Introduction of Top-down Research in Impact Analysis

National Institute for Environmental Studies, Japan

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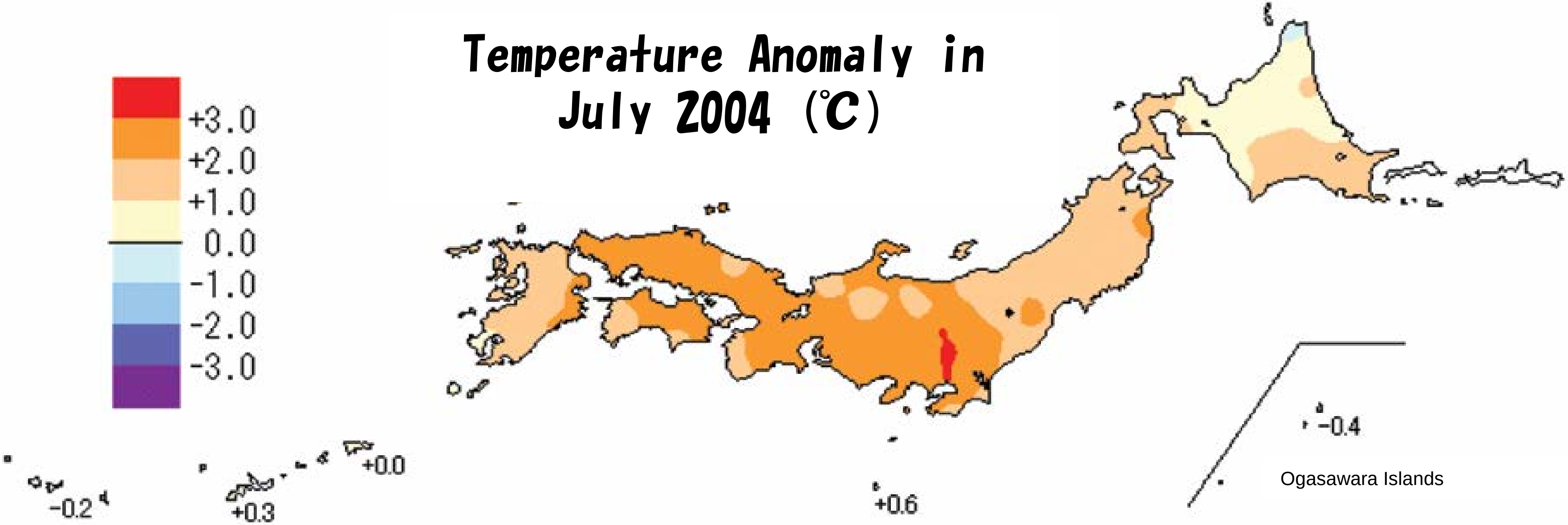
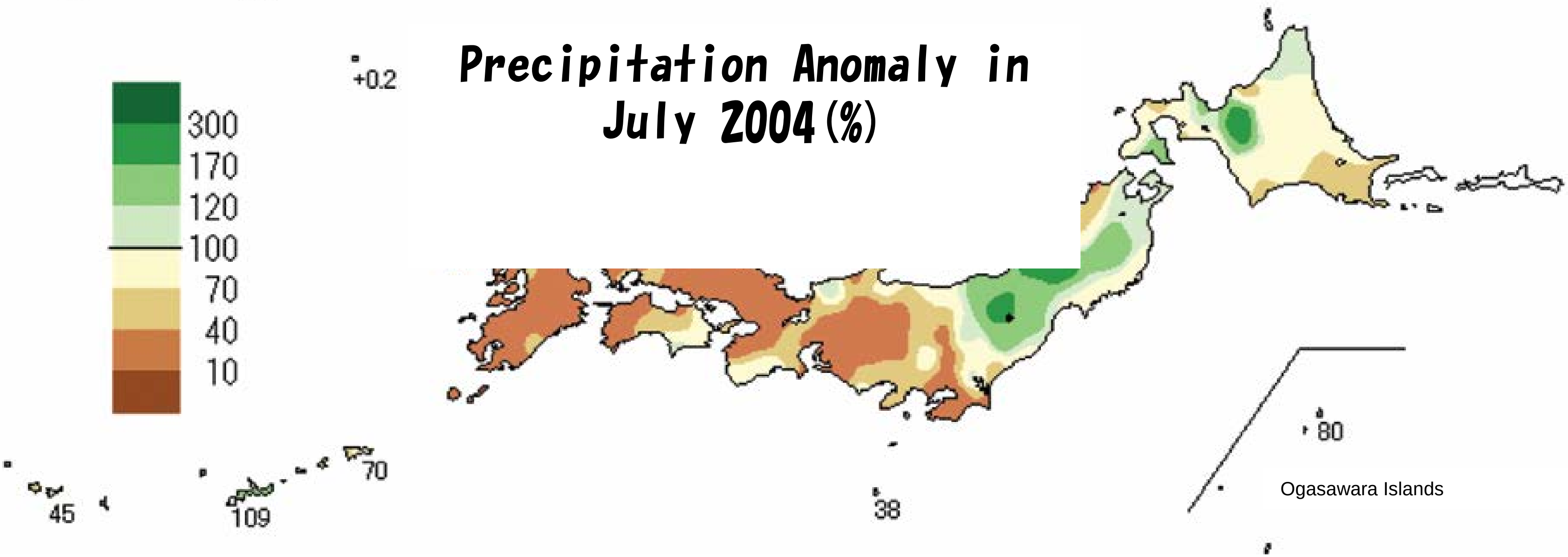
Temperature Anomaly in July 2004 (℃)



Precipitation Anomaly in July 2004 (%)



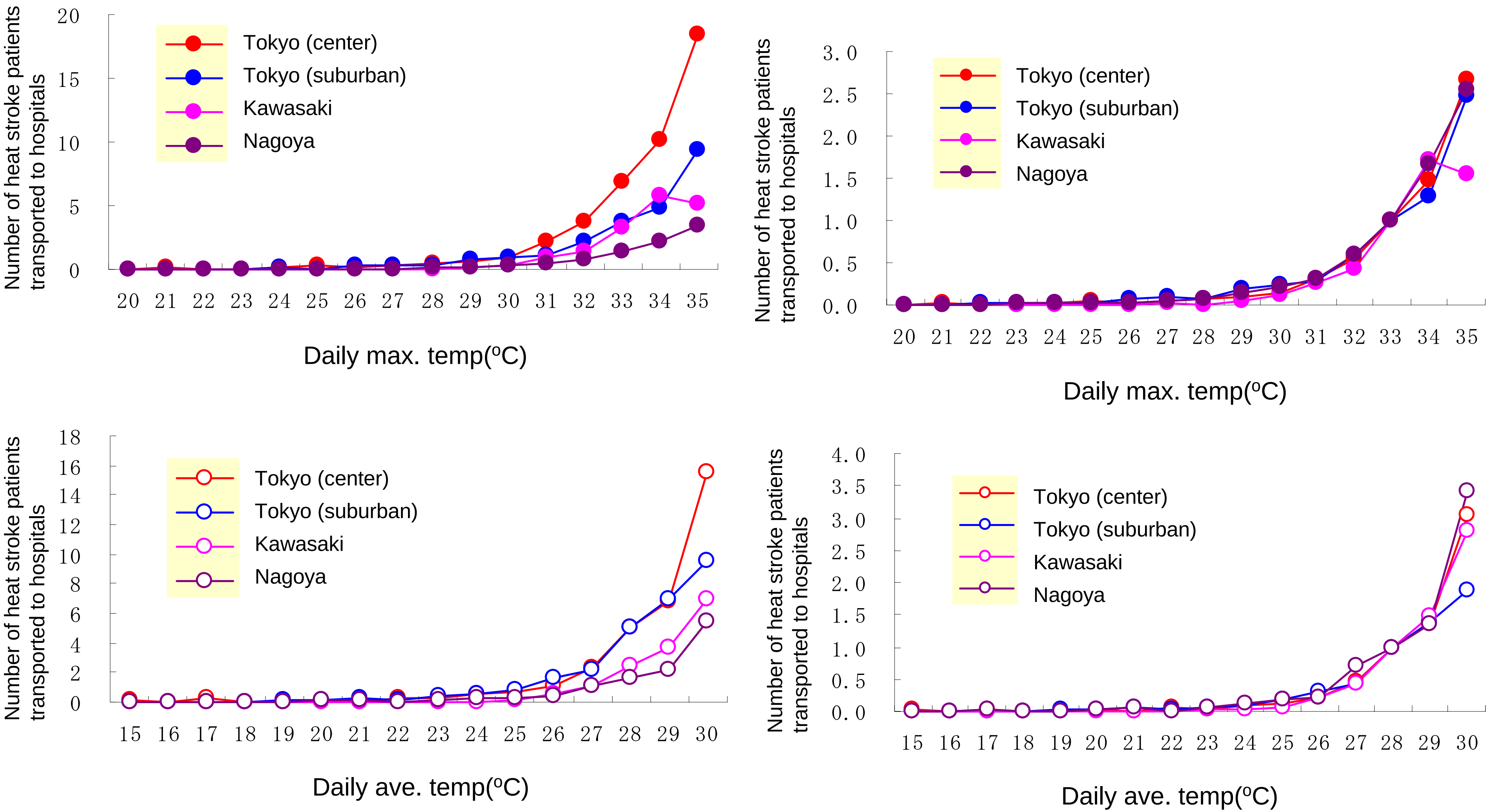
Japan Meteorological Agency

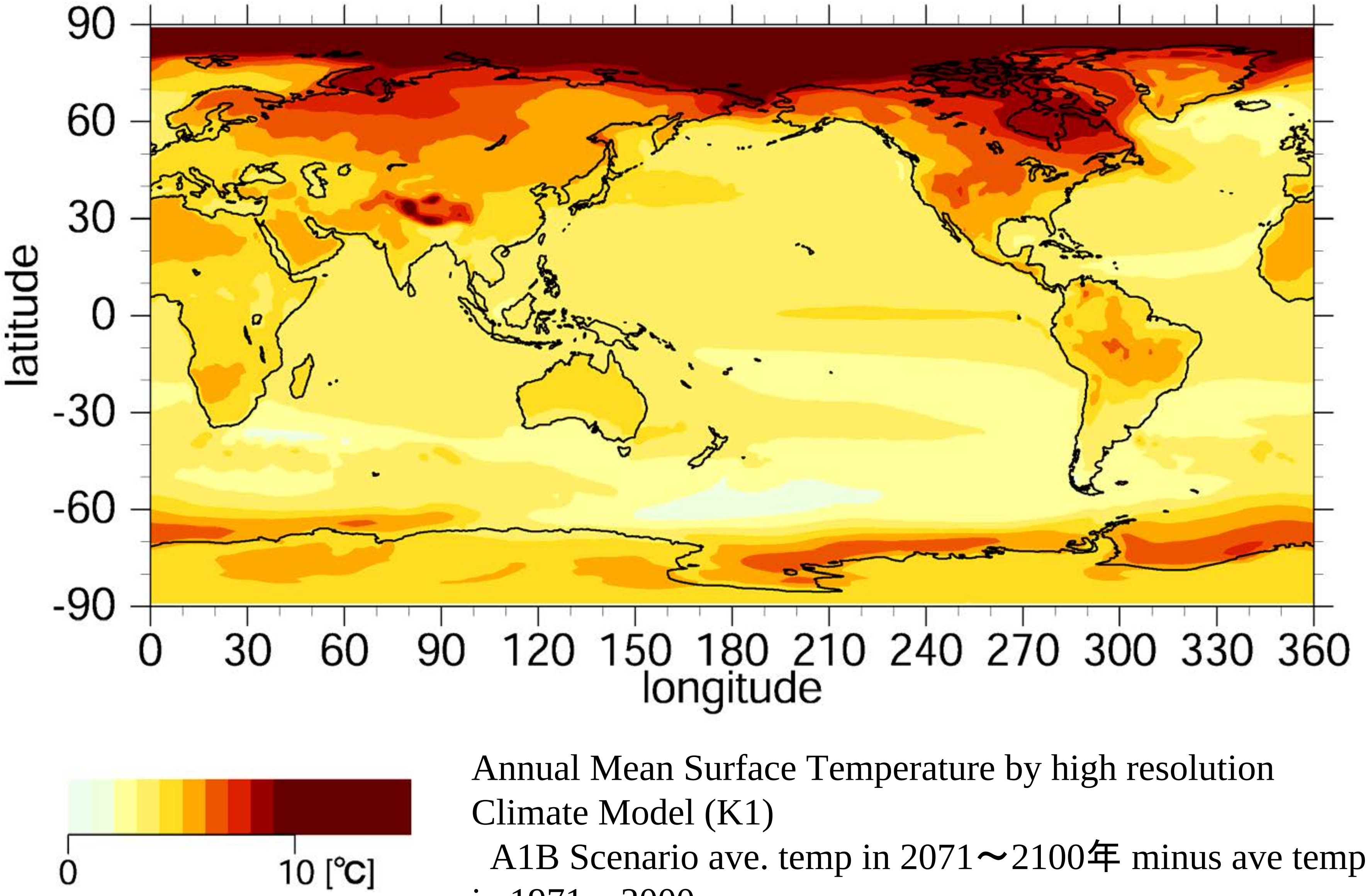
Number of Heat Stroke Patients transported to hospitals

（a）

Number of Heat Stroke Patients transported to hospitals

（b） Standalized

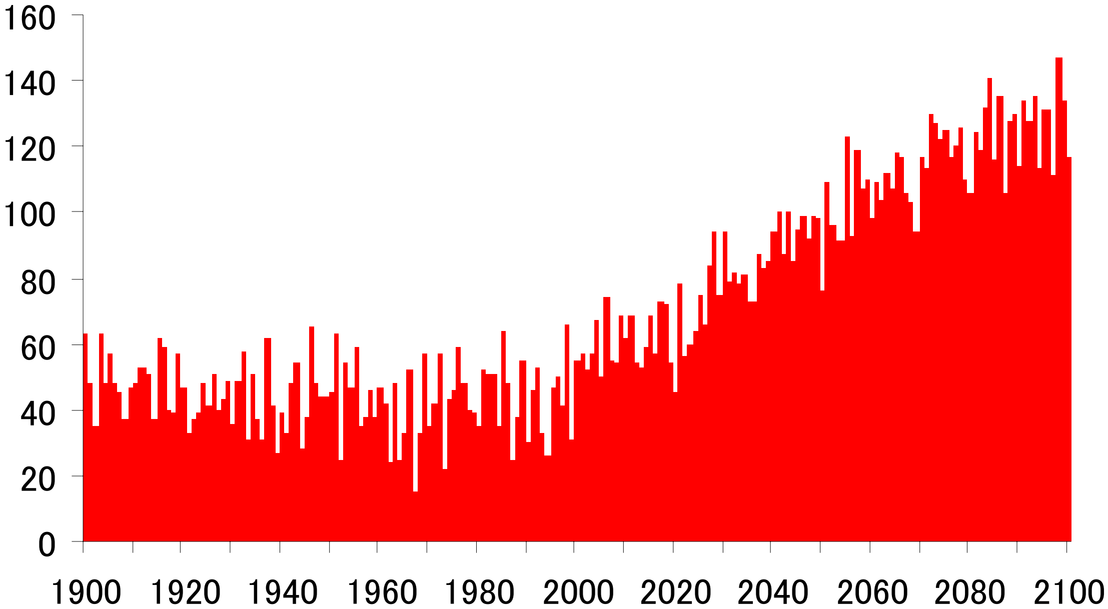




Annual Mean Surface Temperature by high resolution Climate Model (K1)

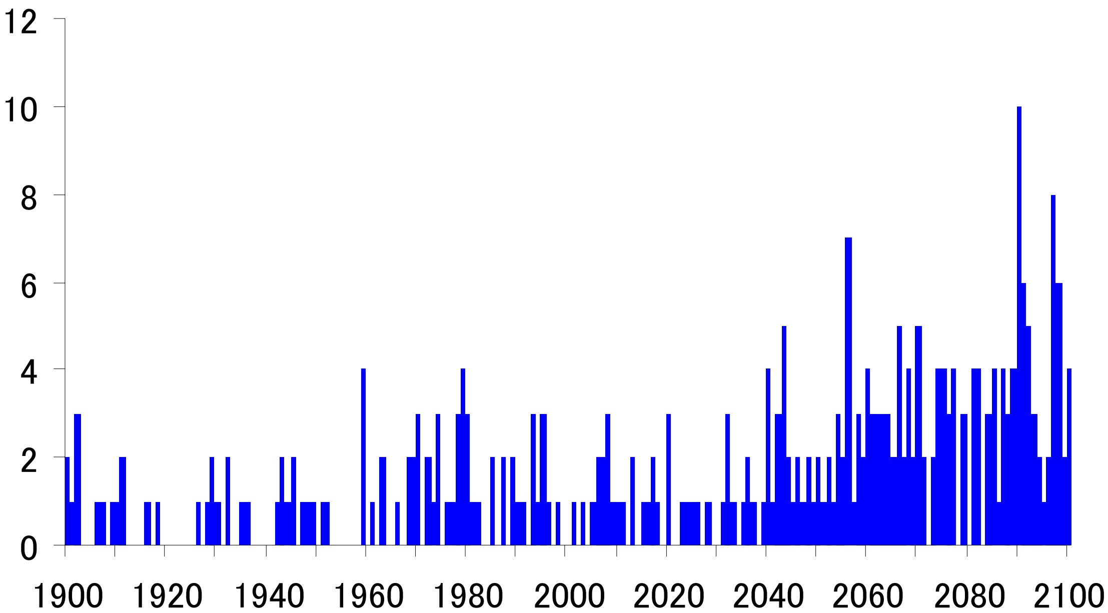
A1B Scenario ave. temp in 2071～2100年 minus ave temp. in 1971～2000

NIES/CCSR/JAMSTEC



Change in higher temperature days（1900〜2100）

Daily maximum temperature 30 ^{o}C without heat island effects



Change in summer heavy rain (June-August, 1990〜2100）

Daily precipitation is more than 100mm

NIES/CCSR/JAMSTEC

Avoiding Dangerous Climate Change

- 1 February 2005 – 3 February 2005
- Hadley Centre (Exeter, UK)
- HOST: DEFRA Dep. For Environment, Food and Rural Affairs
- about 200 participants from about 30 countries

The aim of the symposium was to advance scientific understanding of and encourage an international scientific debate on the long term implications of climate change, the relevance of stabilization goals, and options to reach such goals; and to encourage research on these issues.

Themes

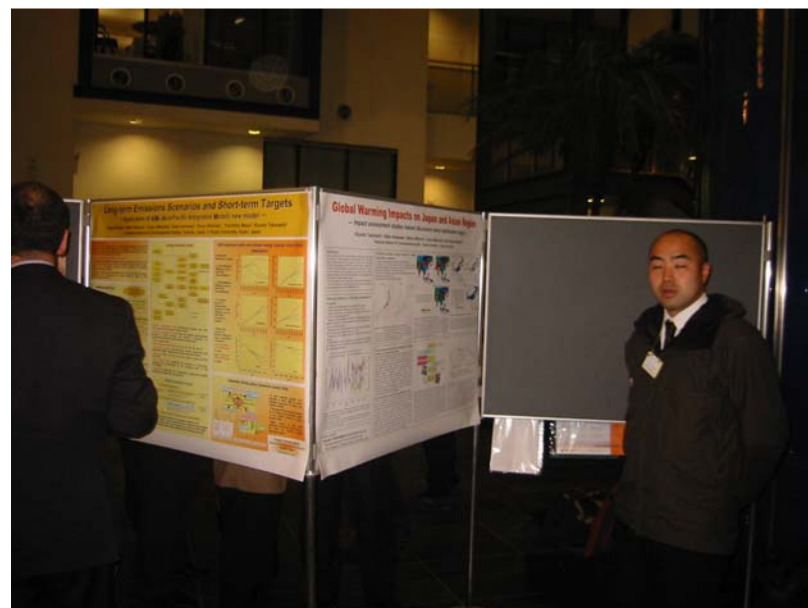
1. For different levels of climate change what are the key impacts, for different regions and sectors and for the world as a whole?

2. What would such levels of climate change imply in terms of greenhouse gas stabilization concentrations and emission pathways required to achieve such levels?

3. What options are there for achieving stabilization of greenhouse gases at different stabilization concentrations in the atmosphere, taking into account costs and uncertainties?


Met Office
Hadley
Centre


Long-term Emissions Scenarios and Short-term Targets


Long-term Emissions Scenarios and Short-term Targets
Global Warming Impacts on Japan and Asian Region

Assessment of Impacts

Compared with the TAR there is greater clarity and reduced uncertainty about the impacts of climate change across a wide range of systems, sectors and societies. In many cases the risks are more serious than previously thought. As noted in the TAR changes up to 1 ^oC may be beneficial for a few regions and sectors such as agriculture in mid to high latitudes. A number of new impacts were identified that are potentially disturbing.

One example is the recent change that is occurring in the **acidity of the ocean**. This is likely to reduce the capacity to remove CO_2 from the atmosphere and affect the entire marine food chain. A number of critical temperature levels and rates of change relative to pre-industrial times were noted. These vary for the globe, specific regions and sensitive ecosystems. For example **a regional increase above present of 2.7 ^oC (this would be associated with a global temperature rise of about 1.5 ^oC) may be a threshold that triggers melting of the Greenland ice-cap**, while an increase in global temperatures of about 1 ^oC is likely to lead to extensive coral bleaching. In general, surveys of the literature suggest increasing damage if the globe warms from about 1 to 3 ^oC. **Serious risk of large scale, irreversible system disruption, such as changes to the thermohaline circulation, reversal of the land carbon sink and possible destabilisation of the Antarctic ice sheets is more likely above 3 ^oC**. Such levels are well within the range of climate change projections for the century. In this context, some felt that it would be useful to agree upon a set of critical thresholds that we should aim not to cross. Others noted it would be difficult to objectively choose such a level.

The impacts of climate change are already being observed in a variety of sectors Ecosystems are already showing the effects of climate change. Changes to polar ice and glaciers and rainfall regimes have already occurred. While consistent with model projections the links to anthropogenic climate change need to be investigated further.

Many climate impacts, particularly the most damaging ones, will be associated with an increased frequency or intensity of extreme events. This is an important area for further work since many studies do not explicitly take into account the effects of extremes, although it is known that such extremes pose significant risks to human well being. The heat-wave that affected Europe in 2003 is a prime example.

Adaptive capacity is highly important to determining the potential future critical or dangerous effects of climate change. In some sectors and systems this capacity may be sufficient to delay or avoid much potential damage, though in others it is quite limited.
The capacity to adapt is closely related to how society develops with respect to technological ability, level of income and type of governance. Thus adaptation and choice of development pathways need to be taken into account in developing strategies to avoid dangerous anthropogenic climate change. This was seen particularly in the review of impacts in Africa.

Climate sensitivity and emission pathways

It is possible to decouple the issue of choice of levels from consideration of the question of what is dangerous. The conference thus explored the emission pathways associated with different greenhouse gas stabilization levels and different global temperature limits. It is helpful to take into account uncertainty in the sensitivity of the climate system to greenhouse forcing by presenting pathways in probabilistic terms. There is evidence that the sensitivity is now likely to be higher than quoted in the TAR, however further observations may constrain the range.

There are a range of emission pathways that could be followed theoretically to avoid different temperature levels. Probability analysis provides a quantitative estimate of the risk that a particular temperature level would not be exceeded. For example, **limiting warming to a 2 ^{o}C increase with a relatively high certainty requires the equivalent concentration of CO_2 to stay below 400 ppm**. Conversely if less certainty was required concentrations could rise to 550 ppm equivalent. In many cases this would mean that concentrations would peak before stabilising, though whether this could be achieved practically was not considered.

Different models suggest that delaying action would require greater action later for the same temperature target and that even a delay of 5 years could be significant. If action to reduce emissions is delayed by 20 years, rates of emission reduction may need to be 3 to 7 times greater to meet the same temperature target.

Technological options

The IEA World Energy Outlook 2004 predicts that CO_2 emissions will increase by 63% over 2002 levels by 2030. This is generally consistent with the IPCC emission scenarios, published in 2000. This means that the world will, in the absence of urgent and strenuous mitigation actions in the next 20 years, almost certainly be committed to a temperature rise of between about 0.5 ^oC and 2 ^oC by 2050. Such changes will require significant investment in energy infrastructure, which will have a lifetime of several decades.

Technological options for reducing emissions over the long term already exist and significant reductions can be attained, using a portfolio of options and the costs are likely to be smaller than previously considered. Sustainable development strategies and make low-level stabilization easier. There are no magic bullets; a portfolio of options is needed and excluding any options will increase costs; multi-gas strategies, emission trading, optimal timing and strong technology development, diffusion and trading are all required to keep costs of low-level stabilization relatively low. Conceptually, the challenges could be broken down into discrete wedges, covering for example energy efficiency, nuclear energy and carbon capture and storage. Limiting climate change to 2 deg C implies stabilizing the atmospheric concentration of all greenhouse gases.

The CO_2 concentration must not exceed 500ppmv, if the climate sensitivity is 2.5 ^oC. Global emissions would need to peak in 2020 and decline to 3.1 GtC/year by 2095. Inclusion of technological learning in models reduces emission the projected costs of reductions by over half.

Globalization and market forces will drive the developing countries to follow the same pattern practiced by the developed countries. However energy efficiency improvements under the present market system are not enough to offset increases in demand caused by economic growth. Efficiency improvements and alternatives of supplies such as nuclear and renewables are of priority for developing country to join the effort of stabilization.

Table 1a: Impacts of level of temperature change on Ecosystems

Temp-erature rise above prein-dustrial	Year in which this occurs	Population scenario	Impacts to unique and threatened ecosystems	Region affected	Source
			OBSERVED CHANGE		
0.6	2004		143 studies of 1473 species showed that of the 587 species which showed changes in phenology (e.g. timing of leaf bud), distribution, abundance, morphology, or genetic frequencies, the change in 82% of these is in direction consistent with response to climate change	All regions	Parmesan and Yohe 2003
0.6	1965-2004		Loss grassland & acacia, loss flora/fauna, shifting sands (not attributed)	Sahel	ECF 2004
0.6	2004		Northward migration plants; disappearance of species from S Europe	Europe	EEA 2004
0.6	2004		Spring phenology advanced by 5 days	All regions	Root et al 2003
0.6	2004		Growing season lengthened 11 days	Europe	IPCC 2001
0.6	2004		3 to 4C winter temperature rise	Alaska/Canada	ACIA 2004
0.6	2004		Major reorganisation of plankton ecosystems: Change in plankton distribution; increasing phytoplankton biomass; extension of the seasonal growth period; N shift of	North Sea	EEA 2004; Richardson and Schoeman 2004

New Strategic Impacts Research Project

- 2004FY – 5 years
- Funded by Ministry of Environment
- Project Leader: Prof. Mimura (Ibaraki Univ.) and TSU (NIES)
- Research Areas: Japan, Asia and Globe
- Top-down and Bottom-up Research

(1)Emission - Stabilization – Temp. – Impacts (AIM/Impact Group)
- AIM/Impact[Policy]
- Climate Scenarios, Socio-economic Scenarios
- Impact Function

(2)Sector impacts in Japan
- Water Resources (Tohoku Univ.)
- Human Health (NIES and National Infectious Disease Institute)
- Agriculture and Food security (National Institute for Agro-Environ. Sciences)
- Forest and Ecosystem (Forest and Forest Product Research Institute)
- Coastal Region (Ibaraki Univ.)
- Economic assessment (Tohoku Univ. and Meijo Univ.)

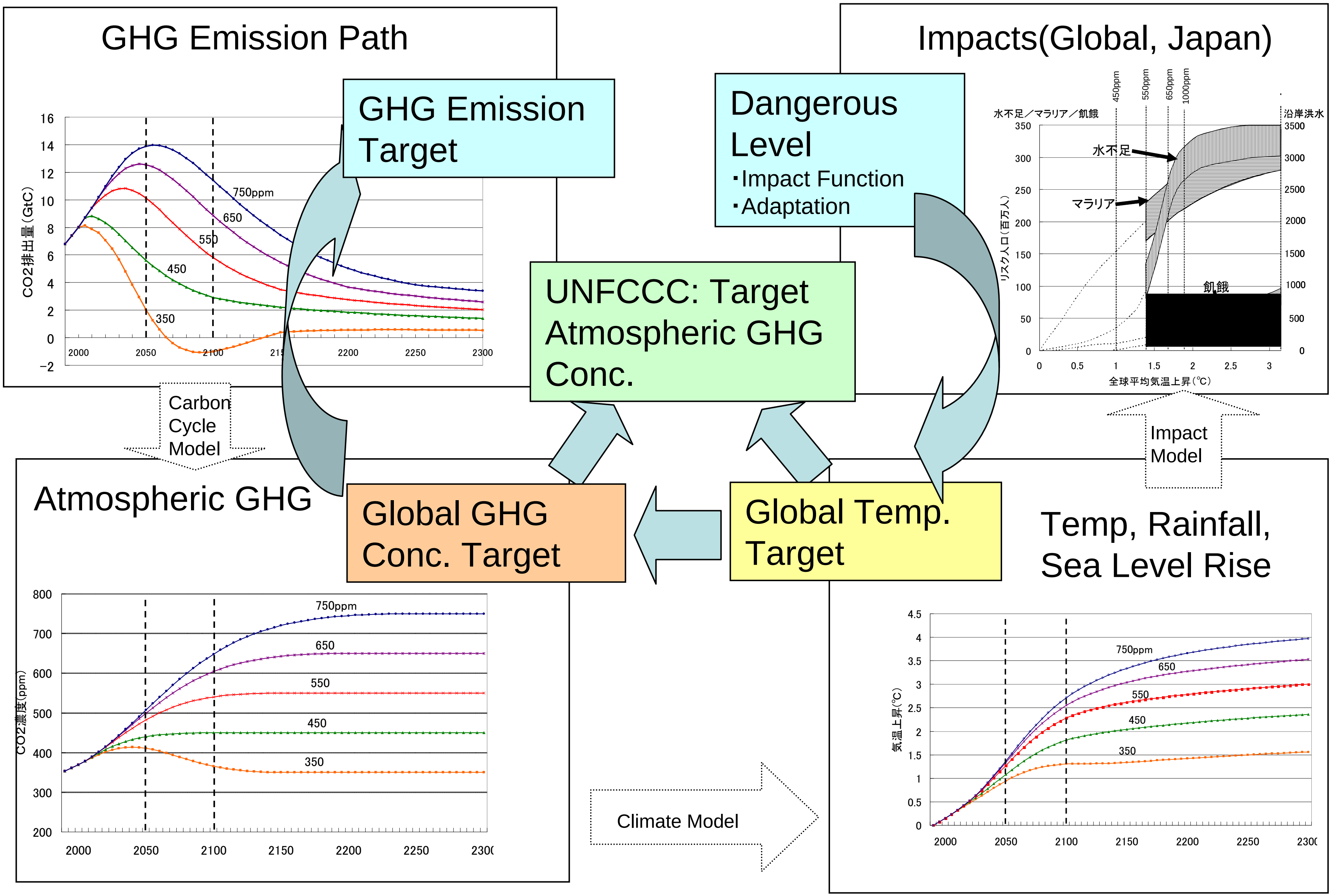
Research Purpose

- Development of AIM/Impact[Policy]
  -Stabilization, Impacts, Emission Path

- Criteria for Evaluation of Stabilization Target
  - Definition of “Dangerous level” from the view points of Equity, Precautionary Principle, and Uncertainties

- Assessment of Stabilization Target, Emission Target
  - Application of AIM/Impact[Policy]

Dangerous Level, GHG/Temp. Target, GHG Emission Path



Dangerous Level of Global Warming

	Human Activity
	↓
GHG emission	Emission Threshold（CL-Emission）
	↓
Atmosphere	**Atmospheric GHG Threshold(CL-GHG)**
	↓
Temp. Increase	Temp. Increase Threshold(CL-Temp)
	↓
Climate Change/ Sealevel rise	Climate Change Threshold(CL-CC、CL-SLR)
	↓
Impacts	**Impact Threshold(CL-Impact)**
	↓
	Mitigation and Adaptation

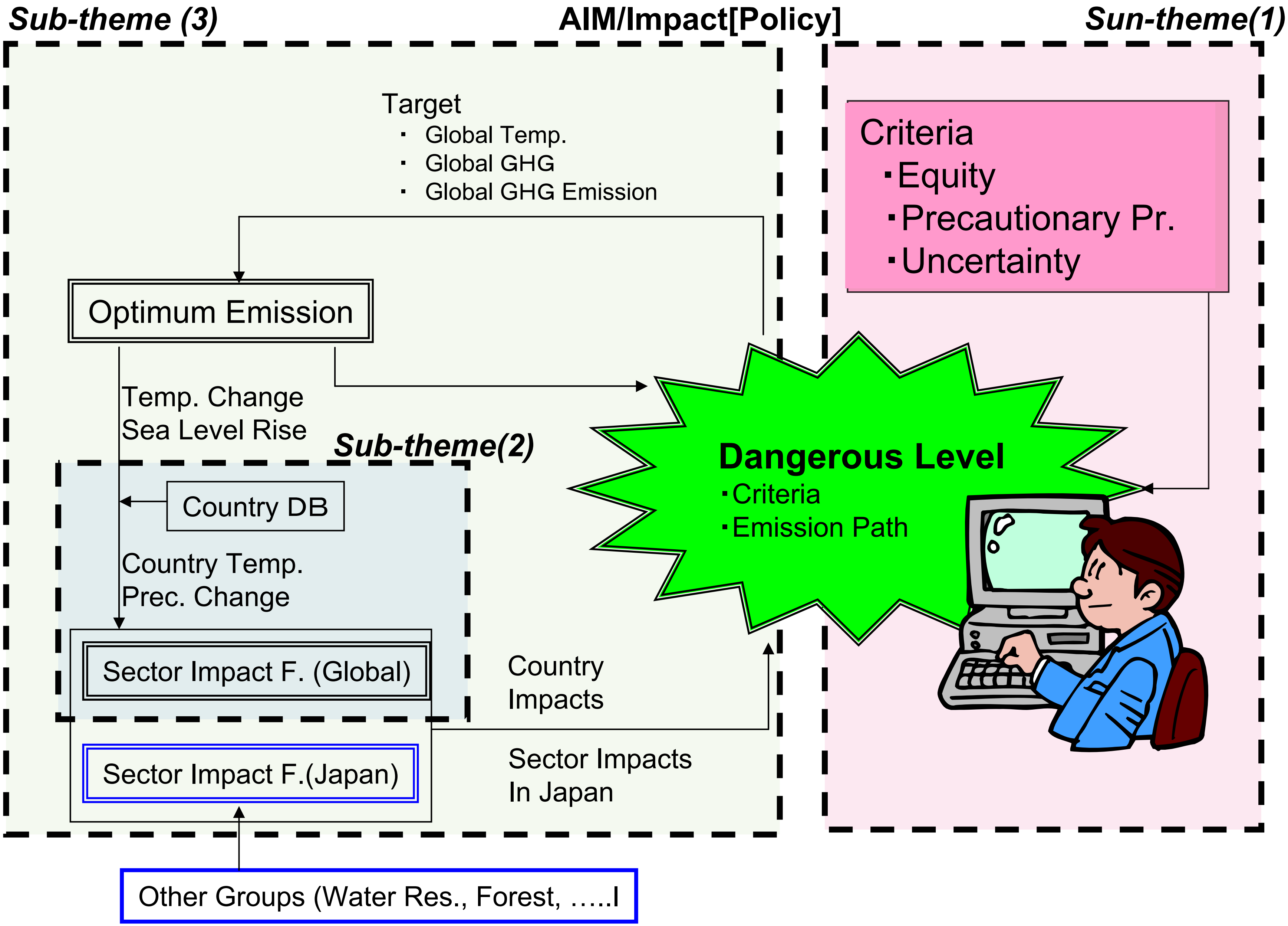
Critical limit, CL or threshold can be defined in the respective step

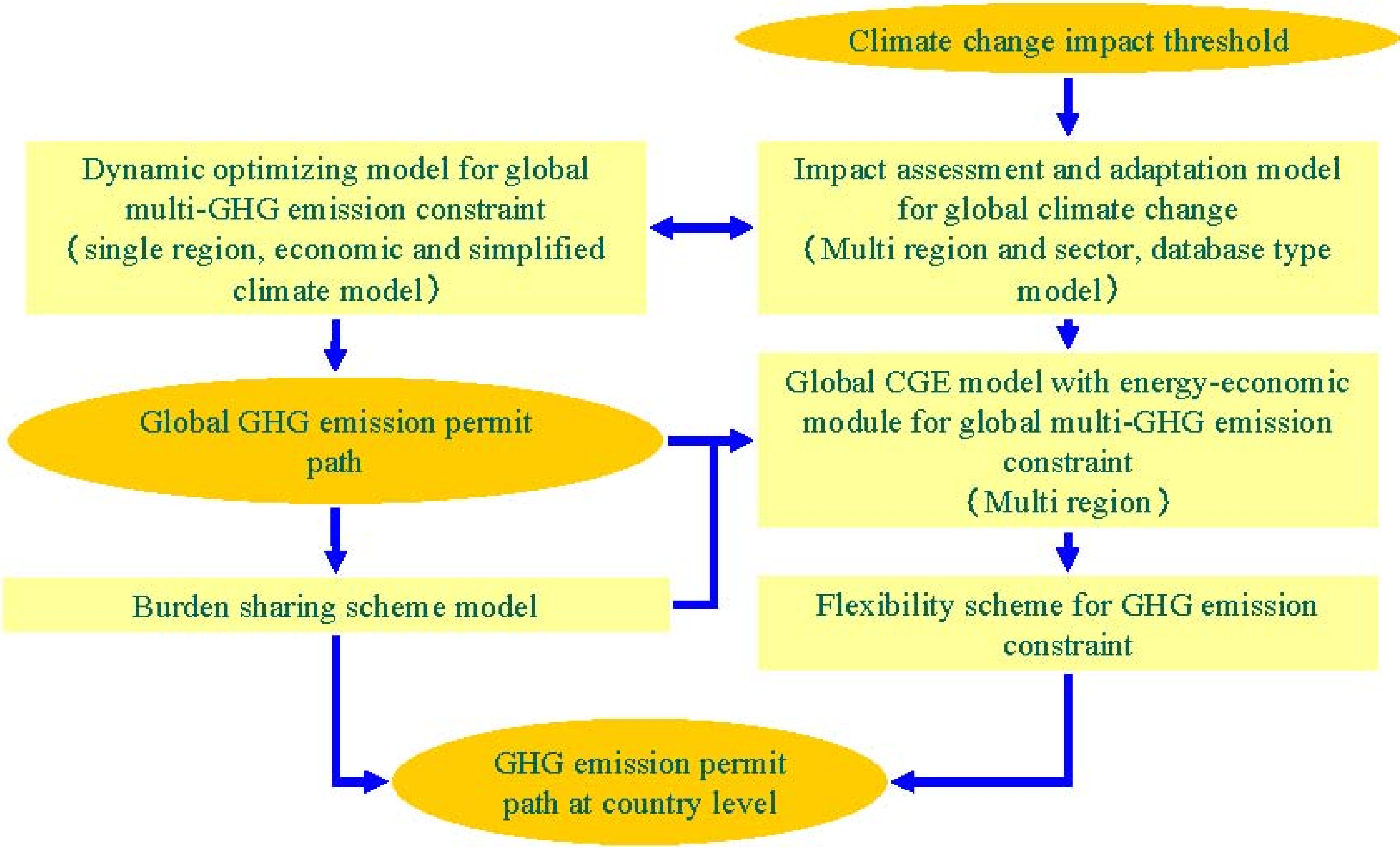
Prof. Mimura (Ibaraki University)

Vulnerable Sector	Exposure System	Threshold
Ecosystem	Plants in high mountain Mangrove	Apparent effects for 2°C increase Cannot survive for 45cm SLR
Agriculture	Rice	Heat effect by over 35°C during flowering
Marine Ecosystem	Coral reef	Bleaching by 1-2°C increase in water temperature
Coastal Zone	Sandy beach Port and coastal structure	Erosion of 56.6% and 90.3% of sandy beaches by 30cm and 1.0m SLR 100 billion US$ for countermeasures against 1m sea-level rise
Human Health	Elder people	Increase of mortality rate for over 33-35°C of daily high temp(regional dependence)
Economy	Nations Electricity	Negative effects for 2-3°C increase Demand increase of 5000MW for 1°C increase in summer

Table Identified threshold from Impact and Vulnerability studies in Japan (CSTP, 2004)

Framework of New Top-down Impact Research

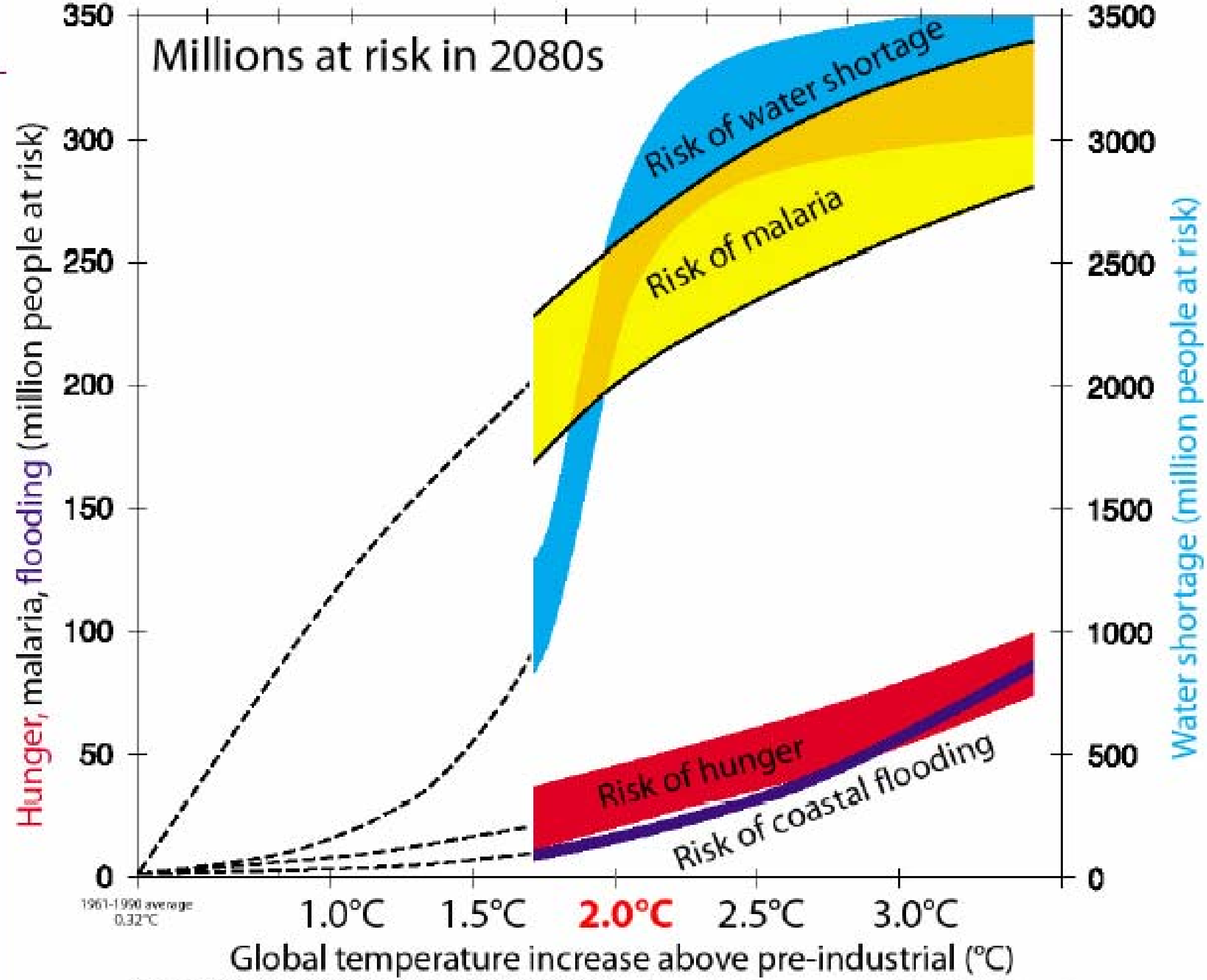


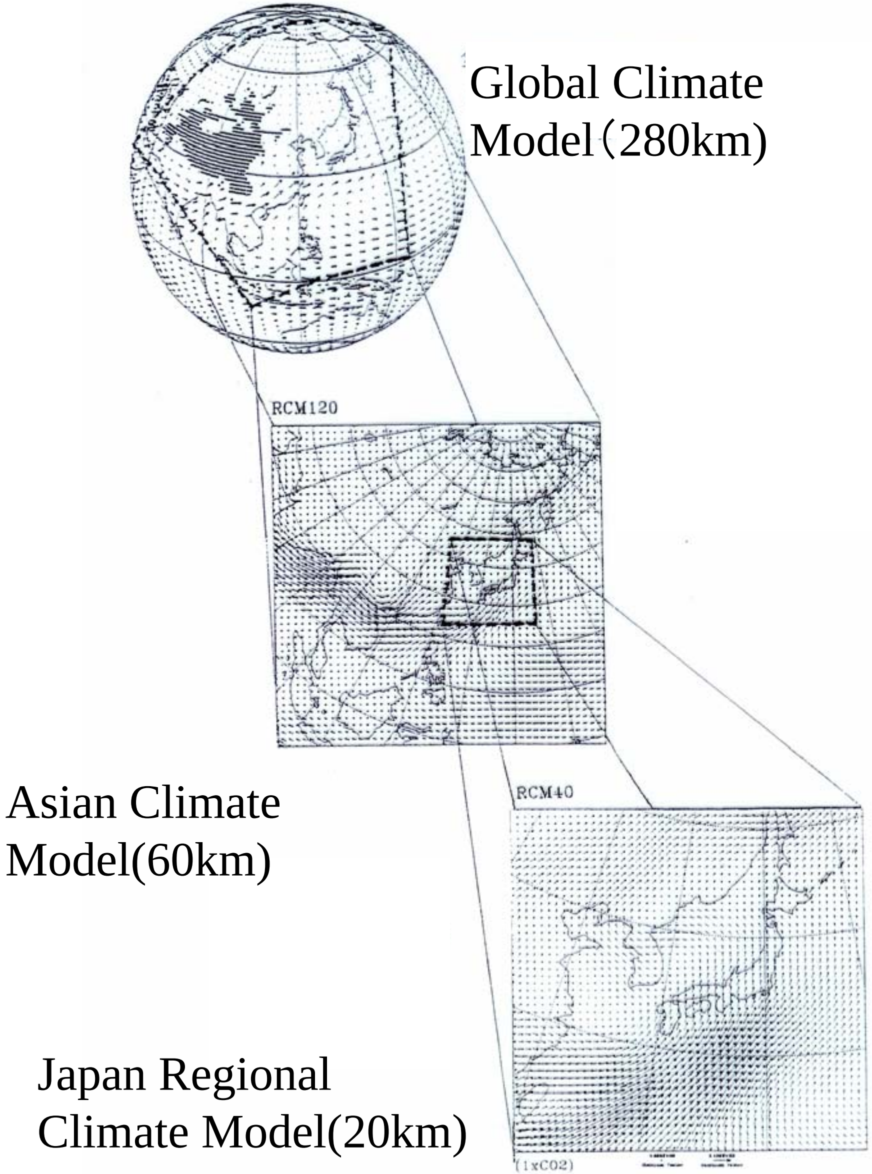


AIM/Impact[Policy] Framework

POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

Millions at Risk (Parry et al., 2001)



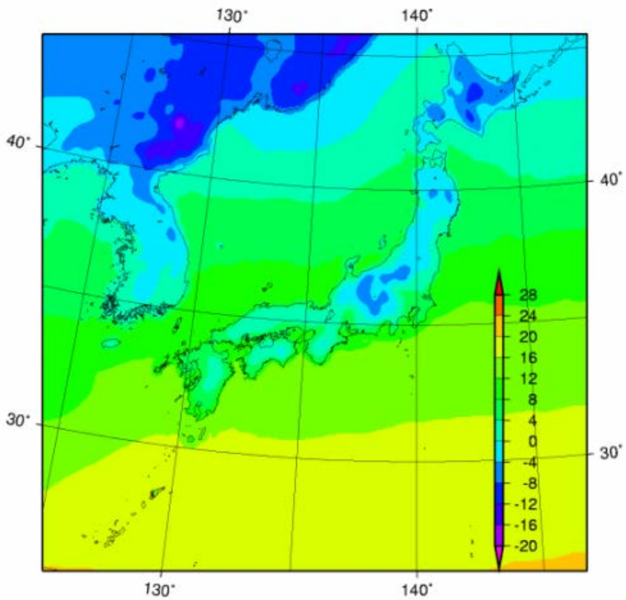


Regional Climate Model

To predict future regional climate change in spatially high resolution

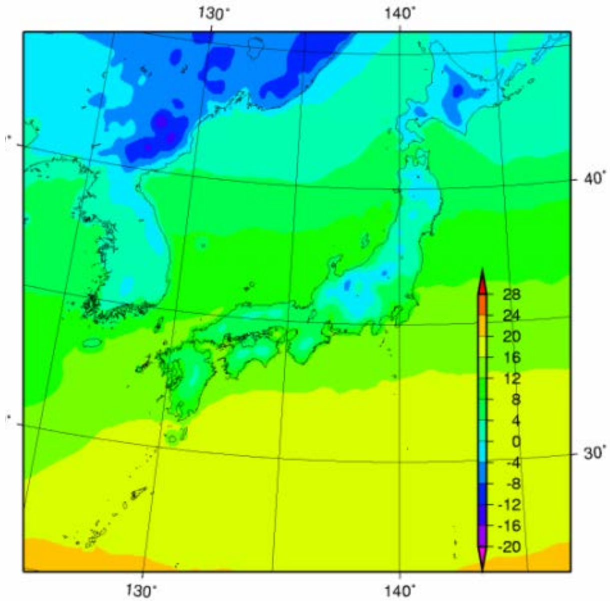
Nesting

To use GCM output as boundary conditions for regional Climate Model



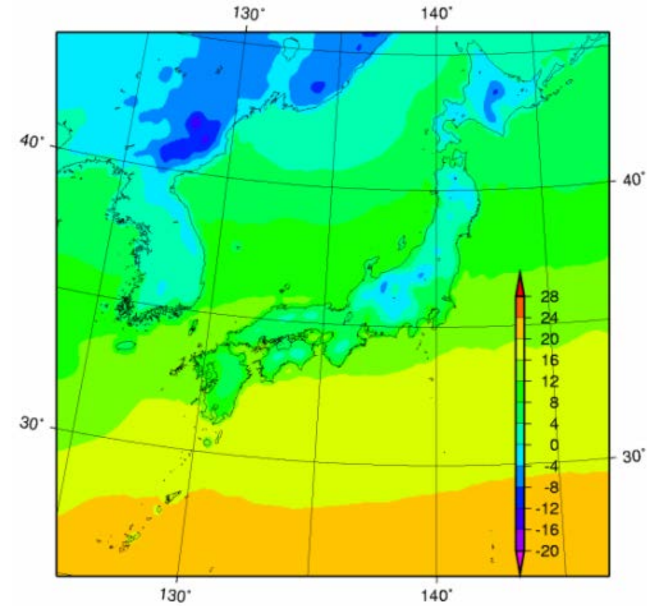
Present

（1981～2000 Ave.）



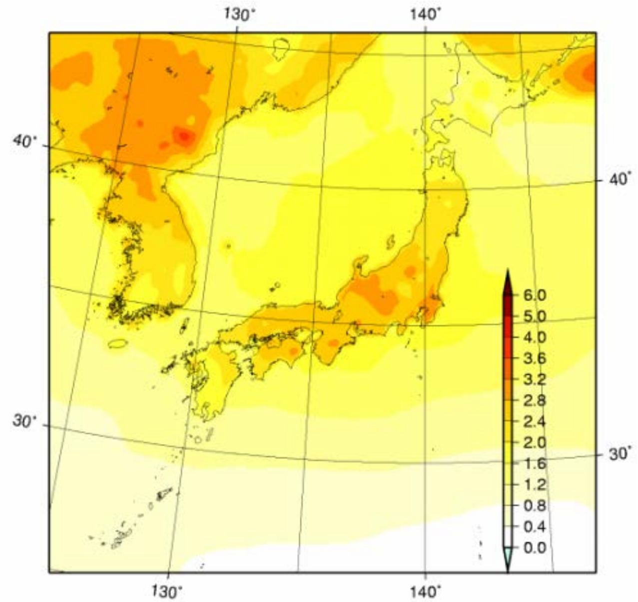
50 years

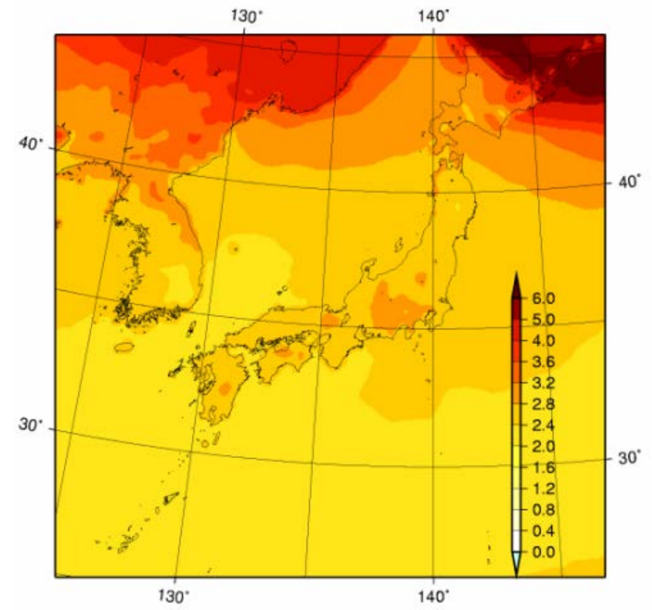
（2031～2050 Ave.）



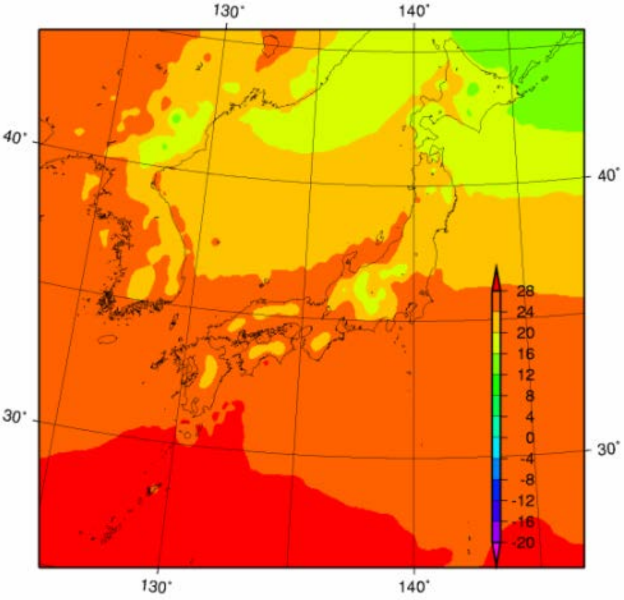
100 years

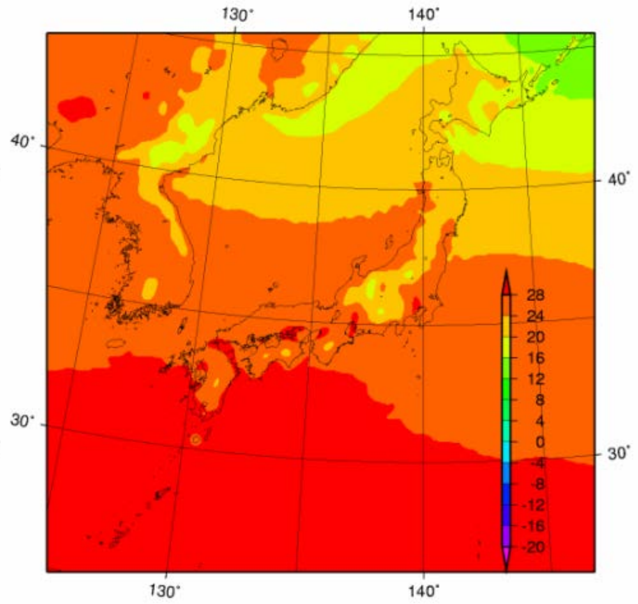
（2081～2100 Ave.）

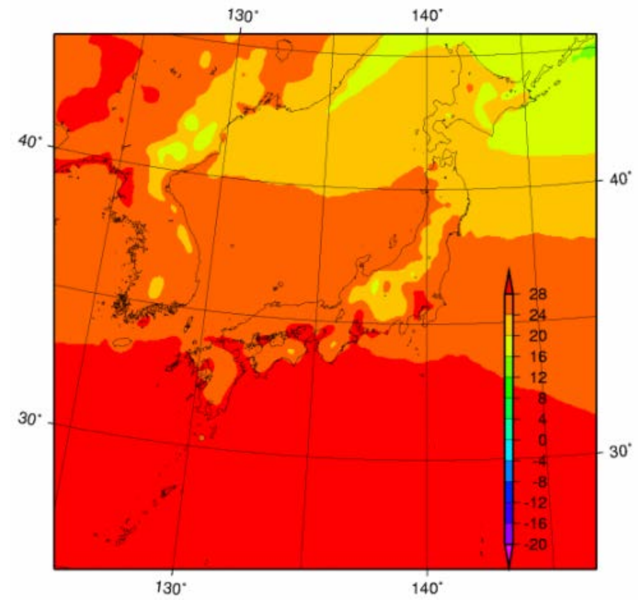




Predicted Average Temperature in January







Present

(1981〜2000 Ave.)

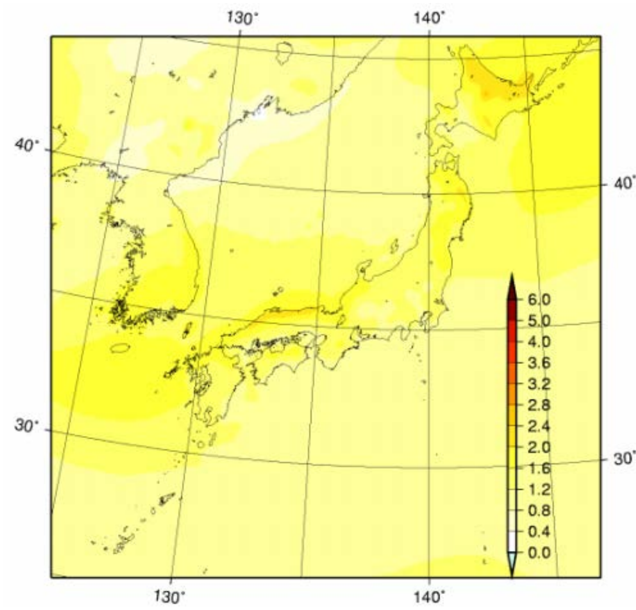
50 years

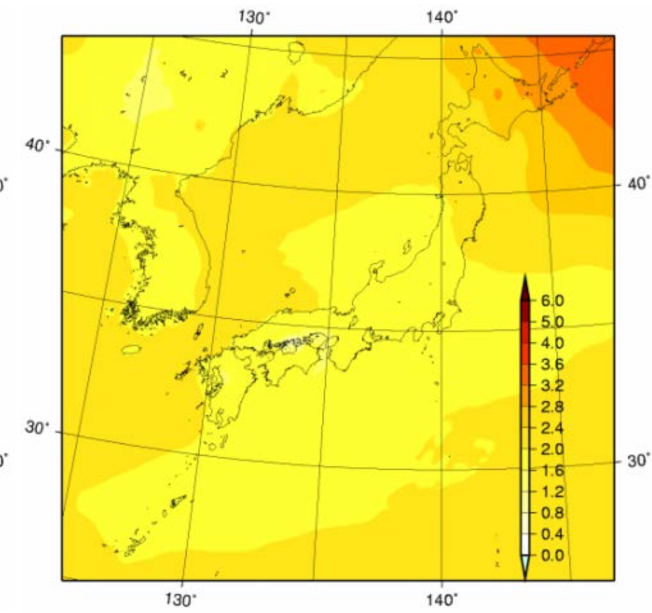
(2031〜2050 Ave.)

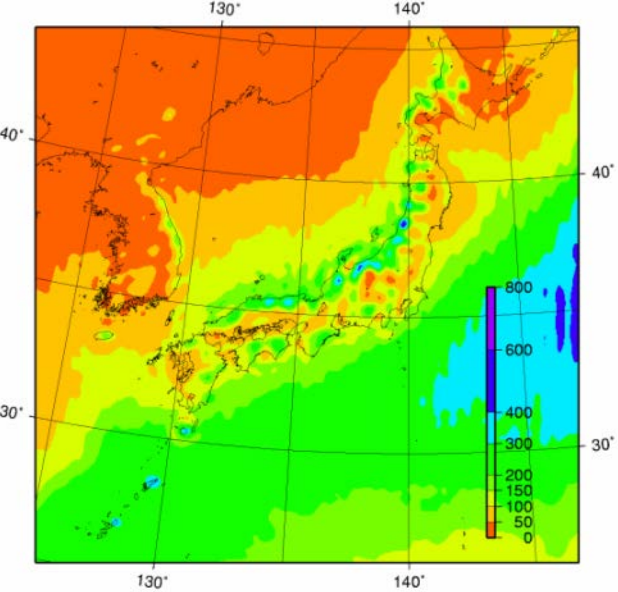
100 years

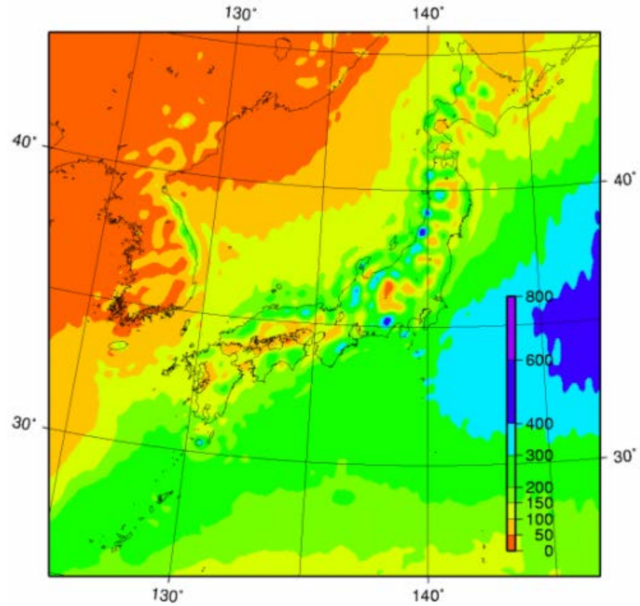
(2081〜2100 Ave.)

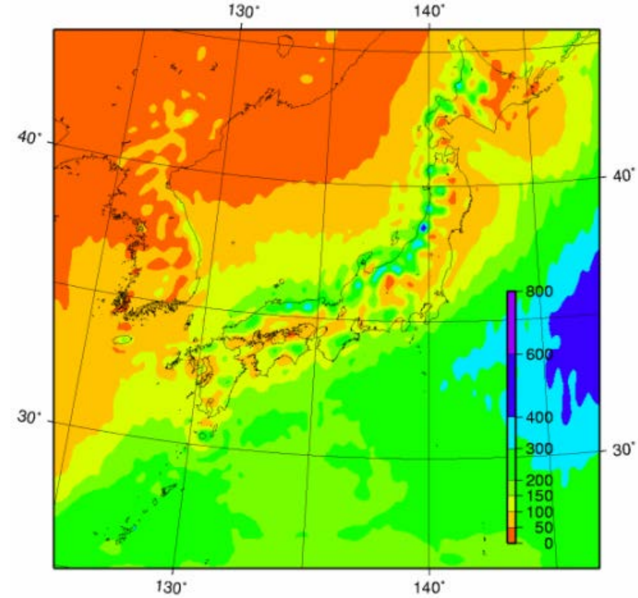
Predicted Average Temperature in July











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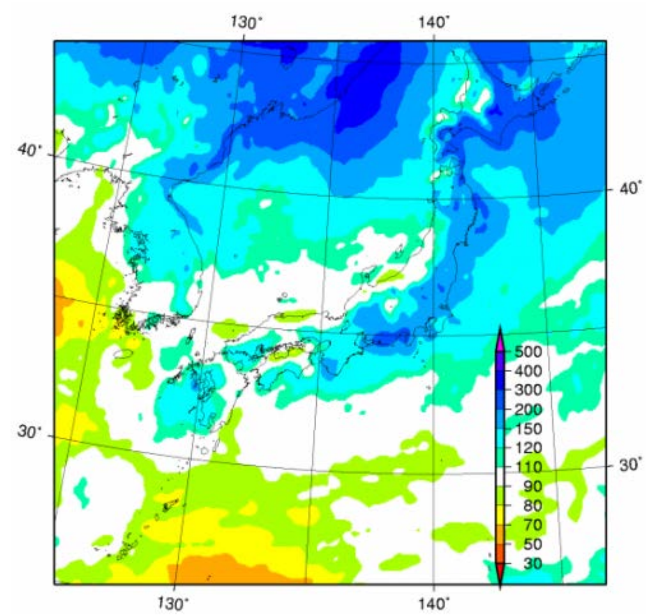
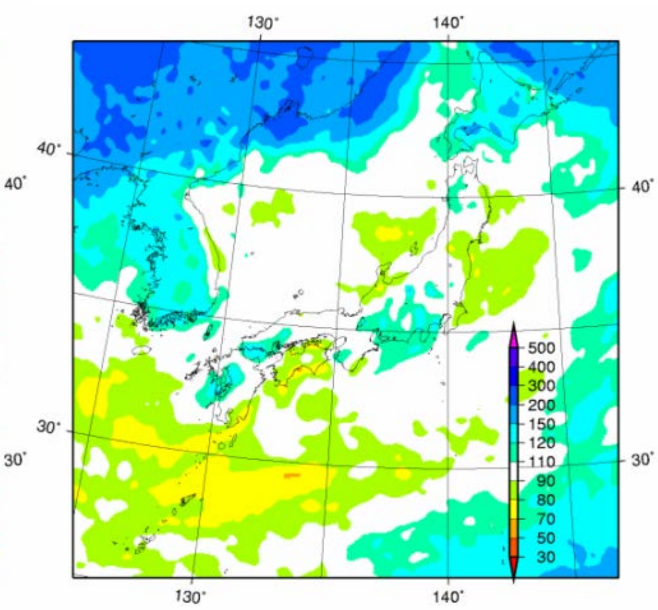
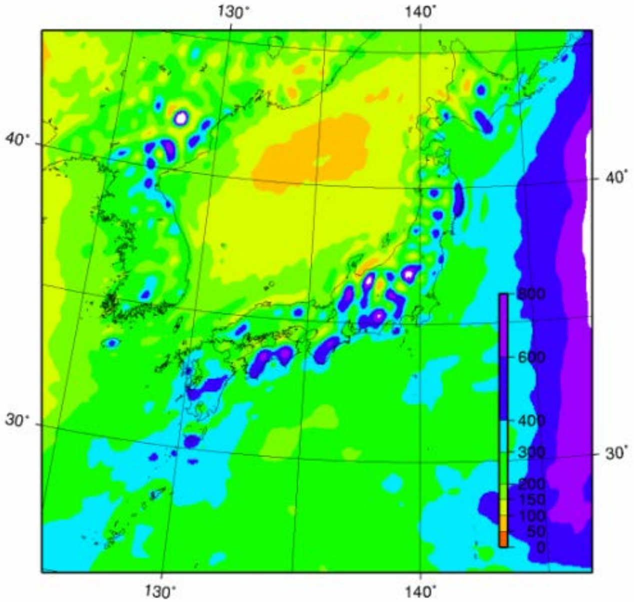


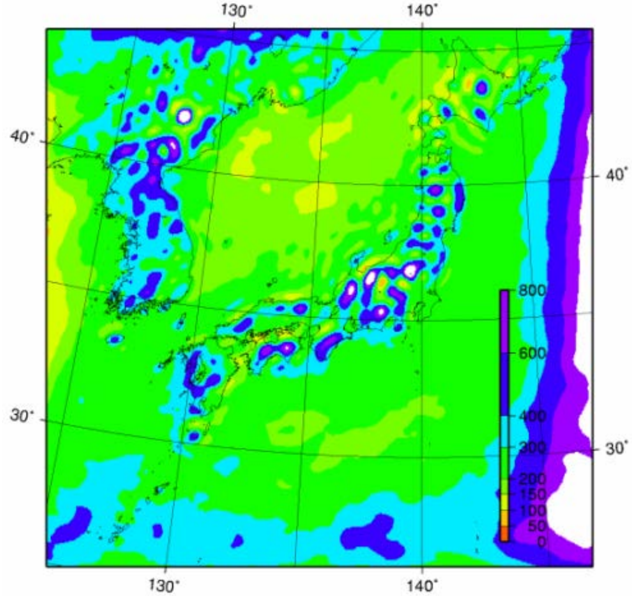


Predicted Average Precipitation in January



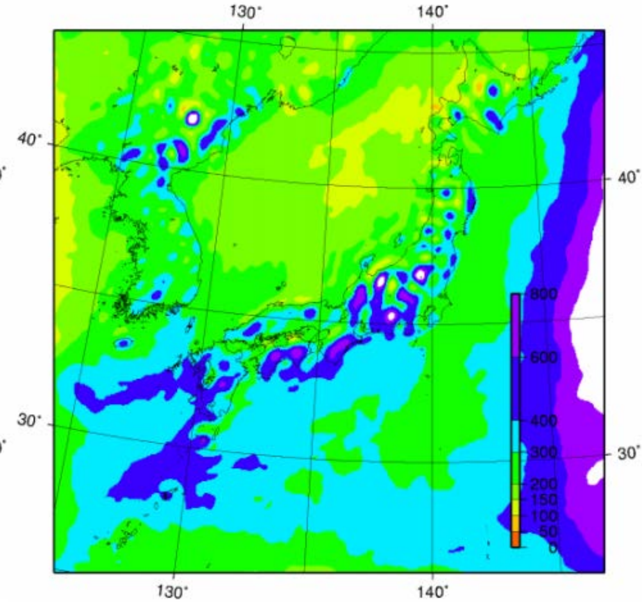
Present

（1981～2000 Ave.）



50 years

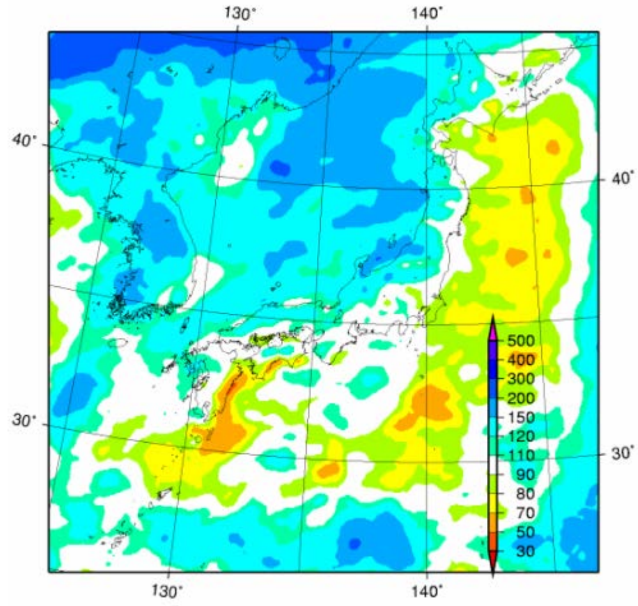
（2031～2050 Ave.）

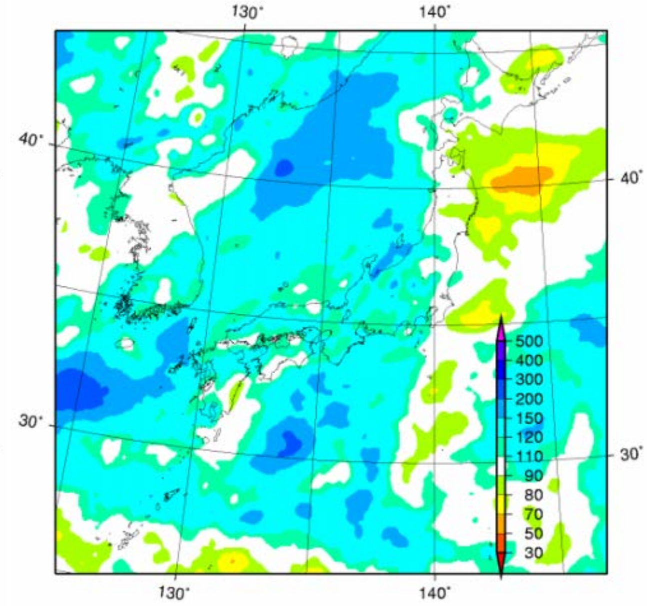


100 years

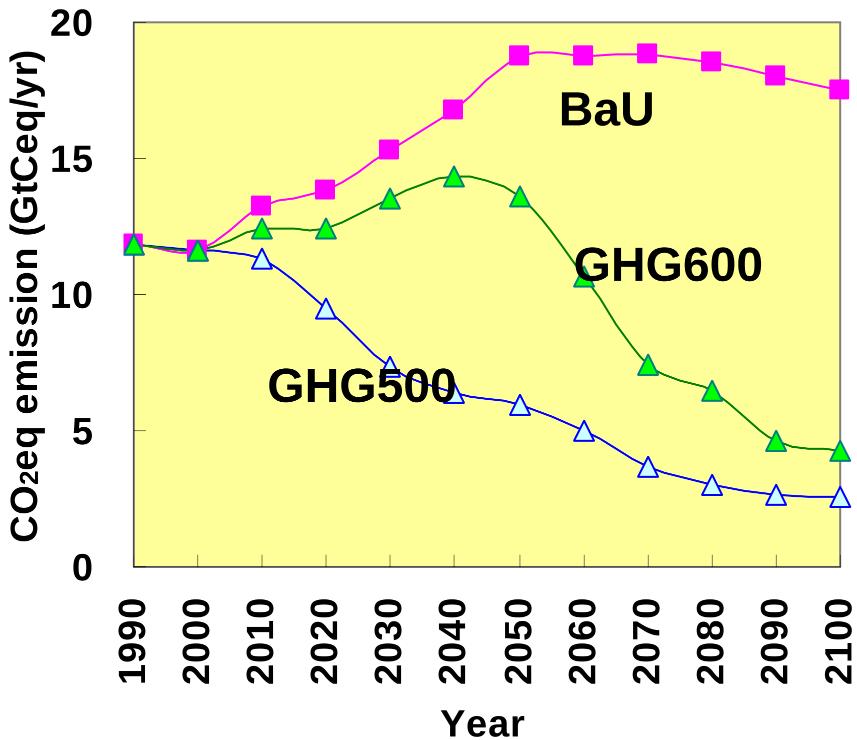
（2081～2100 Ave.）

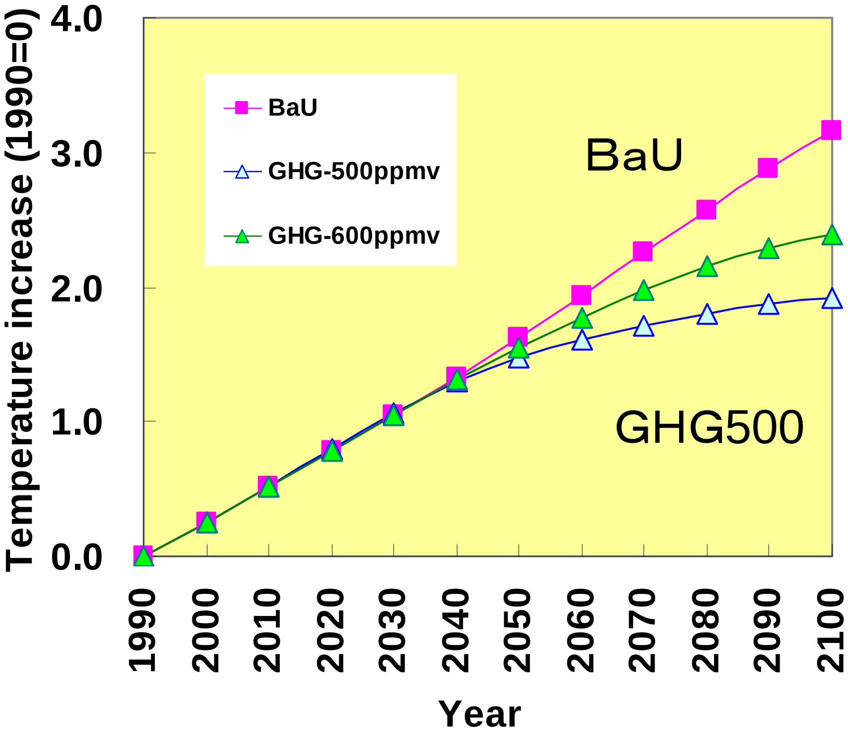
Predicted Average Precipitation in July





危険なレベルを超えないための道筋の範囲:
GHG 500ppmあたりを目標に早期の削減が必要
（AIMによる計算結果。気候感度2.5度、社会厚生関数最大化、時間選好率3%）





- To achieve around 2℃ temperature increase in 2100, 500ppmv cap on total GHG constraint is needed
- Reduction required to achieve 500ppmv cap on total GHG constraint ▸▸▸ 4.4 GtCeq/yr (16.1 $GtCO_2eq/yr$) in 2020 and 7.9 GtCeq/yr (29.0 $GtCO_2eq/yr$) in 2030

研究
出力例

例えば、全ガスの温室効果ガス濃度が500ppmCO2eq、600ppmCO2eqを超過しないという抑制目標を仮定すると、

さらに，その結果，各国の温暖化影響は･･･