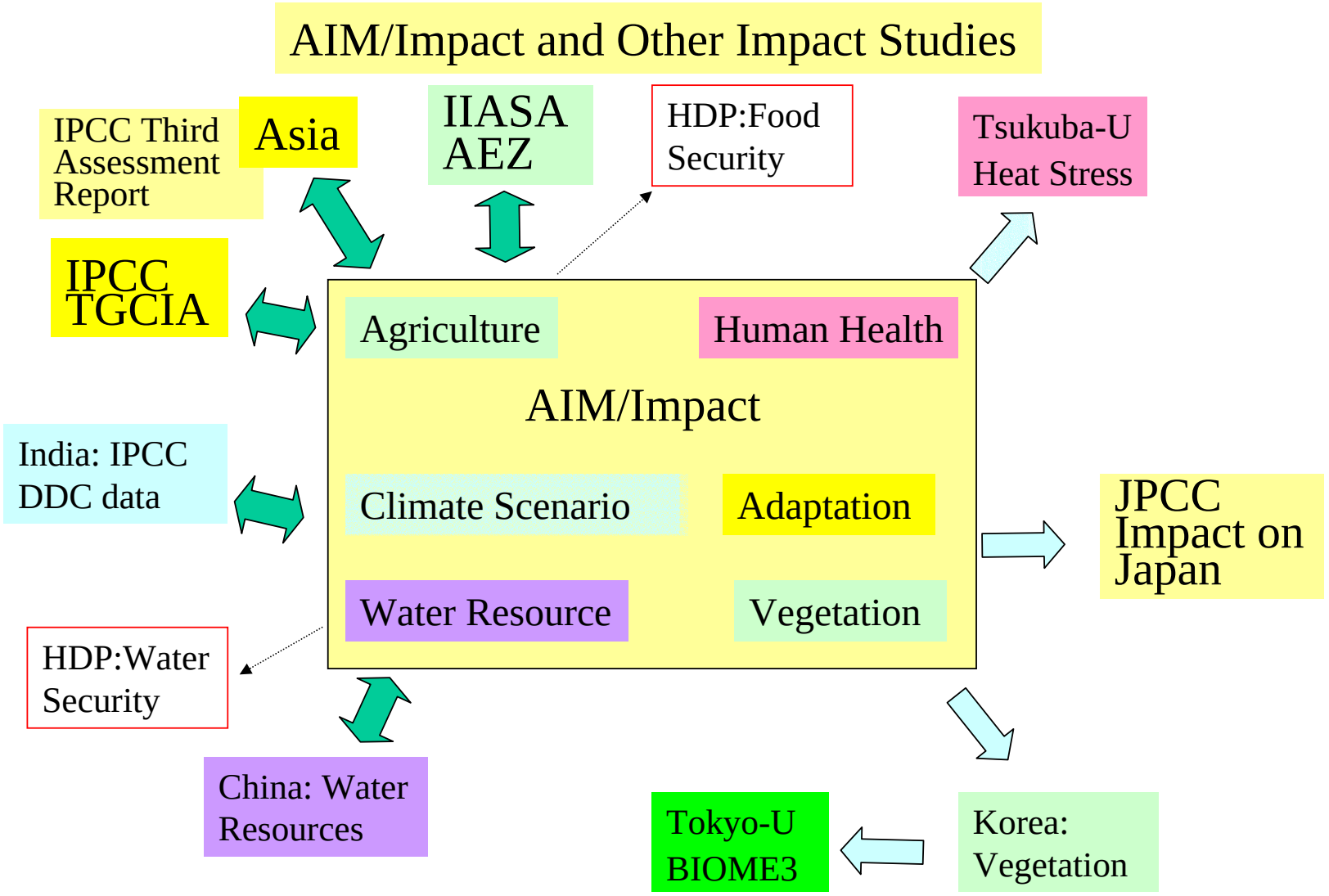
Recent Development of the AIM/Impact Model

1. Impact Study in AIM, IPCC, and Japan
2. Progress of AIM/Impact Models
   - -Climate Scenario : NIES GCM Group & Lal
   - -Water Resource Model : Takahashi
   - -Adaptation Measures : You
   - -China, India, Korea: Profs. Sun & Li, Dr. Jeon
3. Future Direction


AIM/Impact and Other Impact Studies
IPCC Third Assessment Report
Asia
IIASA AEZ
HDP:Food Security
Tsukuba-U Heat Stress
IPCC TGCIA
Agriculture
Human Health
AIM/Impact
India: IPCC DDC data
Climate Scenario
Adaptation
JPCC Impact on Japan
Water Resource
Vegetation
HDP:Water Security
China: Water Resources
Tokyo-U BIOME3
Korea: Vegetation

第一作業部会報告書の概要(IPCC　WG1　TAR)

第二次報告書(SAR, 1995)

“The balance of evidence suggests a discernible human influence on global climate”

「証拠を比較検討した結果、識別可能な人為的影響が全球の気候に現れていることが示唆される。」

・第三次報告書(TAR, 2001)

“There is now stronger evidence for a human influence on global climate than at the time of the Second Assessment Report.”

「第二次評価報告書の時に比べて、地球の気候への人為的影響により確かな証拠がある。」

TARはSARに比べて何が新しいか？　What’s　New?

① 枠組みが違う (New Framework)

　単なるレビューからより政策へのメッセージ性が増した

② より定量的な評価 (Quntification of Impacts)

　確信度の導入(Level of Confidence)

③ 影響の検出　(Detected Impacts)

④ 温暖化の＋/－の影響を評価 (Balanced +/ - Impacts)

⑤ 自然の変動性、異常気候現象を重視

　(Natural Varability and Extremes)

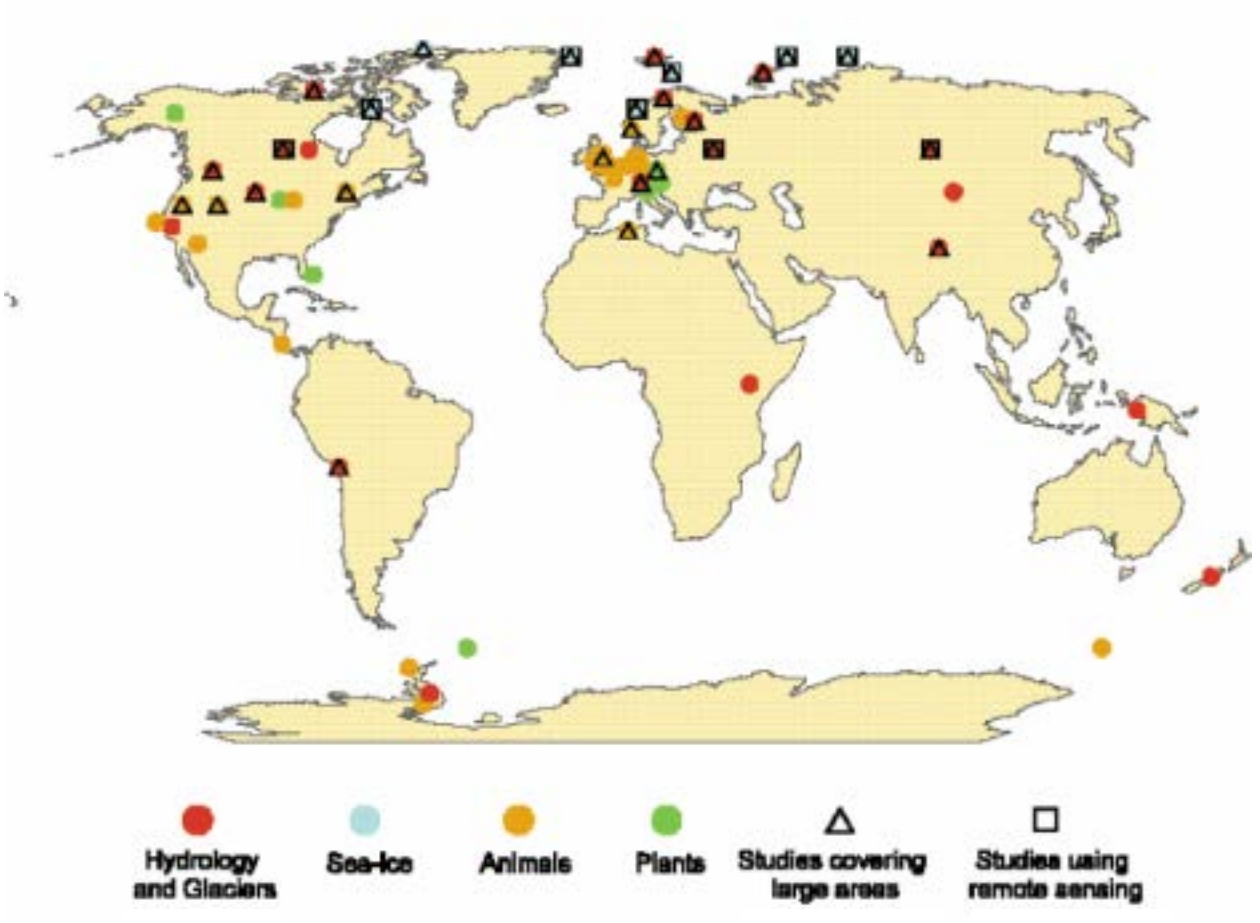
⑤ 適応策、総合化についても言及 (Adaptation, Synthesis)

⑦ 地域の影響：より詳細なアセス(Detailed Regional Impacts)　食糧安全保障、水資源、都市環境問題との接点

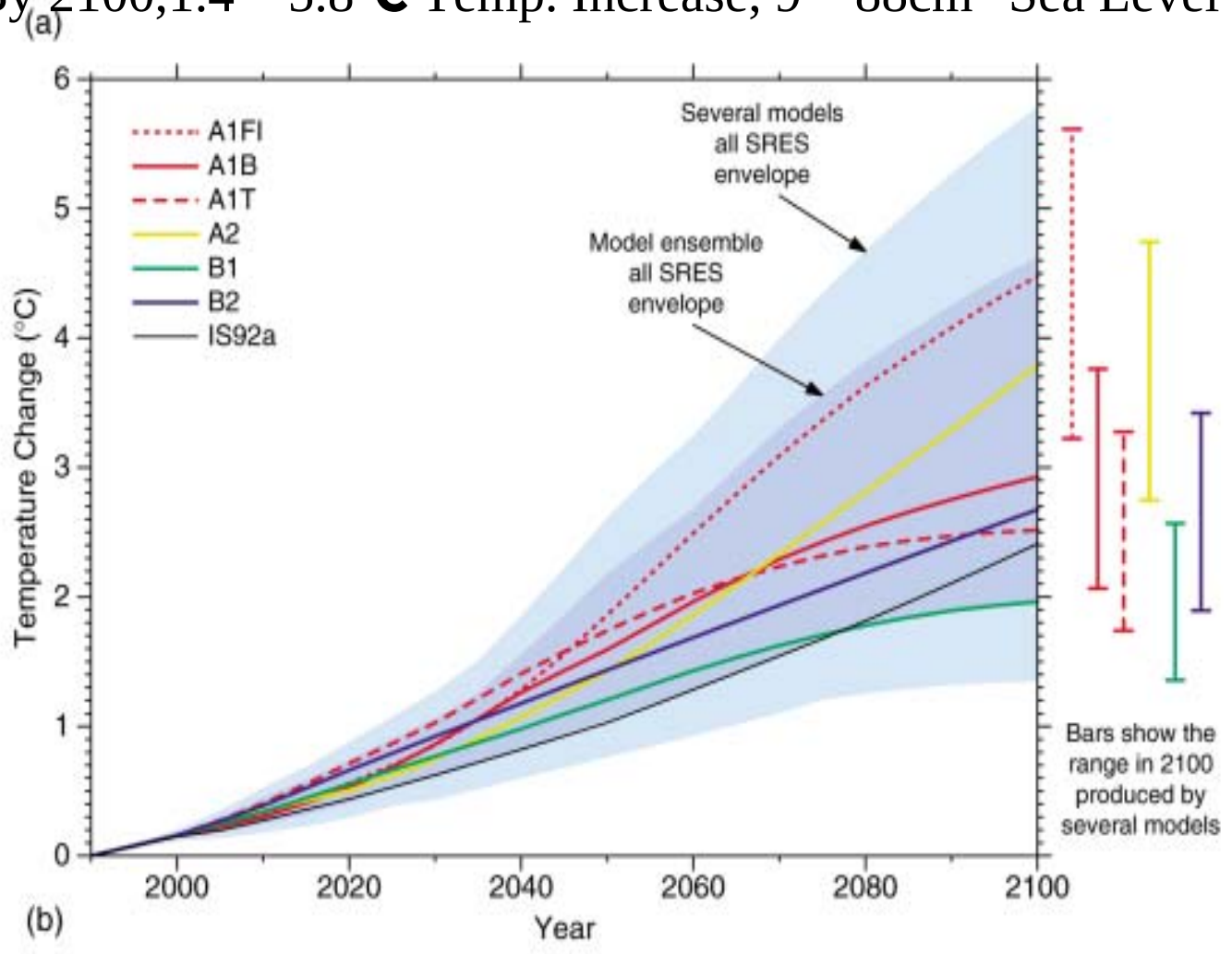
不確実性の評価 (Level of Confidence)

	第一作業部会(Wg1)	**第二作業部会**(WG2)
＞99%	Virtually Certain	
90-99%	Very Likely	>95% Very High Confidence
66-90%	Likely	67-95% High Confidence
33-66%	Medium Likelihood	33-67% Medium Confidence
10-33%	Unlikely	5-33% Low Confidence
1-10%	Very Unlikely	< 5% Very Low Confidence
< 1%	Exceptionally Unlikely	

図ー３　温暖化の影響が現れている生態系や氷河等
Detected Global Warming Impacts

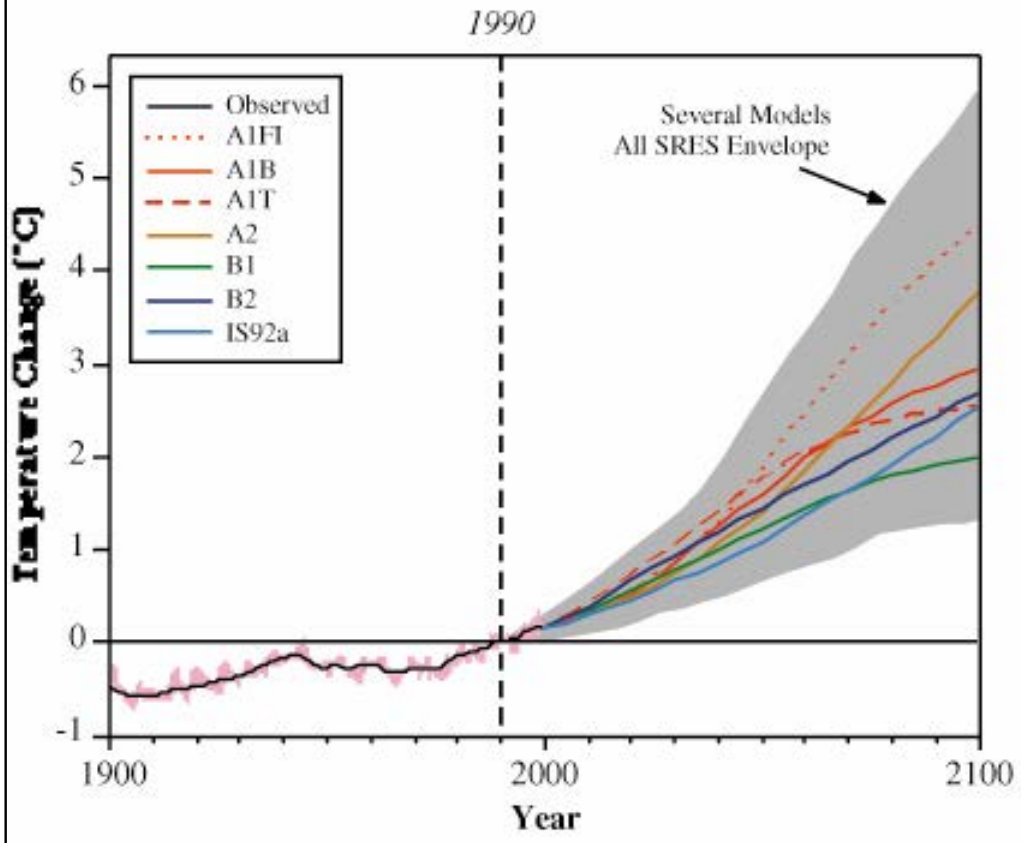


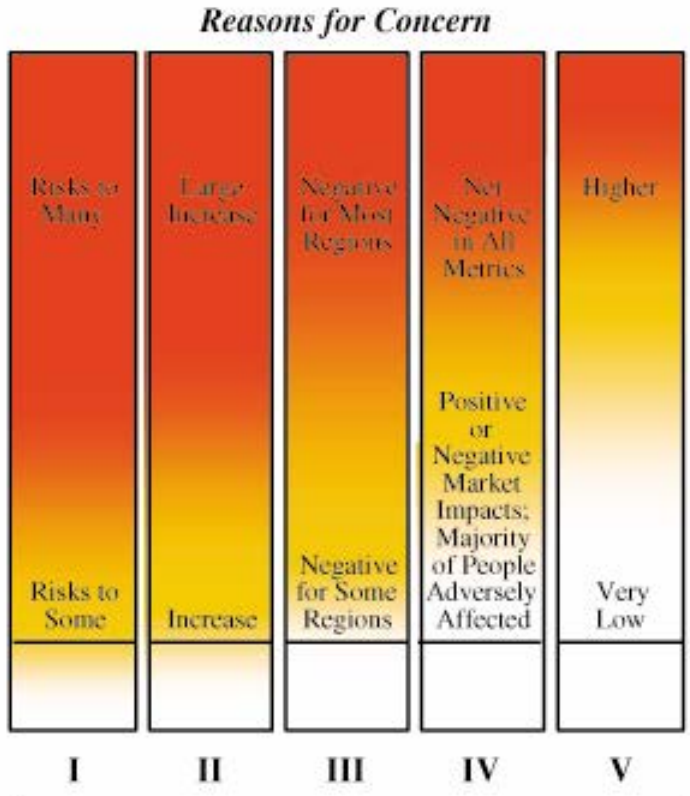
By 2100,1.4～5.8℃ Temp. Increase, 9～88cm Sea Level Rise



Future Temperature Increase (SRES Scenario)

温暖化の予測結果（ＳＲＥＳシナリオによる）





I	Risks to Unique and Threatened Systems
II	Risks from Extreme Climate Events
III	Distribution of Impacts
IV	Aggregate Impacts
V	Risks from Future Large-Scale Discontinuities

Ⅰ：ユニークかつ絶滅の恐れのあるシステム

Ⅱ：異常気候現象のリスク

Ⅲ：影響の空間的分布

Ⅳ：全球で集計された影響

Ⅴ：大規模な非連続性現象のリスク

Balanced Impact Assessment (+ / - Impacts)

Projected adverse impacts based on models and other studies include:

- A general reduction in potential crop yields in most tropical and sub-tropical regions for most projected increases in temperature; [4.2]
- A general reduction, with some variation, in potential crop yields in most regions in mid-latitudes for increases in annual-average temperature of more than a few degrees C; [4.2]
- Decreased water availability for populations in many water scarce regions, particularly in the sub-tropics; [4.1]
- An increase in the number of people exposed to vector-borne diseases (e.g. malaria) and water-borne diseases (e.g. cholera) and an increase in heat stress mortality; [4.7]
- A widespread increase in the risk of flooding for many human settlements (tens of millions of inhabitants in settlements studied) from both increased heavy precipitation events and sea-level rise; [4.5]
- Increased energy demand for space cooling due to higher summer temperatures. [4.5]

Projected beneficial impacts based on models and other studies include:

- Increased potential crop yields in some regions at mid-latitudes for increases in temperature of less than a few degrees C; [4.2]
- A potential increase in global timber supply from appropriately managed forests; [4.3]
- Increased water availability for populations in some water scarce regions, for example in parts of South East Asia; [4.1]
- Reduced winter mortality in mid- and high-latitudes; [4.7]
- Reduced energy demand for space heating due to higher winter temperatures; [4.5]

Table 1: Estimates of confidence in observed and projected changes in extreme weather and climate events.

Confidence in observed changes (latter half of the 20th century)	**Changes in Phenomenon**	Confidence in projected changes (during the 21st century)
Likely[7]	**Higher maximum temperatures and more hot days over nearly all land areas**	Very likely[7]
Very likely[7]	**Higher minimum temperatures, fewer cold days and frost days over nearly all land areas**	Very likely[7]
Very likely[7]	**Reduced diurnal temperature range over most land areas**	Very likely[7]
Likely[7], over many areas	**Increase of heat index[12] over land areas**	Very likely[7], over most areas
Likely[7], over many Northern Hemisphere mid- to high latitude land areas	**More intense precipitation events[b]**	Very likely[7], over many areas
Likely[7], in a few areas	**Increased summer continental drying and associated risk of drought**	Likely[7], over most mid-latitude continental interiors. (Lack of consistent projections in other areas)
Not observed in the few analyses available	**Increase in tropical cyclone peak wind intensities[c]**	Likely[7], over some areas
Insufficient data for assessment	**Increase in tropical cyclone mean and peak precipitation intensities[c]**	Likely[7], over some areas

[a] For more details see Chapter 2 (observations) and Chapter 9, 10 (projections).

[b] For other areas, there are either insufficient data or conflicting analyses.

[c] Past and future changes in tropical cyclone location and frequency are uncertain.

Table SPM-1: Examples of Impacts Resulting from Projected Changes in Extreme Climate Events.

Projected Changes during the 21st Century in Extreme Climate Phenomena and their Likelihood[a]	**Representative Examples of Projected Impacts[b] (all *high confidence* of occurrence in some areas[c])**
Simple Extremes	
Higher maximum temperatures, more hot days and heat waves[d] over nearly all land areas (*Very likely*[e])	• Increased incidence of death and serious illness in older age groups and urban poor [4.7] • Increased heat stress in livestock and wildlife [4.2 and 4.3] • Shift in tourist destinations [Table TS-2 and 5.7] • Increased risk of damage to a number of crops [4.2] • Increased electric cooling demand and reduced energy supply reliability [Table TS-4 and 4.5]
Higher [Increasing] minimum temperatures, fewer cold days, frost days and cold waves[d] over nearly all land areas (*Very likely*[e])	• Decreased cold-related human morbidity and mortality [4.7] • Decreased risk of damage to a number of crops, and increased risk to others [4.2] • Extended range and activity of some pest and disease vectors [4.2 and 4.3] • Reduced heating energy demand [4.5]
More intense precipitation events (*Very likely*[e], over many areas)	• Increased flood, landslide, avalanche, and mudslide damage [4.5] • Increased soil erosion [5.2.4] • Increased flood runoff could increase recharge of some floodplain aquifers [4.1] • Increased pressure on government and private flood insurance systems and disaster relief [Table TS-4 and 4.6]
Complex Extremes	
Increased summer drying over most mid-latitude continental interiors and associated risk of drought (*Likely*[e])	• Decreased crop yields [4.2] • Increased damage to building foundations caused by ground shrinkage [Table TS-4] • Decreased water resource quantity and quality [4.1 and 4.5] • Increased risk of forest fire [5.4.2]
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities (*Likely*[e], over some areas)[f]	• Increased risks to human life, risk of infectious disease epidemics and many other risks [4.7] • Increased coastal erosion and damage to coastal buildings and infrastructure [4.5 and 7.2.4] • Increased damage to coastal ecosystems such as coral reefs and mangroves [4.4]
Intensified droughts and floods associated with El Niño events in many different regions (*Likely*[e]) [See also under droughts and intense precipitation events]	• Decreased agricultural and rangeland productivity in drought- and flood-prone regions [4.3] • Decreased hydro-power potential in drought-prone regions [5.1.1 and Figure TS-7]
Increased Asian summer monsoon precipitation variability (*Likely*[e])	• Increase in flood and drought magnitude and damages in temperate and tropical Asia [5.2.4]
Increased intensity of mid-latitude storms (Little agreement between current models)[g]	• Increased risks to human life and health [4.7] • Increased property and infrastructure losses [Table TS-4] • Increased damage to coastal ecosystems [4.4]

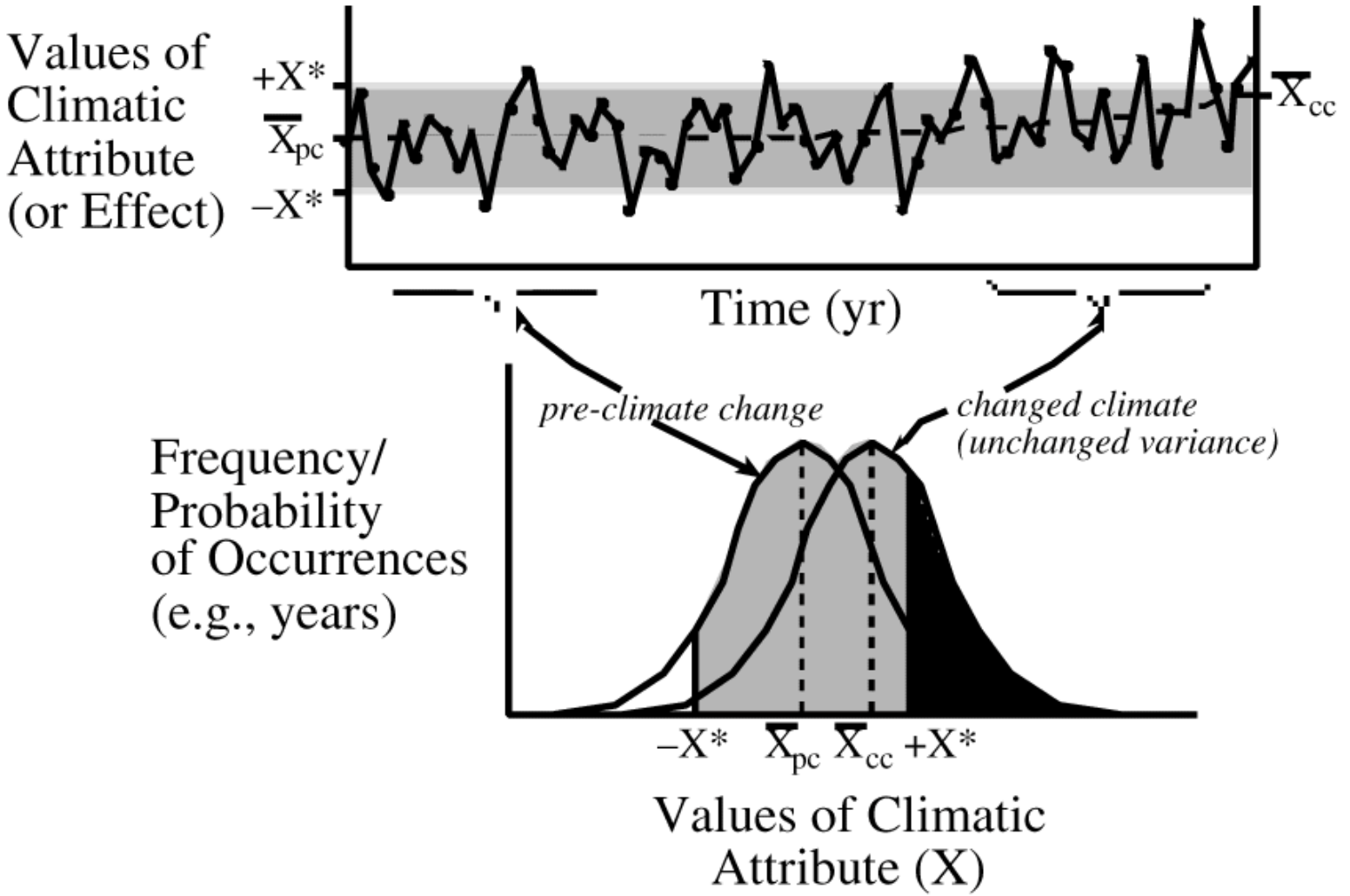
[a] Likelihood refers to judgmental estimates of confidence used by Working Group I: *very likely* (90-99% chance); *likely* (66-90% chance). Unless otherwise stated, information on climate phenomena is taken from the Summary for Policymakers of Working Group I.

[b] These impacts can be lessened by appropriate response measures.

[c] ***High confidence*** refers to probabilities between 67 and 95% as described in Footnote 6.

[d] Information from Working Group I, Technical Summary, Section F.5.

[e] Changes in regional distribution of tropical cyclones are possible but have not been established.


Values of Climatic Attribute (or Effect)
+X*
$\overline{X}_{pc}$
–X*
$\overline{X}_{cc}$
Time (yr)
pre-climate change
changed climate
(unchanged variance)
Frequency/ Probability of Occurrences (e.g., years)
–X*
$\overline{X}_{pc}$
$\overline{X}_{cc}$
+X*
Values of Climatic Attribute (X)

異常気象の経済的影響　Impacts of Extremes

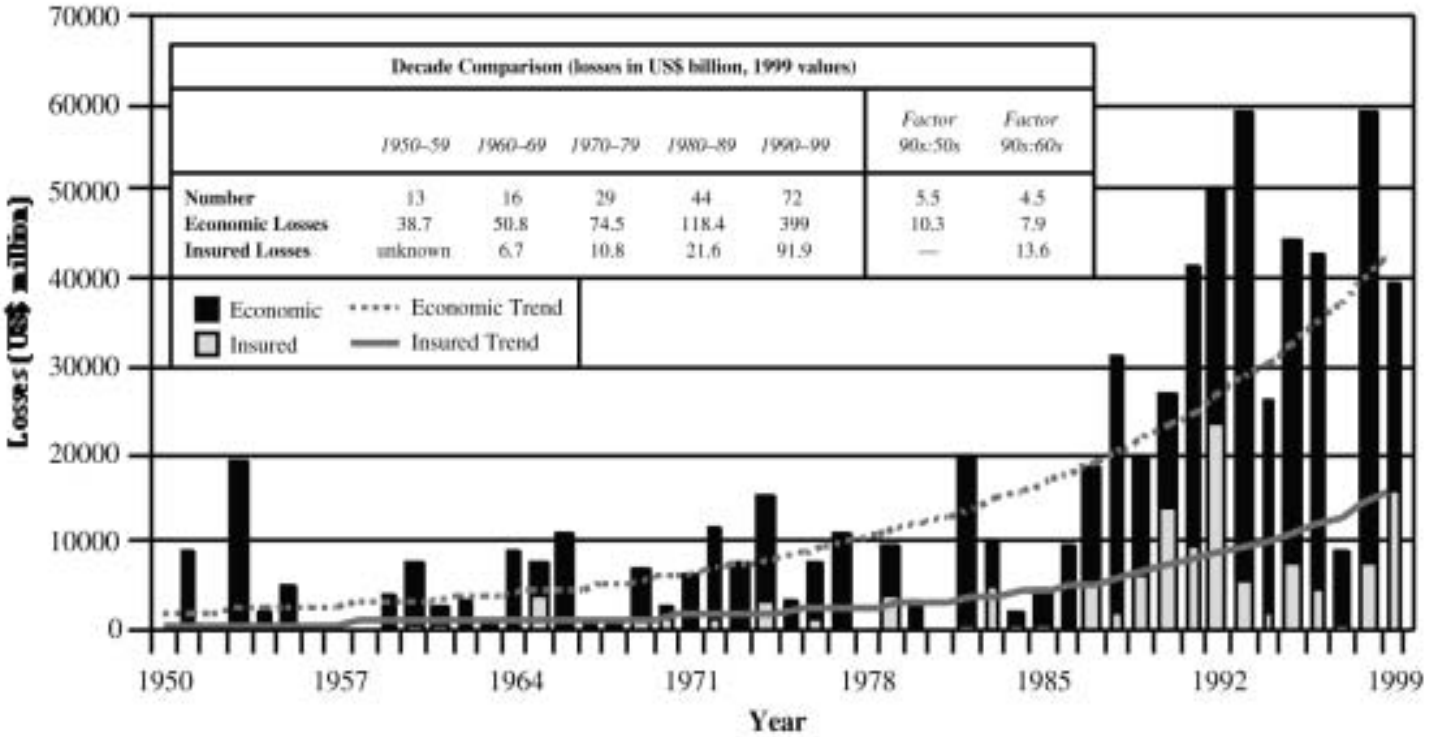
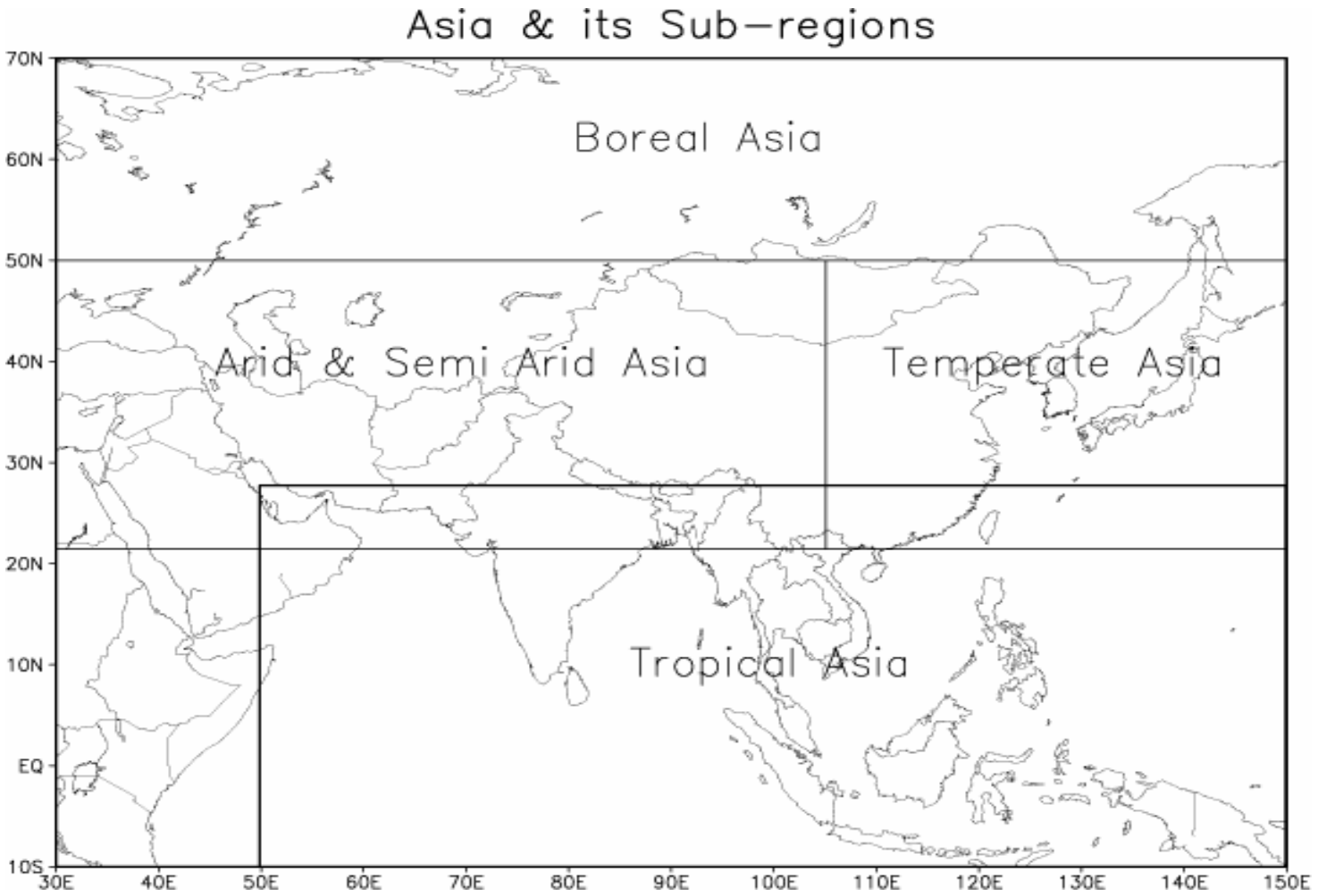


Figure TS-6: The costs of extreme weather events have exhibited a rapid upward trend in recent decades. Yearly economic losses from large events increased ten-fold from US$4 billion in the 1950s to US$40 billion per year in the 1990s (all in 1999 US$). The insured portion of these losses rose from a negligible level to US$ 9 billion annually during the same period, and the ratio of premiums to catastrophe losses fell by two-thirds. Notably, the costs are a factor of two larger when losses from small, non-catastrophic weather-related events are included. The numbers generally include "captive" self-insurers, but not the less formal types of self-insurance.

Ch11. Asia Regionalization of Asia (Climate Scenario: 6 Regions)



Asia	• Adaptive capacity of human systems is low and vulnerability is high in the developing countries of Asia; the developed countries of Asia are more able to adapt and less vulnerable. [5.2.7] • Extreme events have increased in temperate and tropical Asia, including floods, droughts, forest fires, and tropical cyclones (*high confidence*[6]). [5.2.4] • Decreases in agricultural productivity and aquaculture due to thermal and water stress, sea level-rise, floods and droughts, and tropical cyclones would diminish food security in many countries of arid, tropical, and temperate Asia; agriculture would expand and increase in productivity in northern areas (*medium confidence*[6]). [5.2.1] • Runoff and water availability may decrease in arid and semi-arid Asia but increase in northern Asia (*medium confidence*[6]). [5.2.3] • Human health would be threatened by possible increased exposure to vector-borne infectious diseases and heat stress in parts of Asia (*medium confidence*[6]). [5.2.6] • Sea-level rise and an increase in the intensity of tropical cyclones would displace tens of millions of people in low-lying coastal areas of temperate and tropical Asia; increased intensity of rainfall would increase flood risks in temperate and tropical Asia (*high confidence*[6]). [5.2.5 and Table TS-8] • Climate change would increase energy demand, decrease tourism attraction, and influence transportation in some regions of Asia (*medium confidence*[6]). [5.2.4 and 5.2.7] • Climate change would exacerbate threats to biodiversity due to land-use and land-cover change and population pressure in Asia (*medium confidence*[6]). Sea-level rise would put ecological security at risk, including mangroves and coral reefs (*high confidence*[6]). [5.2.2] • Poleward movement of the southern boundary of the permafrost zones of Asia would result in a change of thermokarst and thermal erosion with negative impacts on social infrastructure and industries (*medium confidence*[6]). [5.2.2]

***Table 11-11**: Vulnerability of key sectors to the impacts of climate change by sub-regions in Asia.*

Sub-regions	Food & Fibre	Bio-diversity	Water Resource	Coastal Ecosystem	Human Health	Settlements
Boreal Asia	+1 / H	-2 / M	+1 / M	+1 / L	-1 / L	0 / M
Arid & Semi Arid Asia						
-Central Asia	-2 / H	-1 / L	-2 / H	-1 / L	-1 / M	-1 / M
-Tibetan Plateau	0 / L	-2 / M	-1 / L	Not applicable	No information	No information
Temperate Asia	-2 / H	-1 / M	-2 / H	-2 / H	-2 / M	-2 / H
Tropical Asia						
-South Asia	-2 / H	-2 / M	-2 / H	-2 / H	-1 / M	-2 / M
-S-E Asia	-2 / H	-2 / M	-2 / H	-2 / H	-1 / M	-2 / M

Vulnerability:

-2 – Highly vulnerable
-1 – Moderately vulnerable
0 – Slightly or Not vulnerable
+1 – Slightly resilient
+2 – Most resilient

Level of Confidence:

VH - Very High
H - High
M - Medium
L - Low
VL - Very Low

***Table 3-6**: Approximate chronology of the IPCC process in relation to general circulation model (GCM) simulations, their adoption in impact studies and the development of IPCC emissions scenarios. Abbreviations: AGCM, atmospheric GCM with simple ocean; AOGCM, coupled atmosphere-ocean GCM; GHG, greenhouse gas; IS92, IPCC emissions scenarios published in 1992 (Leggett et al., 1992); SRES, Special Report on Emissions Scenarios (Nakicenovic et al., 2000).*

Date	IPCC process	Working Group I GCM simulations	Working Group II GCM-based scenarios used in impact studies	Working Group III Emissions scenarios
1988-1990	First Assessment Report (FAR) 1990	Equilibrium high resolution AGCM	Equilibrium low resolution 2 x CO_2	Scenarios A-D (A = Business-as-Usual)
1991-1992	FAR Supplement 1992	Transient AOGCM cold start GHG-only (Scenario A emissions)	Equilibrium low resolution 2 x CO_2	IS92a-f
1993-1996	Second Assessment Report (SAR) 1996	Transient AOGCM warm-start GHG + aerosol (0.5 or 1% per year emissions)	Equilibrium low/high resolution; transient cold-start	IS92a-f (modified)
1997-1998	Regional Impacts 1998	Transient AOGCM ensemble/multi-century control	Equilibrium low/high resolution; transient cold-start/warm-start	IS92a-f (modified)
1999-2001	Third Assessment Report (TAR) 2001	Transient AOGCM CO_2-stabilisation; SRES-forced	Transient warm-start; multi-century control and ensembles	SRES; Stabilisation

Climate Scenarios distributed by IPCC Data Distribution Center

	ECHAM4	HadCM2	CSIRO	CCCma	GFDL	NCAR	CCSR
Research Institute (Country)	German Climate Research Center (Germ)	Hadley Center (UK)	CSIRO (Australia)	Canada Climate Model Analysis Center(Canada)	Geophyscial Fluid Dynamics Laboratory(US)	National Canter of Atmospheric Research (US)	Tokyo Univ - Climate System Research Center (Japan)
AGCM Spatial Resolution	2.8 ° x2.8 ° L19	2.5 ° x 3.75 ° L19	3.2 ° x5.6 ° L9	3.7 ° x3.7 ° L10	4.5 ° x7.5 ° L9	4.5 ° x7.5 ° L9	5.6 ° x5.6 ° L20
OGCM Spatial Resolution	2.8 ° x2.8 ° L11	2.5 ° x 3.75 ° L20	3.2 ° x5.6 ° L21	1.8 ° x1.8 ° L29	4.5 ° x 3.75 ° L12	1 ° x1 ° L20	2.8 ° x2.8 ° L17
Control CO_{2c} Concentration	354 ppmv	323 ppmv	330 ppmv	295 ppmv	300 ppmv	330 ppmv	N.A.
CO_2 Conc. Rate of Increase	1% yr^{-1}	1% yr^{-1}	0.9% yr^{-1}	1% yr^{-1}	1% yr^{-1}	1% yr^{-1}	1% yr^{-1}
Calc. Period (Year)	Cont : 240 GHG : 240 GHG+A : 240	Cont : 240 GHG : 240 GHG+A : 240	Cont : 219 GHG : 219 GHG+A : 219	Cont : 200 GHG : 200 GHG+A : 200	Cont : 1000 GHG : 100 GHG+A : 300	Cont : 136 GHG : 136 GHG+A : 136	Cont : 210 GHG : 210 GHG+A : 210
2xCO_2 Global Average Temperature Increase(°C)	1.3	1.7	2.0	2.7	2.3	2.3 (est.)	N. A.
2 x CO_2 Equilibrium Temperature (°C)	2.6	2.5	4.3	3.5	3.7	4.6	N. A.

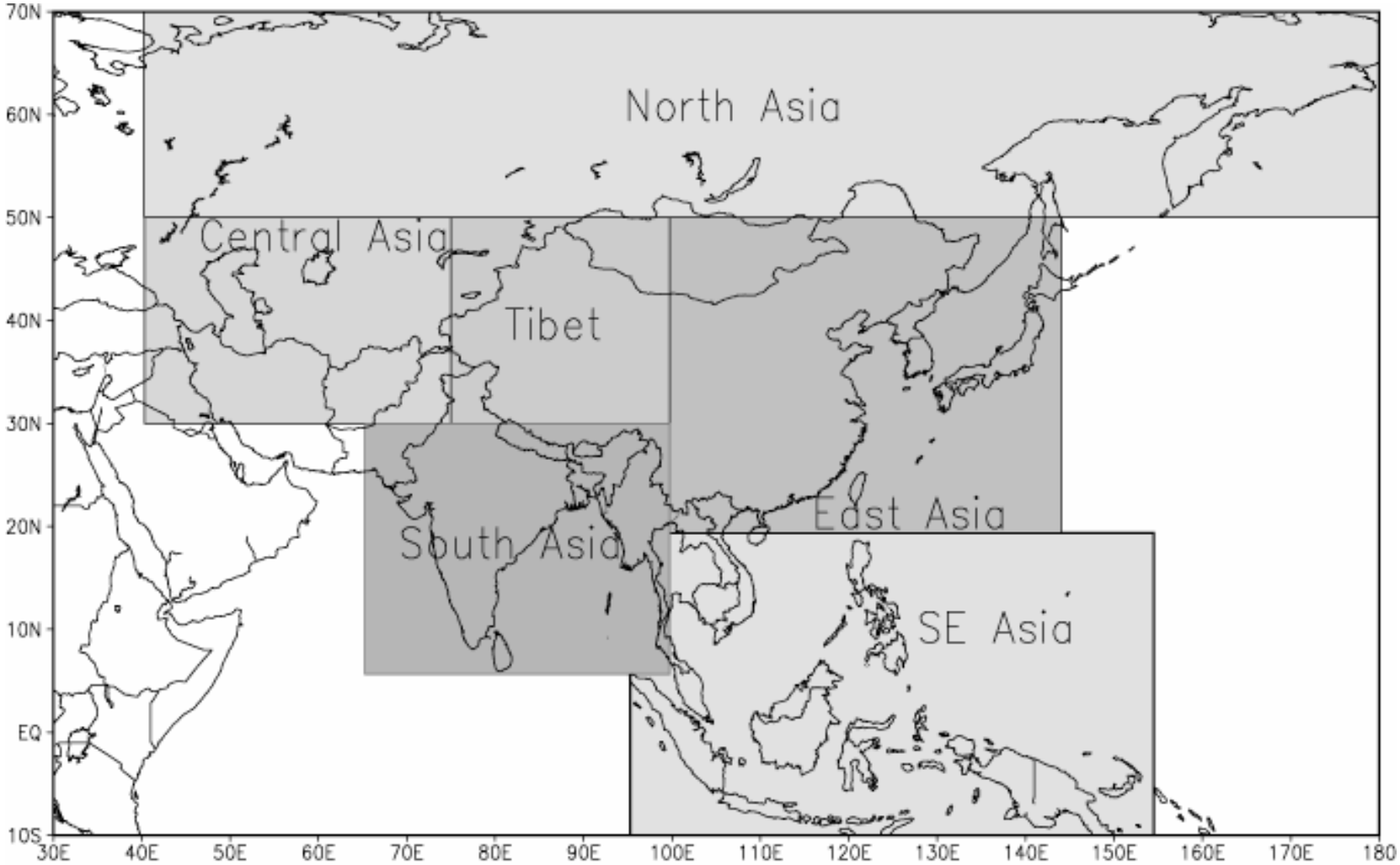


Fig. 1: The geographical domain of Asia and its sub-regions as considered in the study

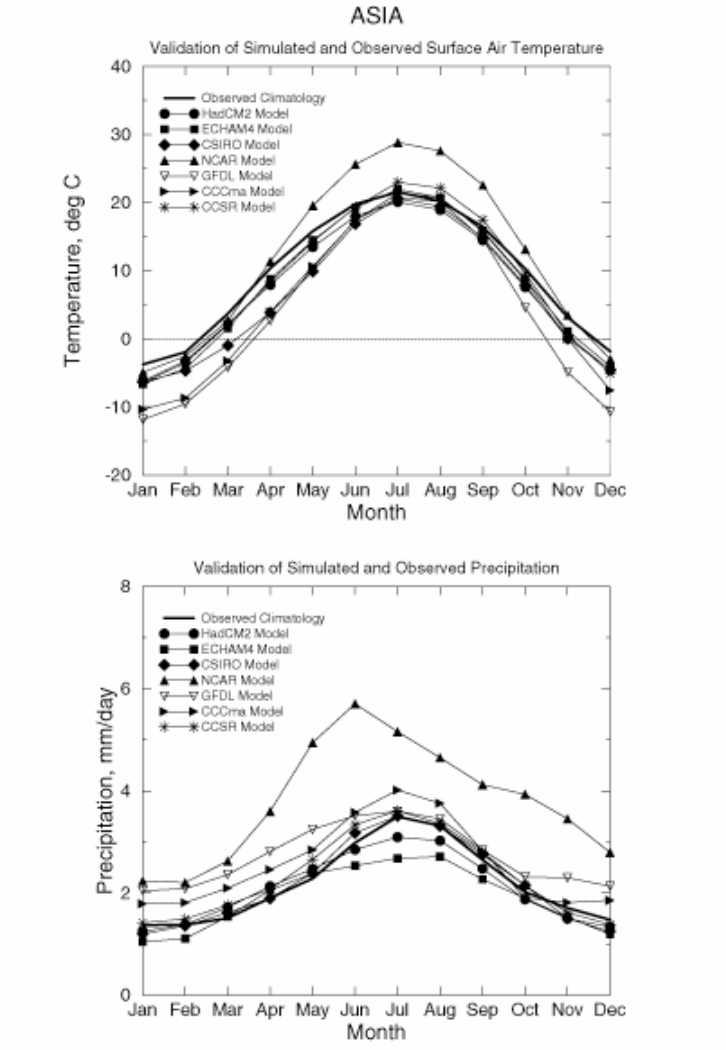


Fig. 2: The area-averaged monthly mean observed and simulated surface air temperature (deg C) and precipitation (mm day^{-1}) climatology over the Asian continent (land regions only).

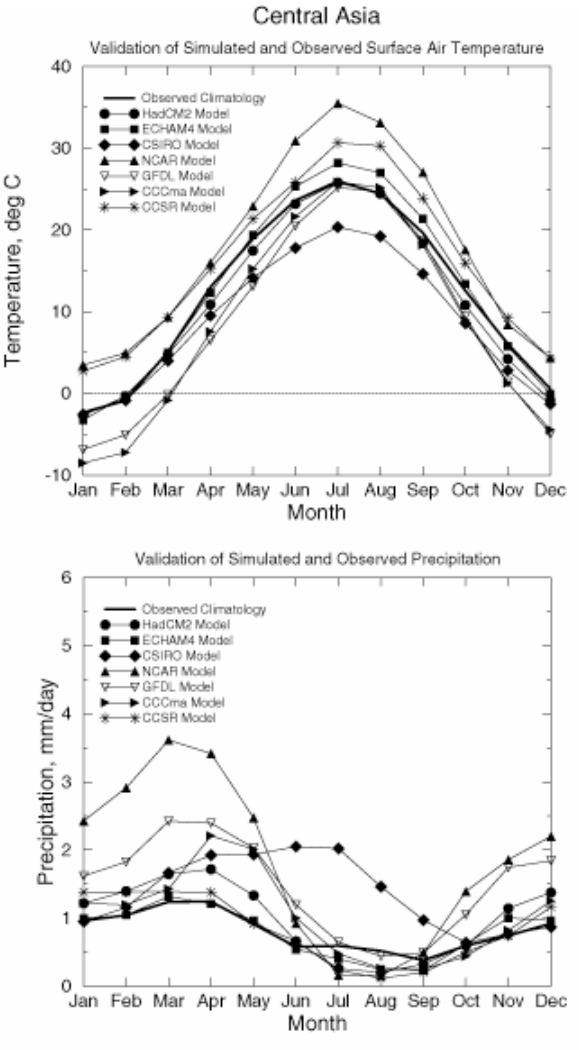


Fig. 3: The area-a veraged monthly mean obser ved and simulated surface air temperature (deg C) and precipitation (mm day^{-1}) climatology over Central Asia (land regions only)

JPCC Project (Global Warming Impact on Japan)

・Committee on Global Warming Problem, Japan Environment Agency (1988 ---)

・Sub-committee on Impact Assessment

1996.1 Sub- committee Member Meeting

Basic Policy

Research Fields

1996.7 Section Coordinator and Lead Author Meeting

Contents

Baseline climate scenario

Cross-cutting Issue

Schedule

1997.12 First Order-draft

Review by Committee Members and Experts

Revision by Coordinators and Lead Authors

1997.4 Report of The Potential Impacts of Global Warming in Japan

National Communication → UNFCCC

1997.5 ***Pamphlet of "The Potential Impacts of Global Warming in Japan***"

1997.9 ***Book of "Global Warming and Japan – Impacts on Nature and Society***"

1997.10 ***Book of "Global Warming- What impacts Japan will face?" for General Public***

1997.12 COP3: Kyoto Conference on Global Warming Prevention

JPCC2

2000.1 Sub-Committee Member Meeting

2000.7 Writing Team Meeting (about 70 researchers)

2001.1 Experts Review

2001.3 Completion of the JPCC2 Report

2001～ National Impact Assessment ??

Future Development

- World Water Model

  Water Supply vs. Water Demand

- Adaptation

  Countermeasures and Cost Estimation

- High Temperature Impacts
- GCM-Impact Study (LINK Project)
- Regional Climate Scenario (incl Extremes)