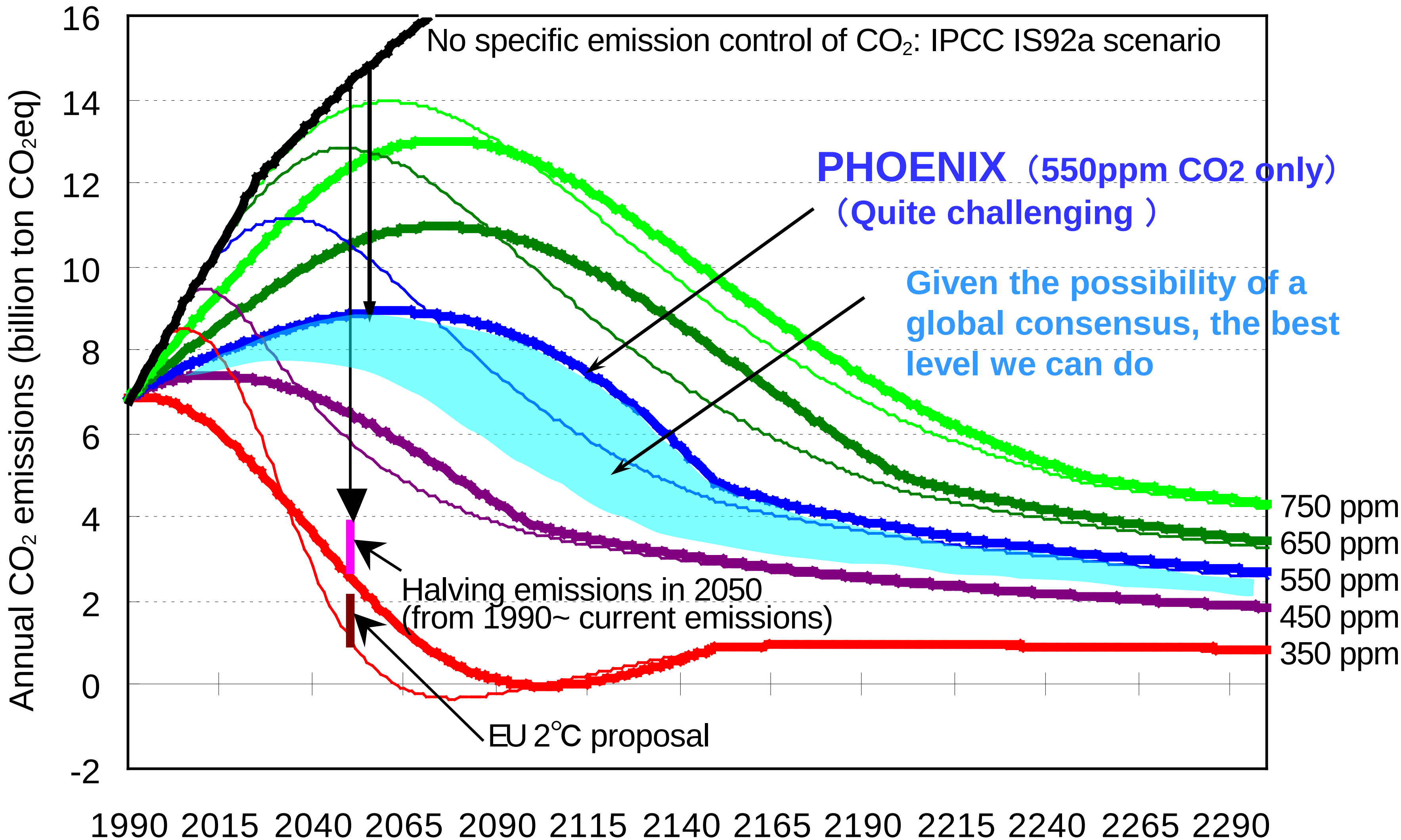
	Annex I	Non-Annex I
population	19.7%	80.3%
GHG emissions	48%	52%
Emissions per capita	16.1 tCO2eq./cap	4.2 tCO2eq./cap

source）IPCC WG3 AR4, SPM

What the 2050 Halving Target of AR4 Means

- Considering the 2050 halving target with the 2004 per capita GHG emissions by region in AR4 …
- If GHG emission is zero at all in Annex I countries, non-Annex I countries are also required to reduce emissions more than 2004 (CO_2 emissions from fossil fuel combustion; Annex I: Non-Annex I=0.55:0.45)
- If the world's population reaches 9.4 billions in 2050 (IPCC SRES B2), the global per capita GHG emissions would be required 2.2tCO_2eq. in 2050 to achieve the halving target, which is about half of the present emissions from Non-Annex I countries, about 1/8 from Annex I countries and less than the present emissions from Africa.

An Appropriate Stability Target of CO2 Concentration



Note）IPCC WG1 scenarios are shown in thick lines and WRE (Wigley, Richels, Edmonds) scenarios with thin lines

Summary

- **Major countries are required to agree on a long-term target for stabilization, so that long-term technological development, social systems change and implementation of short- and mid-term emission targets can be facilitated.**
- **EU and Japanese governments have no scientifically based long-term targets.**
- **The Stern Review should be considered not as a scientifically based but as a political report, by which EU (or UK government) attempted to justify the target.**
- **For RITE PHOENIX project, we worked on cost-benefit estimates of global warming effects and mitigation costs by concentration stability level and also derived the desired stabilization level, including value judgments.**
- **Our work shows that the desired stabilization level is around 550 ppmv CO2 only and there are no discrepancies between**

  IPCC AR4 and the results.
- **The target to halve the global emissions by 2050 will make the developing countries challenging to participate. The level should be limited at most 450 ppmv CO2 only.**
- **We should aim for a global agreement at around 550 ppmv CO2 only or CO2eq.**