気候変動交渉における IPCCと科学者の役割

２０１１年１０月

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(IPCC 33回総会, Abu Dhabi)

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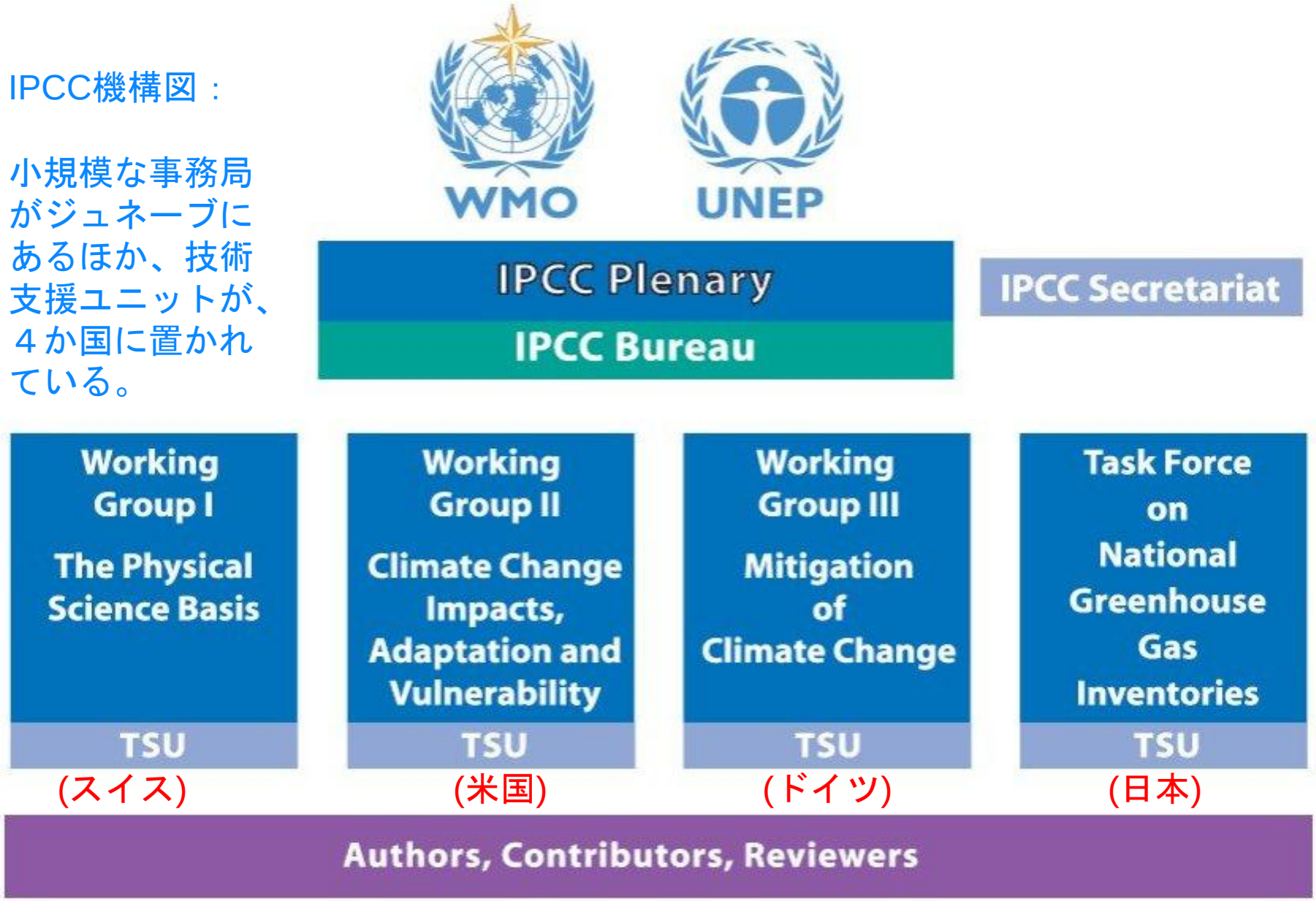
気候変動に関する政府間パネル(IPCC)とは、

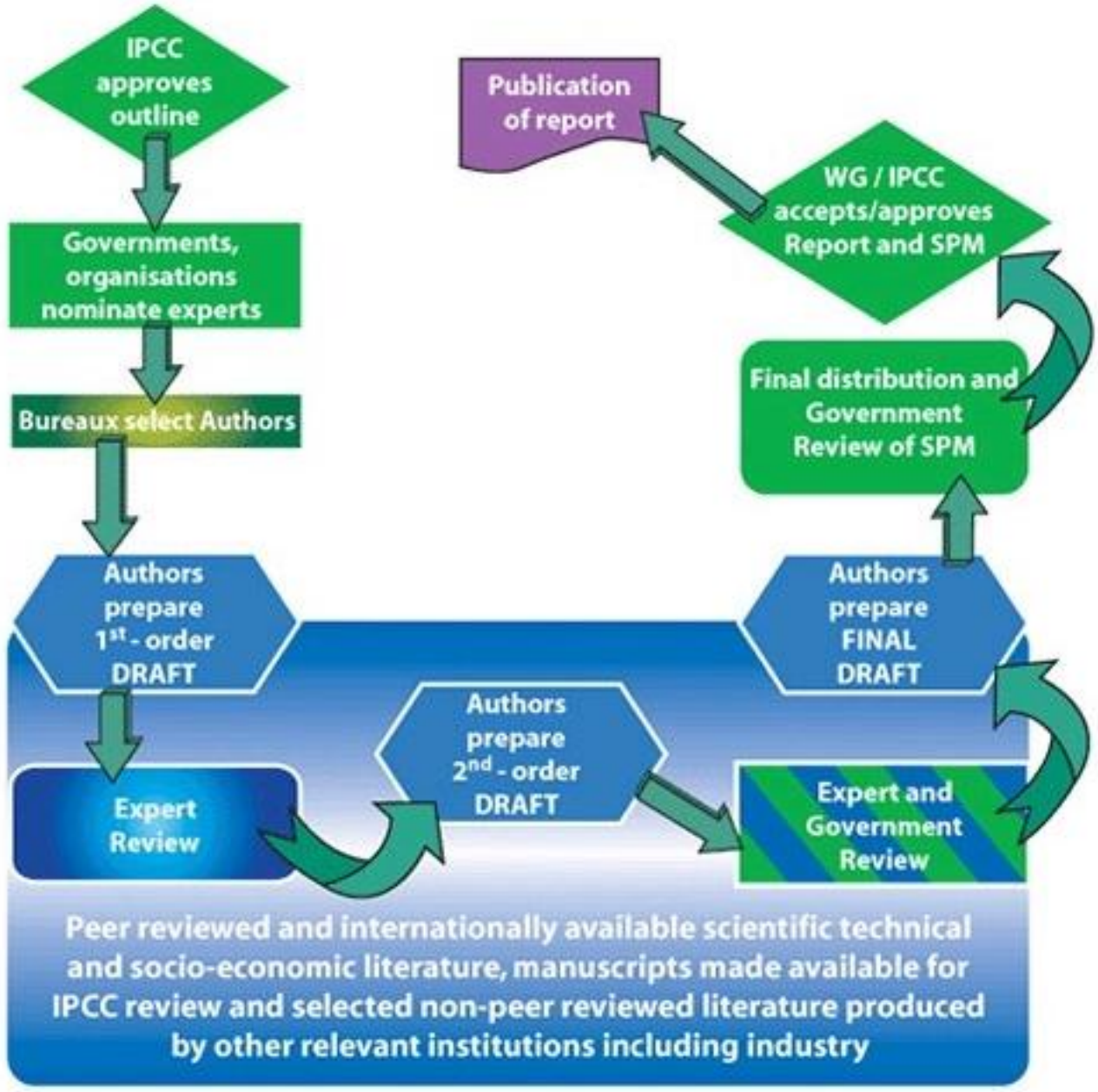
- 1998年に、世界気象機関(WMO)と国連環境計画(UNEP)により設置。その加盟国は、 WMO 及び UNEP の加盟国。
- IPCCは、アセスメント報告書、特別報告書、方法論報告書、及び技術的報告書を作成する。これらの報告書は、課題ごとの最新の文献等を反映し、専門家でない人々が理解できるようなものとして作成される。
- IPCC の報告書作成のプロセスには、広範な科学的な意見を反映するため、２次にわたる査読のステップが含まれている。**IPCCは、政策的に意義のある活動を目指しているが、政策を規定・勧告することはない。**

IPCC機構図：

小規模な事務局がジュネーブにあるほか、技術支援ユニットが、４か国に置かれている。



IPCC Writing and Review Process



報告書は多数の国際的な専門家による厳格な査読を経て作成されるため、少数の著者の意見のみをまとめたものではない。

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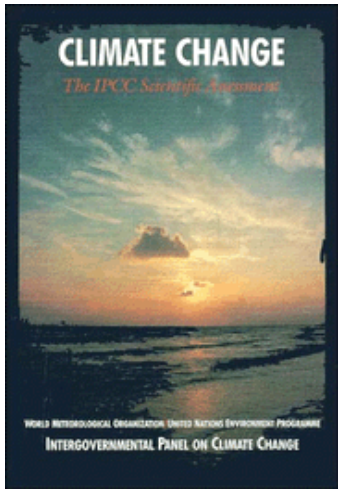
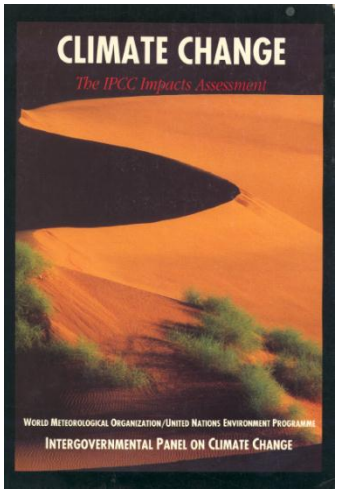
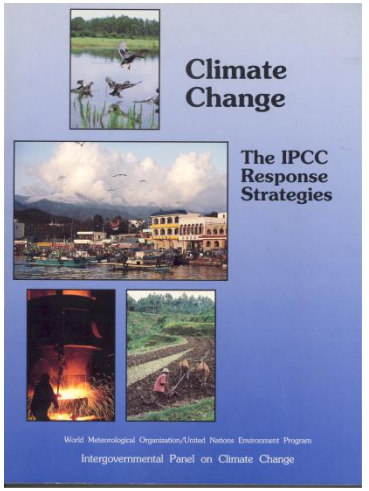
第一次アセスメント報告書(1990)







WG-I

Emissions from human activities

increase substantially GHG concentrations

This results in additional warming

0.3°C per decade

SLR 6 cm per decade

WG-II

Assessed impacts on main sectors

Uncertainties with regard to timing, magnitude and regional patters

Impacts felt most severely in regions under stress

WG-III

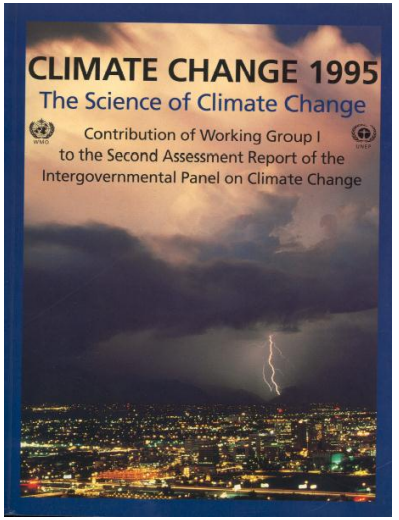
Sectoral subgroups on adaptive and mitigative response options

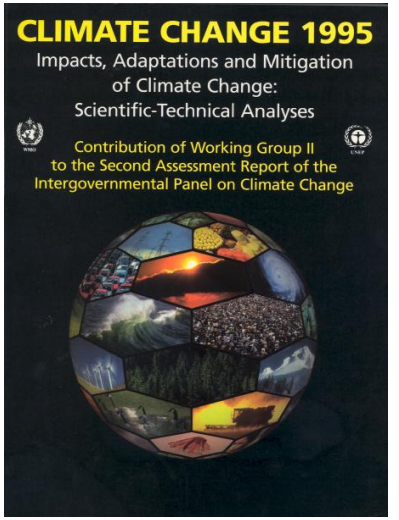
Flexible approach of shorter term and more intensive action over the longer term

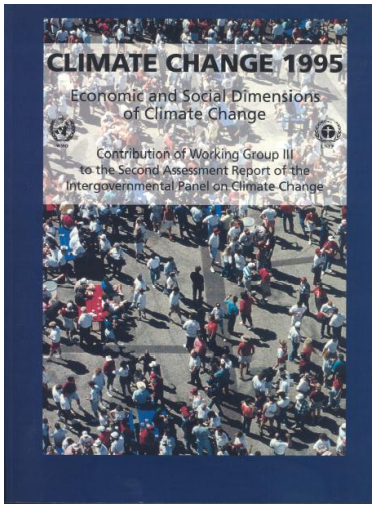
Draft Convention text

Special committee on participation of developing countries

第二次アセスメント報告書(1995)







WG-I

GHG concentrations continued to increase

Aerosols produce negative radiative forcing

Climate has changed over the past century

Balance of evidence suggests a discernible human influence on global climate

Climate change expected to continue

WG-II

Climate change adds new stress

Most systems are sensitive

Impacts difficult to quantify

Successful adaptation depends on technology, institutions, finance and information

Vulnerability increases as adaptive capacity decreases

Detection difficult, unexpected changes possible

WG-III

Portfolio of mitigation, adaptation, knowledge improvement

Earlier mitigation increases flexibility in moving towards stabilization

Significant "no-regrets" opportunities

Risk of damage and precautionary principle provide rationales for action beyond no-regrets

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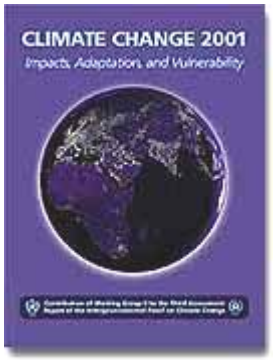
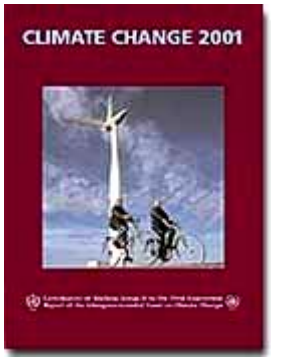
第三次アセスメント報告書(2001)





WG-I

Confidence in ability of models to project future climate has increased

There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities
Emissions of GHGs and aerosols continue to alter the atmosphere
Temperature and sea level expected to rise
Atmospheric climate change will persist for many centuries

WG-II

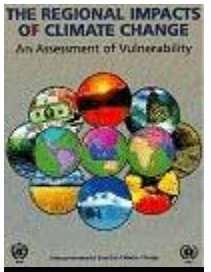
Recent regional climate changes affected many physical and biological systems
Preliminary indications that human systems have been affected
Natural systems are vulnerable and some will be irreversibly damaged
Many human systems are sensitive to climate change and some are vulnerable
Projected changes in climate extremes could have major consequences
Risks for large scale and possibly irreversible impacts need to be quantified
Adaptation necessary to complement mitigation
Those with least resources are most vulnerable
Adaptation, sustainable development and equity mutually reinforcing

WG III

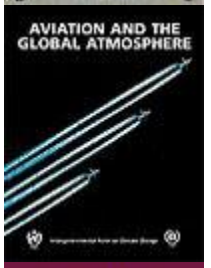
Portfolio of mitigation, technology development and reduction of scientific uncertainty increases flexibility in moving towards stabilization
Alternative development paths result in different greenhouse gas emissions
Climate change mitigation affected by and have impacts on development, sustainability and equity
Significant tech. progress, faster than anticipated
Forests, agricultural lands offer significant, not necessarily permanent mitigation potential
550ppmv, 450ppmv or below over the next 100 possible with known technological options
Limitations possible at no or negative social costs
Integration with non-climate policy objectives

IPCC Special Reports

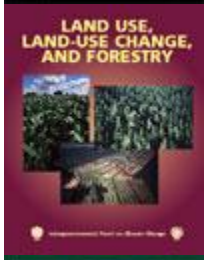
Regional Impacts (1997)



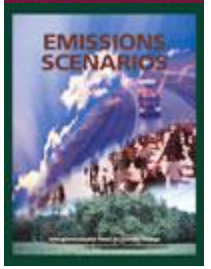
Aviation (1999)



LUCF (2000)

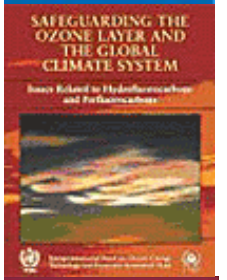


Emission Scenarios (2000)

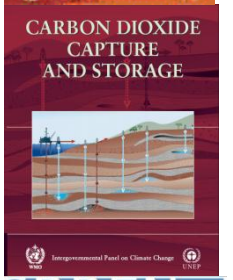


Technology Transfer (2000)

Ozone Layer (2005)



CO2 Capture and Storage (2005)



Renewable Energy (2011)

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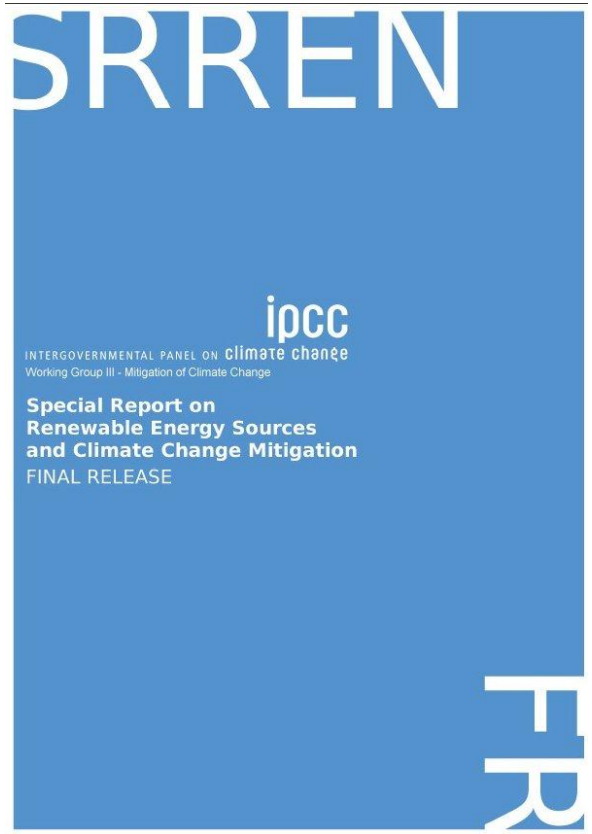
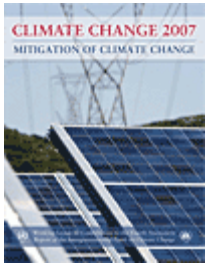
Special Report on Renewable Energy Sources and Climate Change Mitigation (2011, SRREN) <http://srren.ipcc-wg3.de/>

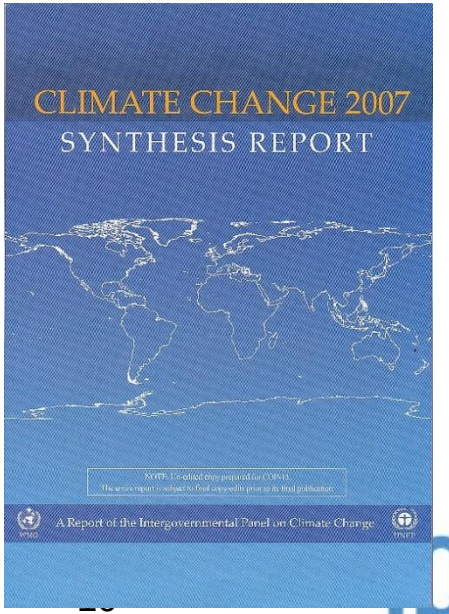


第四次アセスメント報告書(AR4)

- WG-I: **“The Physical Science Basis”** (February 2007)
- WG-II: **"Impacts, Adaptation and Vulnerability"** (April 2007)
- WG-III: **"Mitigation of Climate Change"** (May 2007)



AR4 Synthesis (November 2007)



第四次アセスメント報告書のキーポイント

- 大気、海洋の地球的な平均温度の上昇、雪氷の融解、地球的な海面の上昇の観測から明らかになっており、気候システムの温暖化については、意見が一致している。
- 20世紀中葉以降の温度上昇の大部分が、人為的な温暖化ガスの増加に起因している可能性が極めて高い。

大気中の温暖化ガスが増加している。

• 炭酸ガスは、産業革命以前（約２８０ppm）に比較して、2005年までに、395ppm と増加している。これは、過去 65万年の中で見られなかった濃度。

• メタンは、約 715 ppb tから 1,774 ppb まで増加。

• 亜酸化窒素（N2O）は、270 ppb から 319 ppb に増加。

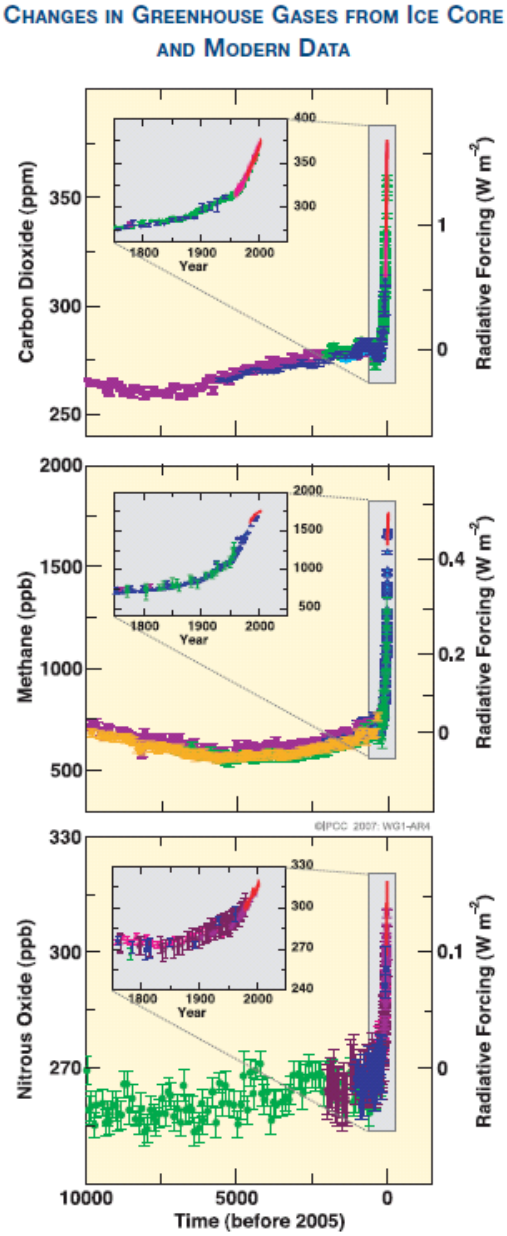


Figure SPM.1. *Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colours for different studies) and atmospheric samples (red lines). The corresponding radiative forcings are shown on the right hand axes of the large panels. (Figure 6.4)*

全球平均気温、海水面、雪氷面積の変化が観測されている。

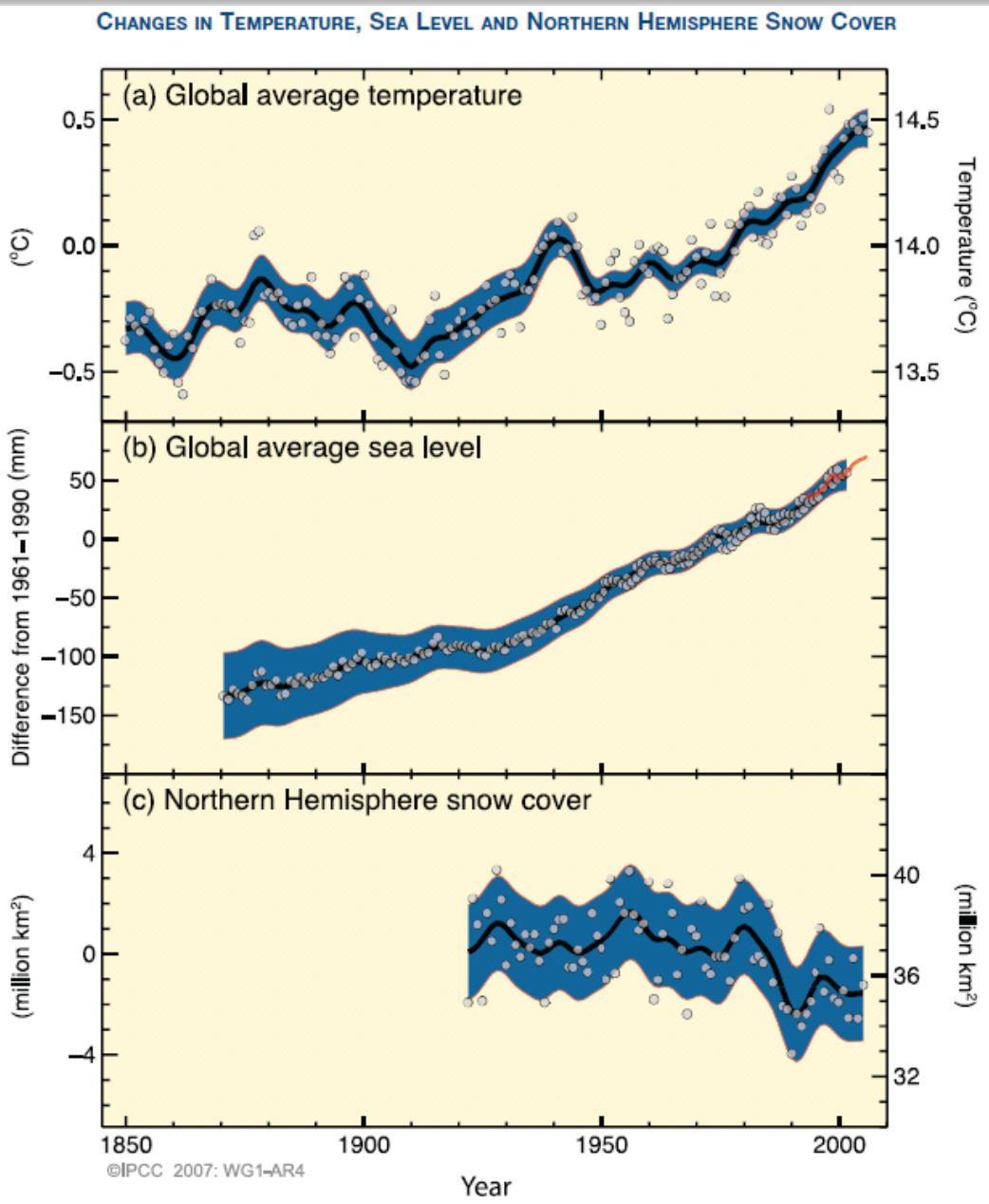


Figure SPM.3. *Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {FAQ 3.1, Figure 1, Figure 4.2, Figure 5.13}*

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観測された温度の変化は、人為的な原因を考慮した温度変化予測に合致している

（青は、自然起因（太陽活動、火山活動）のみを加味した温度予測。赤は、温暖化ガスの影響を加えたモデル計算の結果）

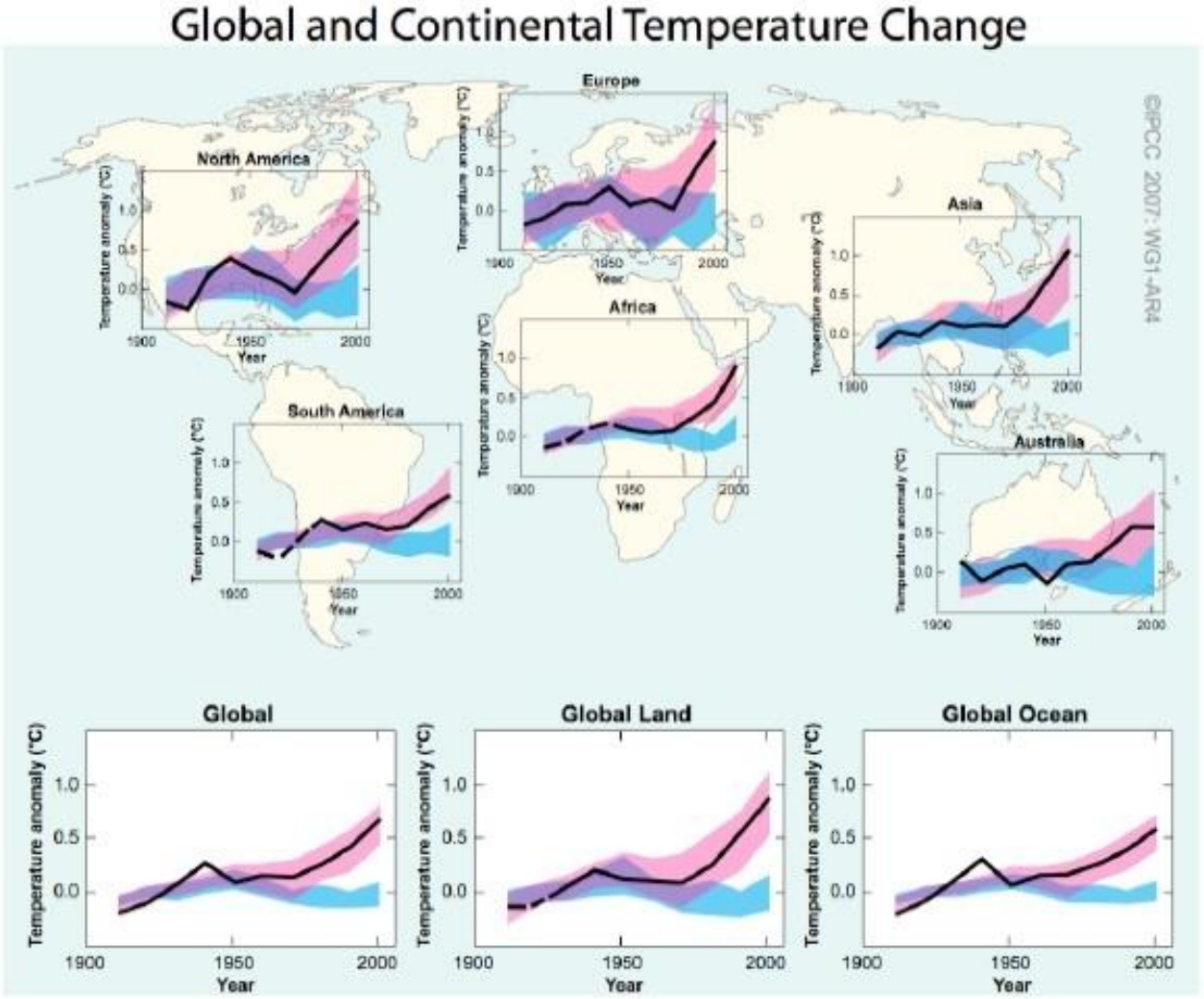

FIGURE SPM-4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906–2005 (black line) plotted against the centre of the decade and relative to the corresponding average for 1901–1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5–95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. {FAQ 9.2, Figure 1}

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将来の温度変化の予測。

(予測の幅は、将来の社会経済の予測が困難であることによるところが大きい。)

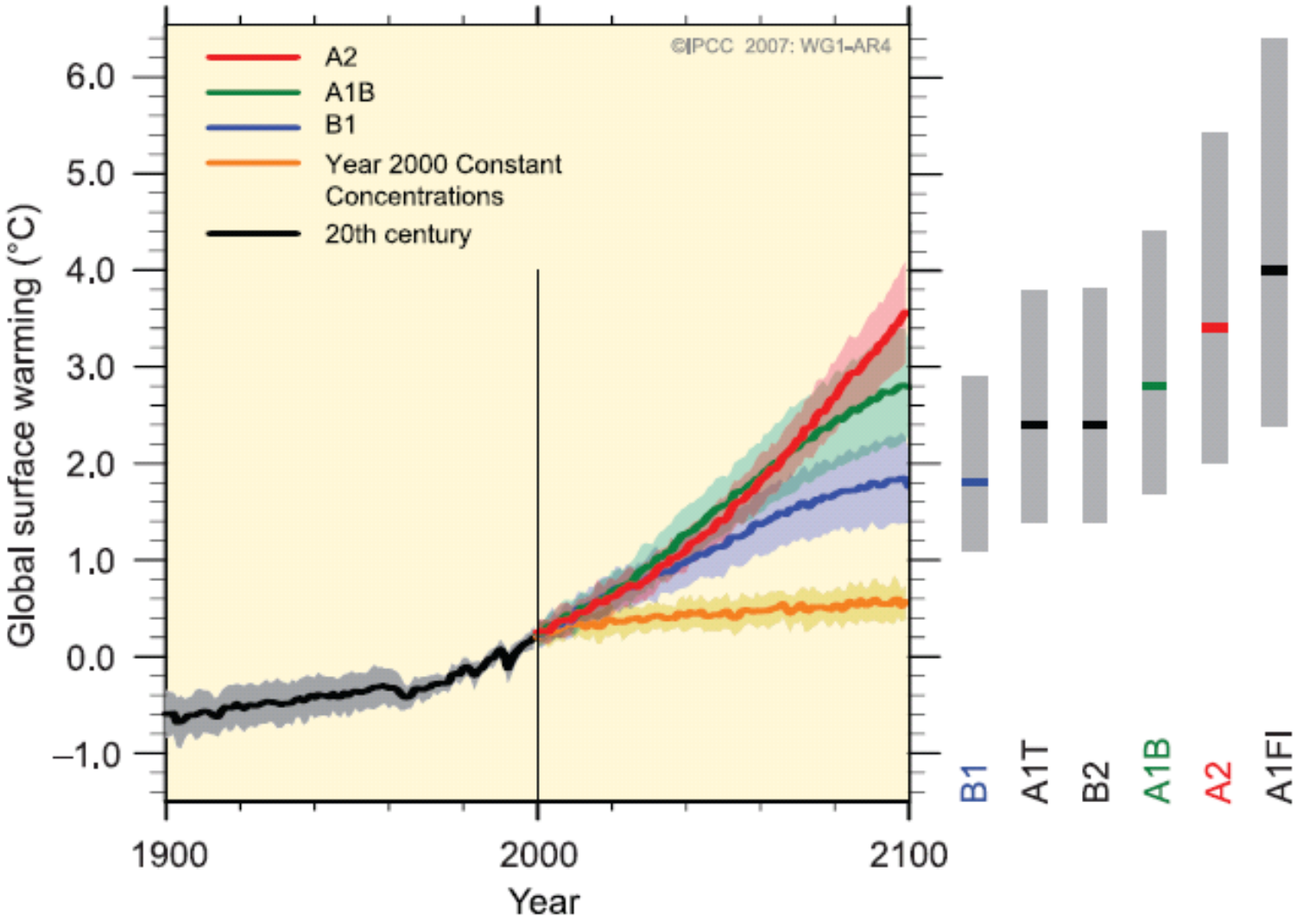

Figure SPM.5. *Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the **likely** range assessed for the six SRES marker scenarios. The assessment of the best estimate and **likely** ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. {Figures 10.4 and 10.29}*

将来の温暖化と海面上昇の予測

Table SPM.3. *Projected global average surface warming and sea level rise at the end of the 21st century. {10.5, 10.6, Table 10.7}*

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999)[a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations[b]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Table notes:

[a] These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth System Models of Intermediate Complexity and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs).

[b] Year 2000 constant composition is derived from AOGCMs only.

温度上昇は地域により異なる

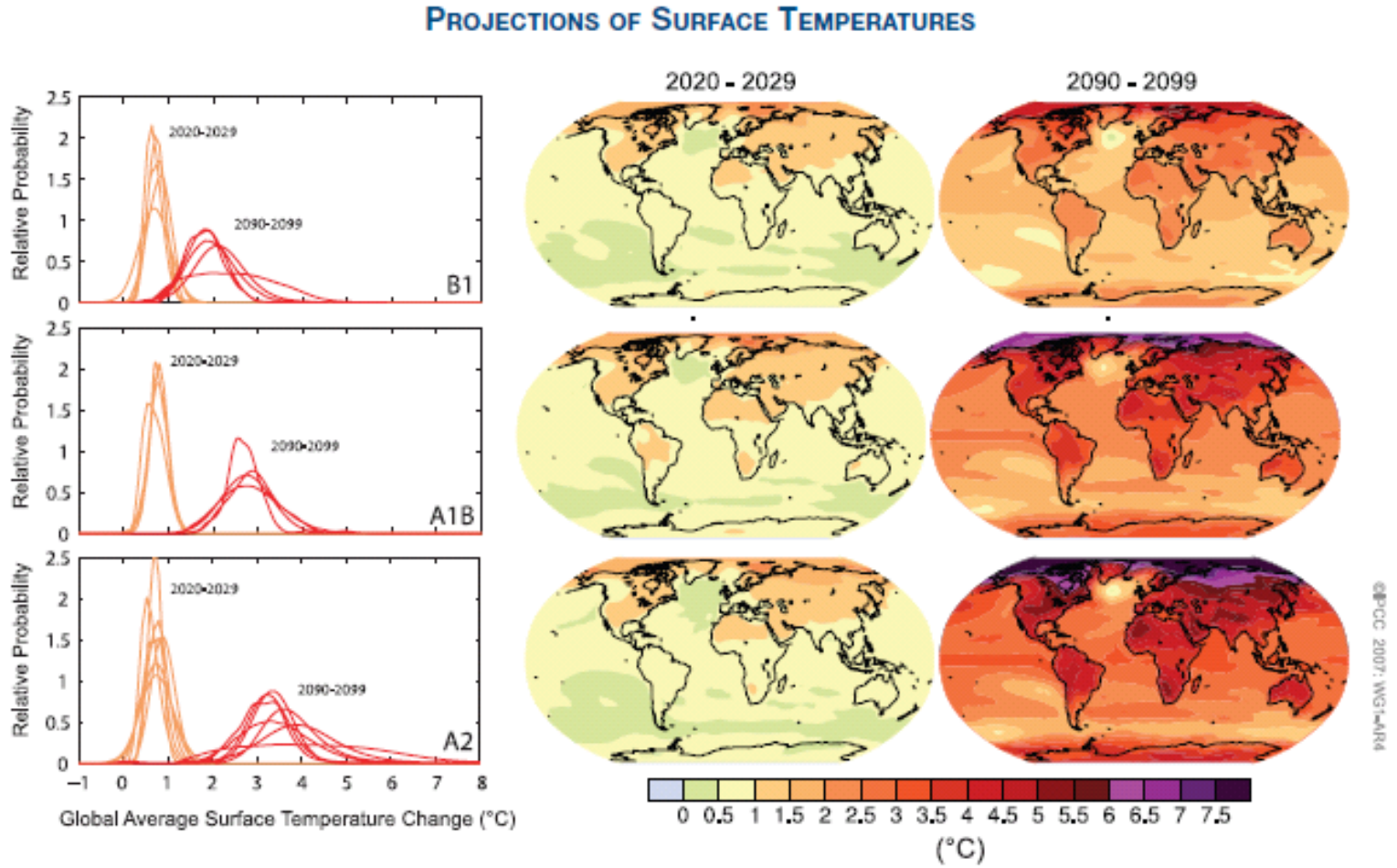

Figure SPM.6. *Projected surface temperature changes for the early and late 21st century relative to the period 1980–1999. The central and right panels show the AOGCM multi-model average projections for the B1 (top), A1B (middle) and A2 (bottom) SRES scenarios averaged over the decades 2020– 2029 (centre) and 2090–2099 (right). The left panels show corresponding uncertainties as the relative probabilities of estimated global average warming from several different AOGCM and Earth System Model of Intermediate Complexity studies for the same periods. Some studies present results only for a subset of the SRES scenarios, or for various model versions. Therefore the difference in the number of curves shown in the left-hand panels is due only to differences in the availability of results. {Figures 10.8 and 10.28}*

将来の降雨量(予測)も地域により異なる。

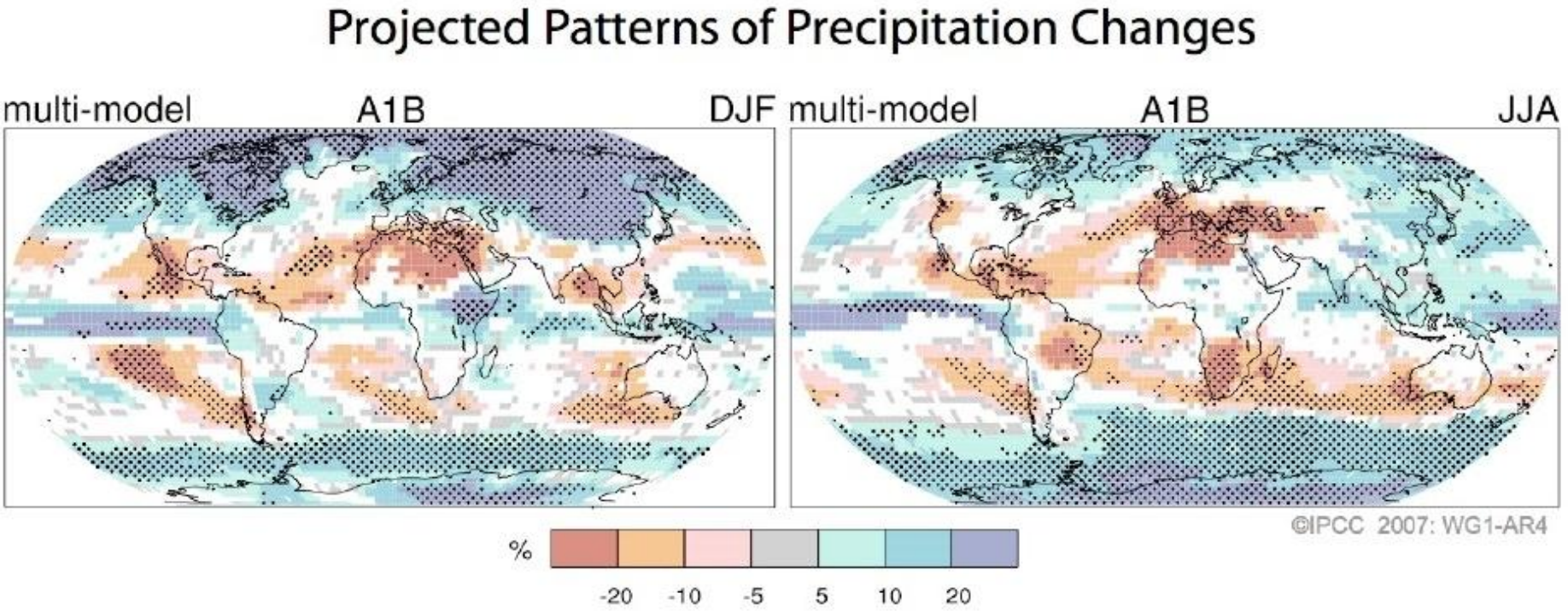

FIGURE SPM-6. Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {Figure 10.9}

Table SPM-1

将来の温度上昇に伴い種々の影響が出てくることが予測されている。

21世紀の温度上昇に応じた影響の予測が示されている。

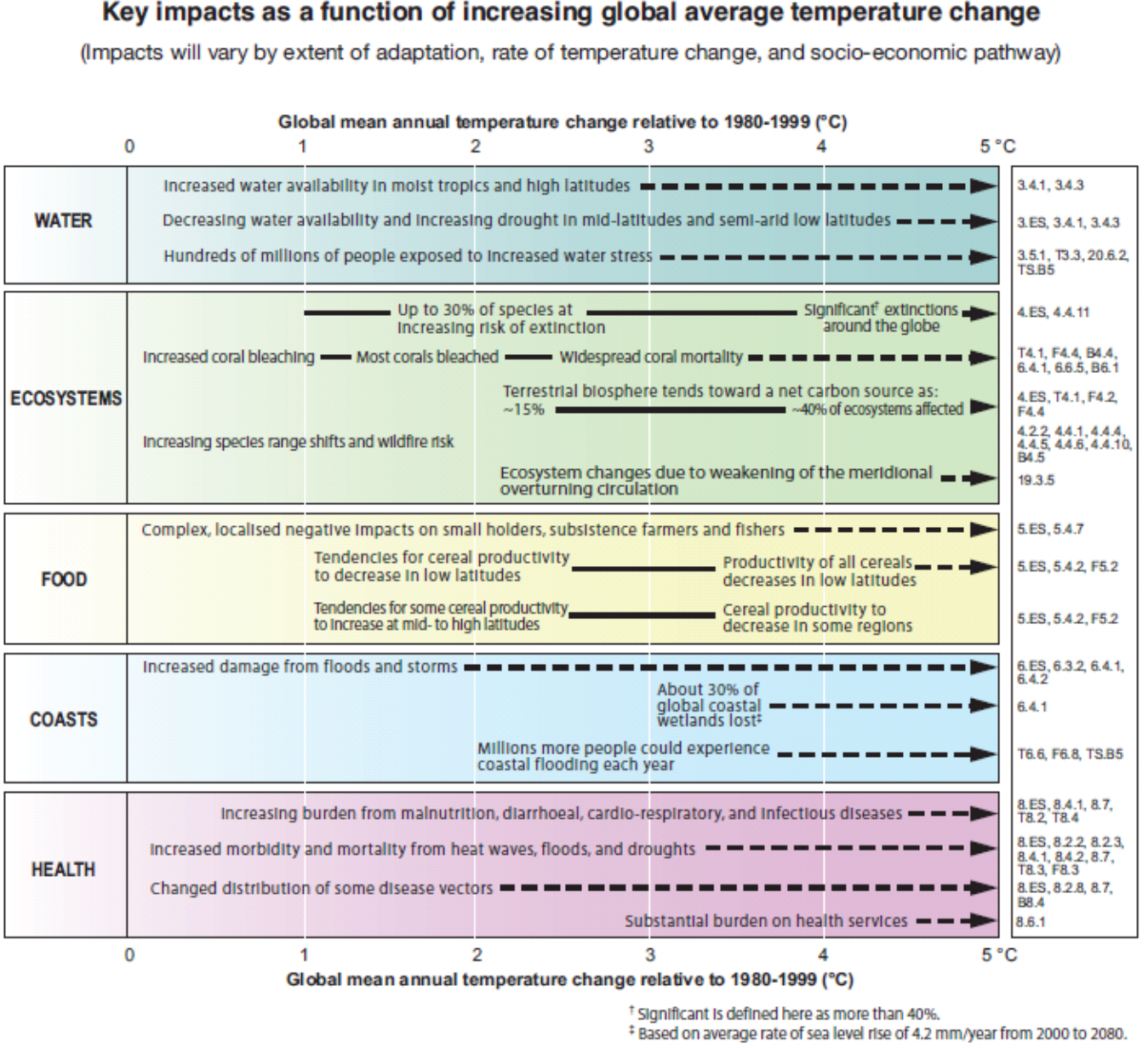

Figure SPM.2. *Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century [T20.8]. The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of the text indicates the approximate onset of a given impact. Quantitative entries for water stress and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Emissions Scenarios (SRES) scenarios A1FI, A2, B1 and B2 (see Endbox 3). Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Sources are given in the right-hand column of the Table. Confidence levels for all statements are high.*

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主要な温暖化ガスの放射強制力が示されている。

(I-----I は、科学的な知見が不十分であることを示している。)

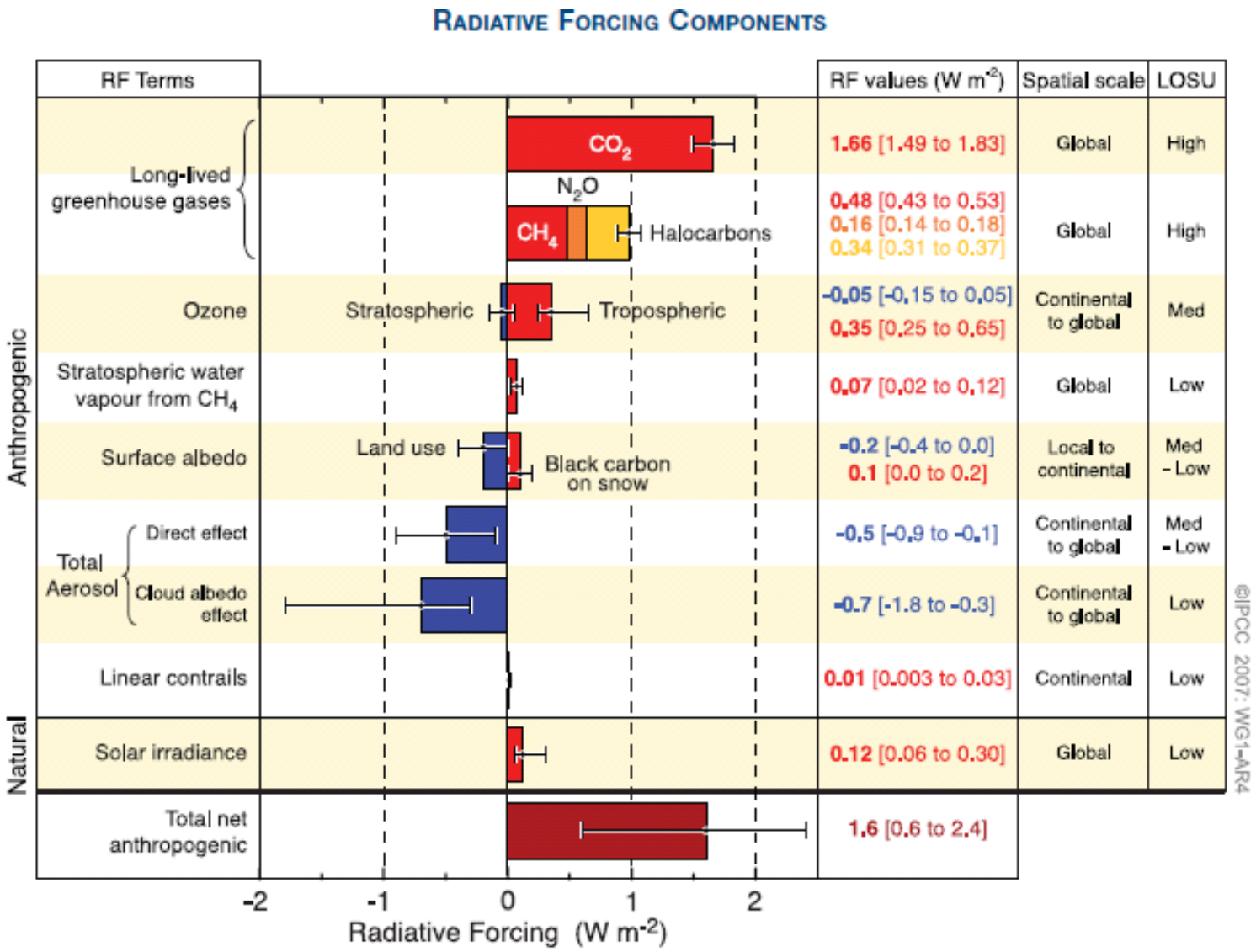


Figure SPM.2. *Global average radiative forcing (RF) estimates and ranges in 2005 for anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms, and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness. {2.9, Figure 2.20}*

温暖化ガスの排出量の増加が著しい。

Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land-cover and solar radiation alter the energy balance of the climate system.

Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 (Figure SPM.3).[5] {2.1}

Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000. {2.1}

Global anthropogenic GHG emissions

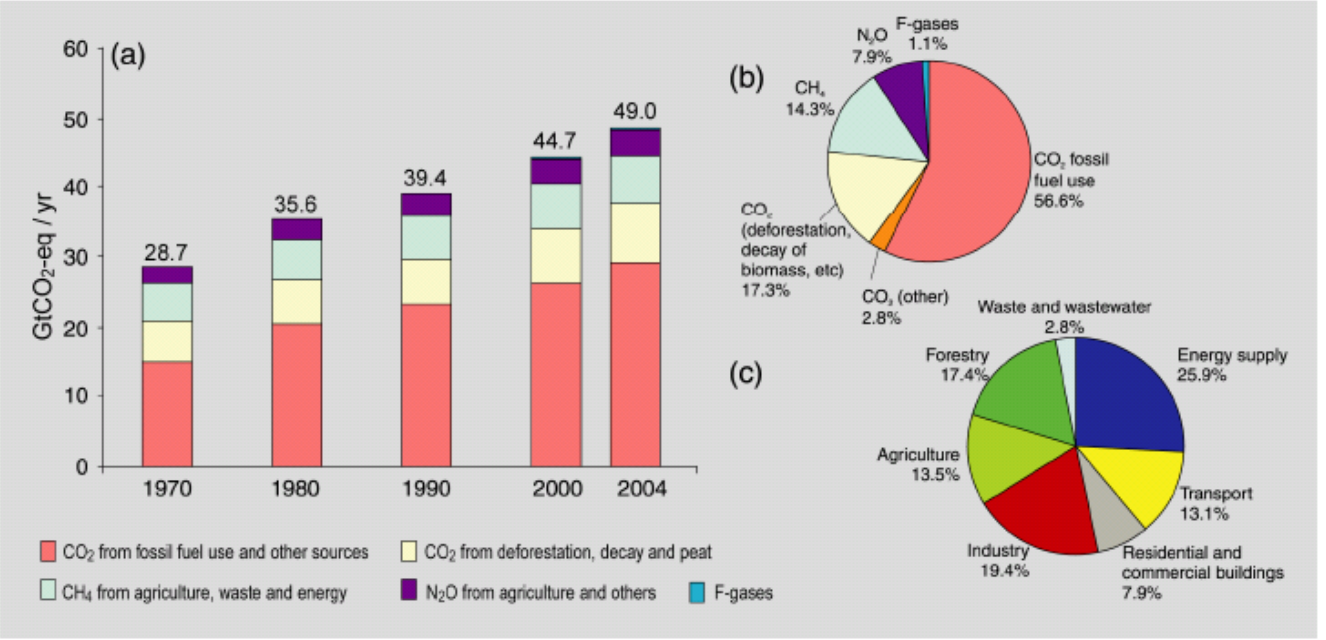


Figure SPM.3. (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.[5] (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO_2-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation). {Figure 2.1}

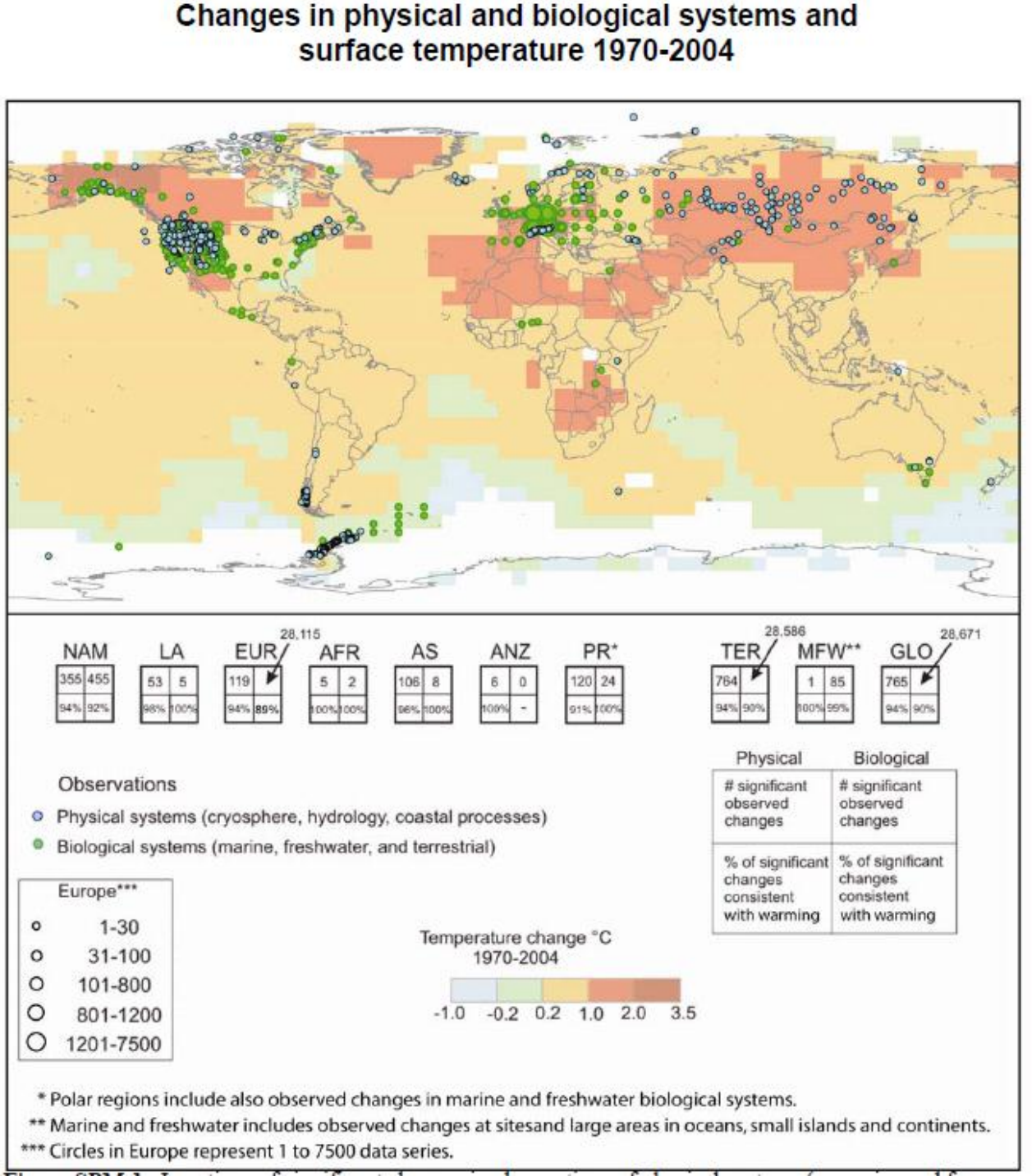
今後20年間を見ると、
0.2度/10年 程度の温度上昇
が起こるであろう。

(仮に、2000年時点の温暖化ガスの濃度レベルで維持することが可能となった場合にも、0.1度/10年程度の温度上昇が発生するであろう。)

- For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emissions scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emission scenarios.

Figure SPM-1

すでに温度上昇等に伴う生態学的な影響を示す科学論文が多数出ている。



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IPCC WG-III Chapt.13. Page 776

Box 13.7 The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group[a]

Scenario category	Region	2020	2050
A-450 ppm CO_2-eq[b]	Annex I	–25% to –40%	–80% to –95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
B-550 ppm CO_2-eq	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
C-650 ppm CO_2-eq	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and MIddle East, East Asia

Notes:

[a] The aggregate range is based on multiple approaches to apportion emissions between regions (contraction and convergence, multistage, Triptych and intensity targets, among others). Each approach makes different assumptions about the pathway, specific national efforts and other variables. Additional extreme cases – in which Annex I undertakes all reductions, or non-Annex I undertakes all reductions – are not included. The ranges presented here do not imply political feasibility, nor do the results reflect cost variances.

[b] Only the studies aiming at stabilization at 450 ppm CO_2-eq assume a (temporary) overshoot of about 50 ppm (See Den Elzen and Meinshausen, 2006).

Source: See references listed in first paragraph of Section 13.3.3.3

（平石 注： しばしば、この表から、 IPCC が 25-40% の削減を勧告した、とされるが、IPCC は、政策目標のレベルごとに必要となる削減レベル（複数）を提示したのみであることにご注意頂きたい。）

Table SPM.5: *Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10]*[a)]

Category	Radiative forcing (W/m^2)	CO_2 concentration[c)] (ppm)	CO_2-eq concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)]	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010-2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020-2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050-2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140	5
						Total	177

a) The understanding of the climate system response to radiative forcing as well as feedbacks is assessed in detail in the AR4 WGI Report. Feedbacks between the carbon cycle and climate change affect the required mitigation for a particular stabilization level of atmospheric carbon dioxide concentration. These feedbacks are expected to increase the fraction of anthropogenic emissions that remains in the atmosphere as the climate system warms. Therefore, the emission reductions to meet a particular stabilization level reported in the mitigation studies assessed here might be underestimated.

b) The best estimate of climate sensitivity is 3°C [WG 1 SPM].

c) Note that global mean temperature at equilibrium is different from expected global mean temperature at the time of stabilization of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150.

d) Ranges correspond to the 15th to 85th percentile of the post-TAR scenario distribution. CO_2 emissions are shown so multi-gas scenarios can be compared with CO_2-only scenarios.

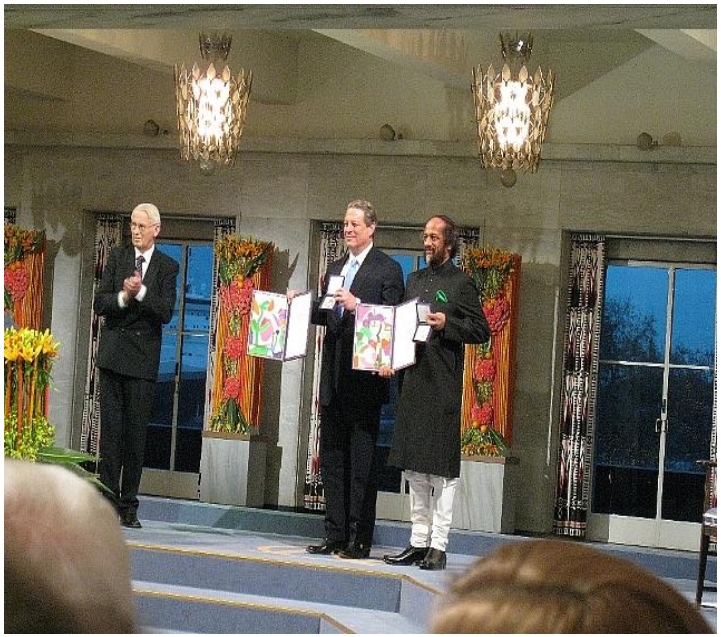
対策シナリオ別 平衡濃度、温度上昇、ピーク時期、2050年の排出

平衡温度は 2100-2150 に起こるとの予測が多い（表注 c））。

2007 年ノーベル平和賞!

2007年12月、オスロー。

元米国副大統領 Albert Arnold (Al) Gore Jr. とともに、IPCCは、人為的な気候変動に関する知識を確立し、普及し、かかる気候変動に対処するための対策の基盤を設定した努力に対して、ノーベル平和賞を授与された。



IPCC 第5次アセスメント報告書

第5次報告書(AR5)作成のプロセスが開始されており、各WGの報告書と統合報告書(Synthesis Report)は、2013年9月-2014年10月の間に順次完成する予定

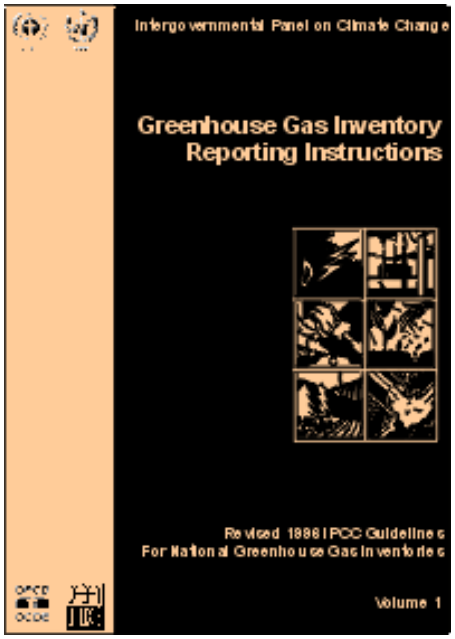
IPCC インベントリー計画事業
<http://www.ipcc-nggip.iges.or.jp/>

IPCC – NGGIP 報告書(1)

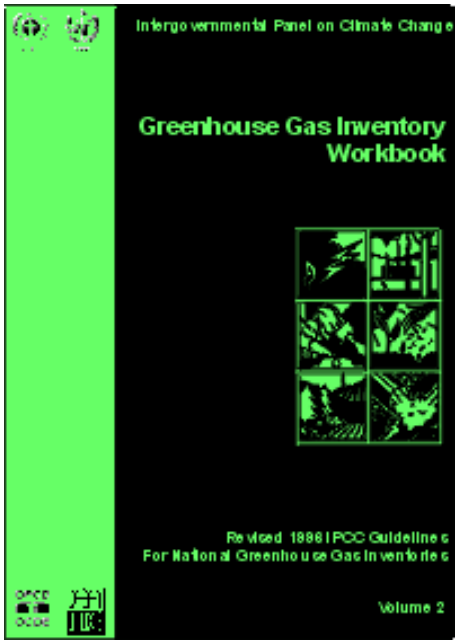
改定 1996年 IPCC 国別GHGインベントリーガイドライン

<http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>

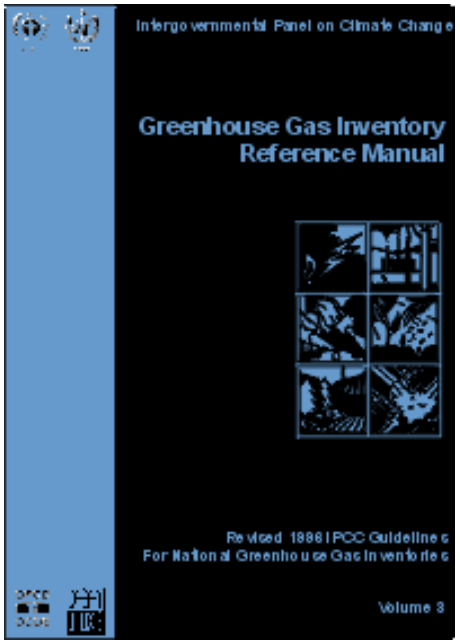
(cf. COP Decisions 4/CP.1, 9/CP.2, 2/CP.3 & *17/CP.8*)



Volume 1
Reporting
Instructions



Volume 2
Workbook
+
IPCC Software



Volume 3
Reference
Manual

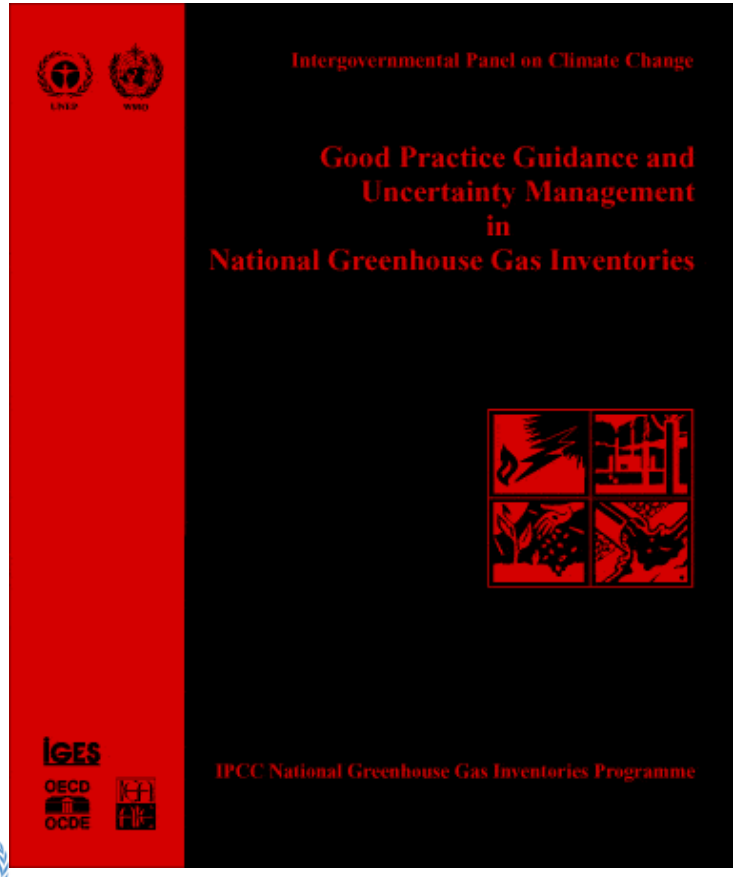
WMO UNEP

ipcc
INTERGOVERNMENTAL PANEL ON climate change

IPCC NGGIP 報告書(2)

IPPC 国別GHGインベントリー優良指針(Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories)

<http://www.ipcc-nggip.iges.or.jp/public/gp/english/> (All UN language versions)



Complements the Revised 1996 IPCC Guidelines

Published in 2000

Endorsed by SBSTA12 (June 2000)

Require its use by Annex-I Parties -"should". For Non-Annex-I Parties, Dec.17/CP.8 encourages its use.

Background Papers: IPCC Expert Meeting on Good Practice Guidance and Uncertainty Management in National GHG Inventories

Published in late 2002

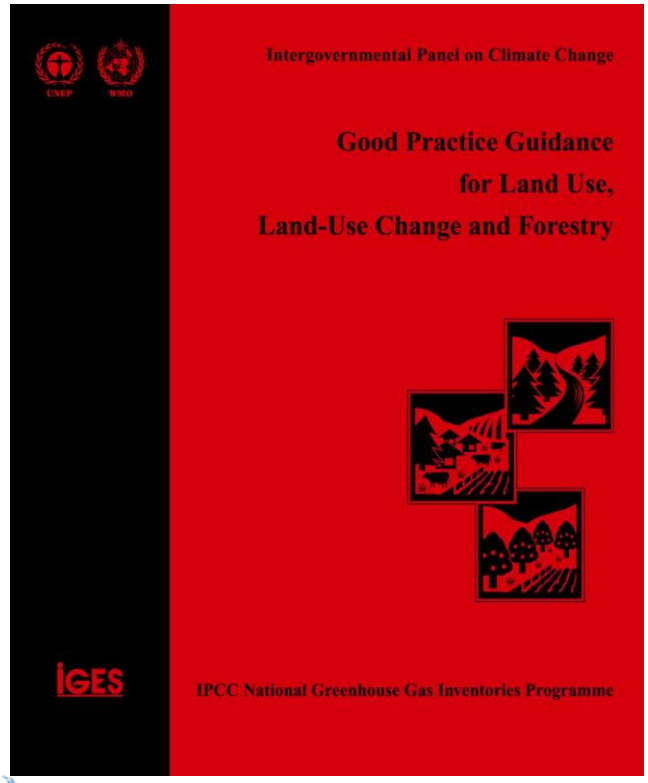
<http://www.ipcc-nggip.iges.or.jp/public/gp/gpg-bgp.htm>

IPCC NGGIP 報告書(3)

土地利用、森林に関する優良指針(IPCC Good Practice Guidance for Land use, Land-Use Change and Forestry, 2003)

<http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>

- **Actions by SBSTA at 19th, 20th, 21st sessions and Dec. 13/CP.9 (General) and Dec. 15/CP.10 (Art 3.3/3.4)**



Complements the Revised 1996 IPCC Guidelines.

GPG-LULUCF provides supplementary methods and good practice guidance for estimating, measuring, monitoring and reporting on carbon stock changes and greenhouse gas emissions from LULUCF activities under Article 3, paragraphs 3 and 4, and Articles 6 and 12 of the Kyoto Protocol.

IPCC NGGIP 報告書(4)

2006 年IPCC インベントリーガイドライン

(2,000 pages, 10 Kgs. Adopted by IPCC 26 (Mauritius, April 2006)

- Revision of the Revised 1996GLs was completed in April 2006. http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm
- UNFCCC SBSTA is considering its implementation – for Annex-I Parties

IPCCは、policy-relevant ではあるが、non-policy-prescriptive であることを基本的な方針としている。
これをすべての科学研究に当てはめることは不可能だが、政策決定のための基礎情報を科学的、中立的な立場から提供することは、科学研究者の究極の責務ではないでしょうか?

ご清聴ありがとうございました。