

Necessity of Global Warming Projection Information

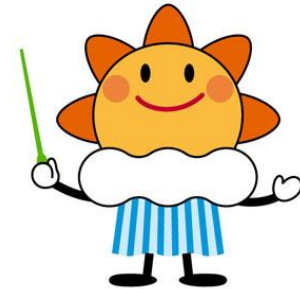
Koji Ishihara

Hirokazu Murai

Nubuyuki Kayaba

Souichirou Yasui

Shunya Wakamatsu



Schedule of this seminar

1st Day (26 January)

- Lectures on global warming, IPCC AR5 and experimental design of GWP
- **Reception**

2nd Day (27 January)

- Lectures on JRA55 and outline of our work
- Lectures and exercises : check of reproducibility, assessment of future climate change and uncertainty check of the results

3rd Day – 4th Day (28 - 29 January)

- Exercise of global warming projection for your country

4th Day (29 January)

- **13:00- 16:00 Symposium** (Science of climate change and our future)

5th Day (30 January)

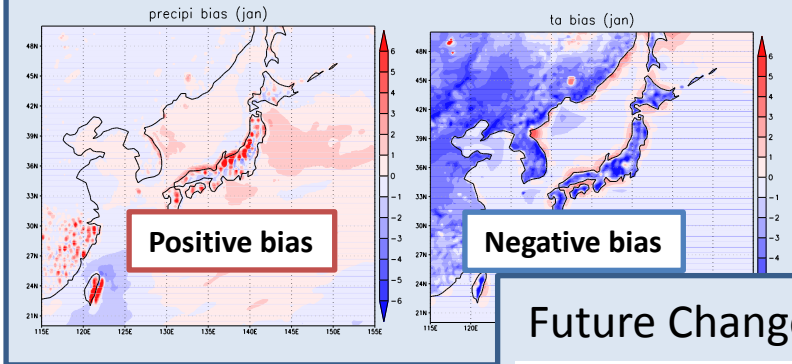
- Your presentation (15 minutes per person)
- **Technical tour**

Goal of this seminar

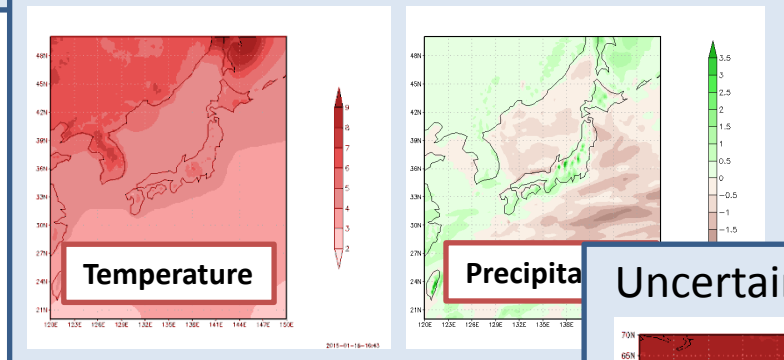
Ex : case of Japan

Global warming projection information for your country

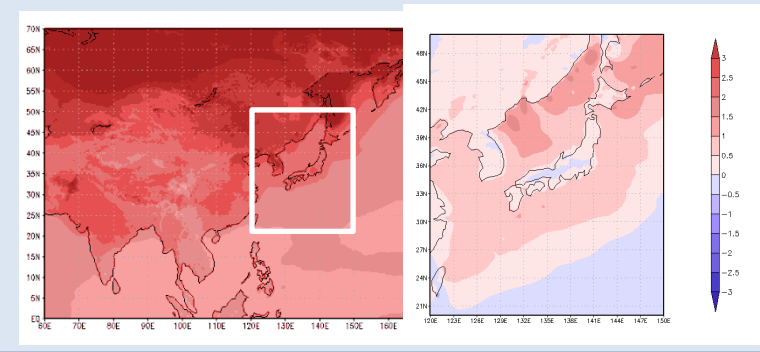
Reproducibility



Future Change



Uncertainty (Reliability)



➔ Detailed lectures will be given tomorrow

History of the Earth

Earth's formation
(4.6 billion years
before present)



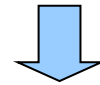
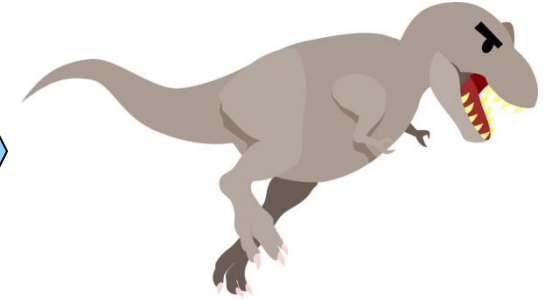
January 1st 00:00



Beginning of life
(4 billion years
before present)



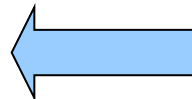
Disappearance of the dinosaurs
(65 million years before present)



Present



December 31st 24:00



Foundation of Japan
(2,000 years before present)

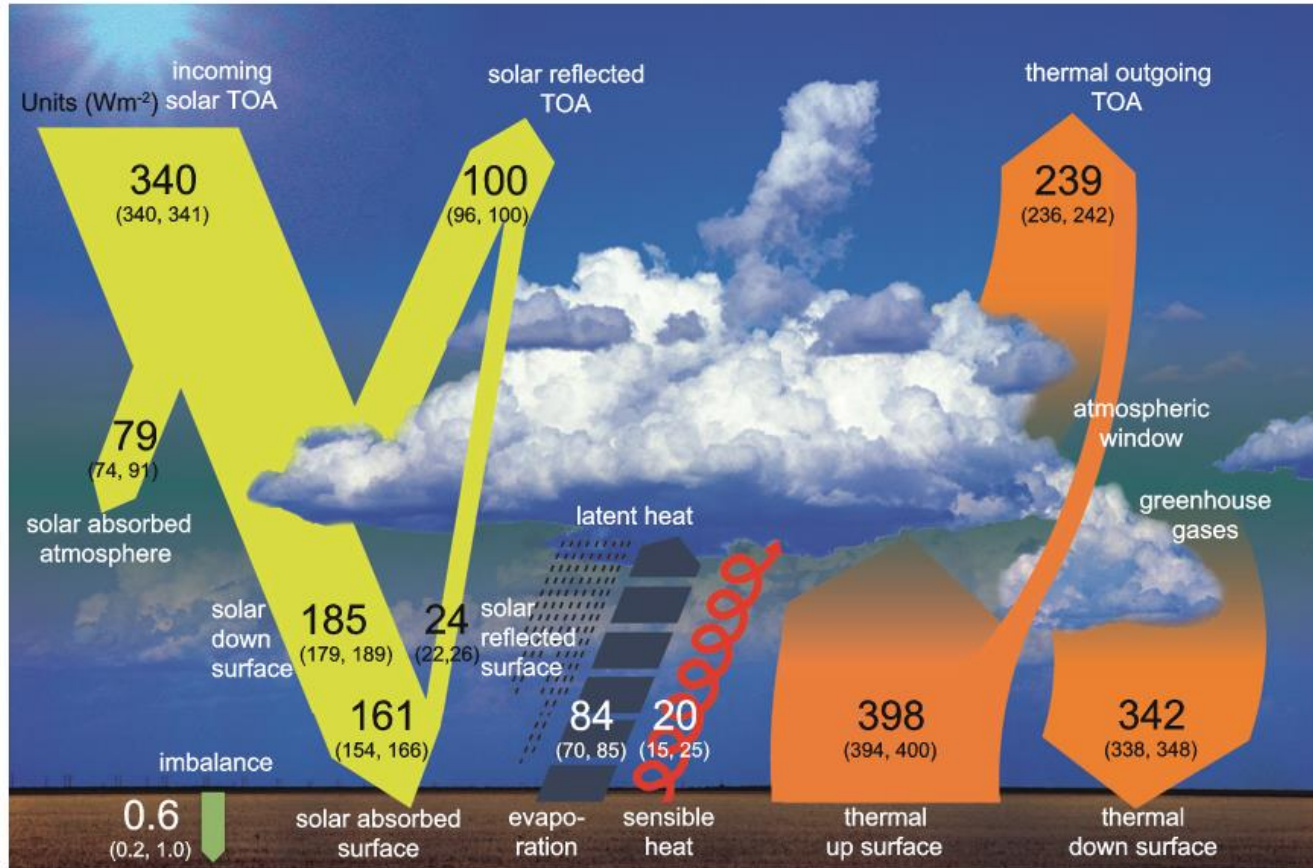


Dawn of humanity
(5 million years before present)



Date & Time?

Energy Budget & Global Warming

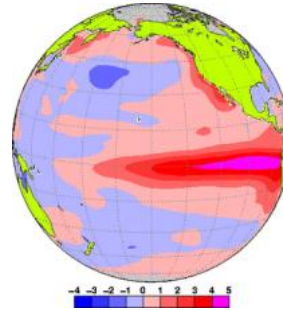


Natural greenhouse gases such as carbon dioxide, methane and nitrous oxide have an important role to play in balancing the earth's temperature by trapping, absorbing and re-radiate the Sun's warmth, and maintaining the Earth's surface temperature at a level necessary to support life. Increasing concentrations of greenhouse gases due to human activities like burning of fossil fuels have led to an greater trapping of the Sun's heat and in turn a warming of the earth's atmosphere and surface known as global warming.

Factors of Climate Change

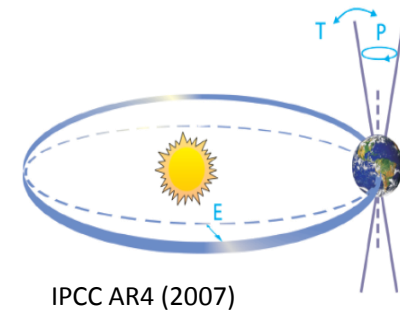
Natural Internal Variability

- El Niño phenomenon



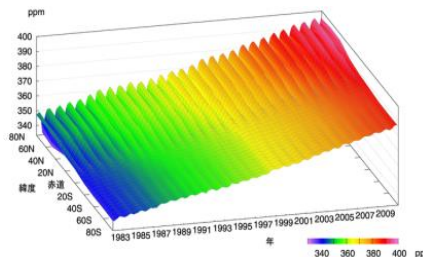
Natural External Factor

- Eruption of volcanos
- Fluctuation of Sun's activity



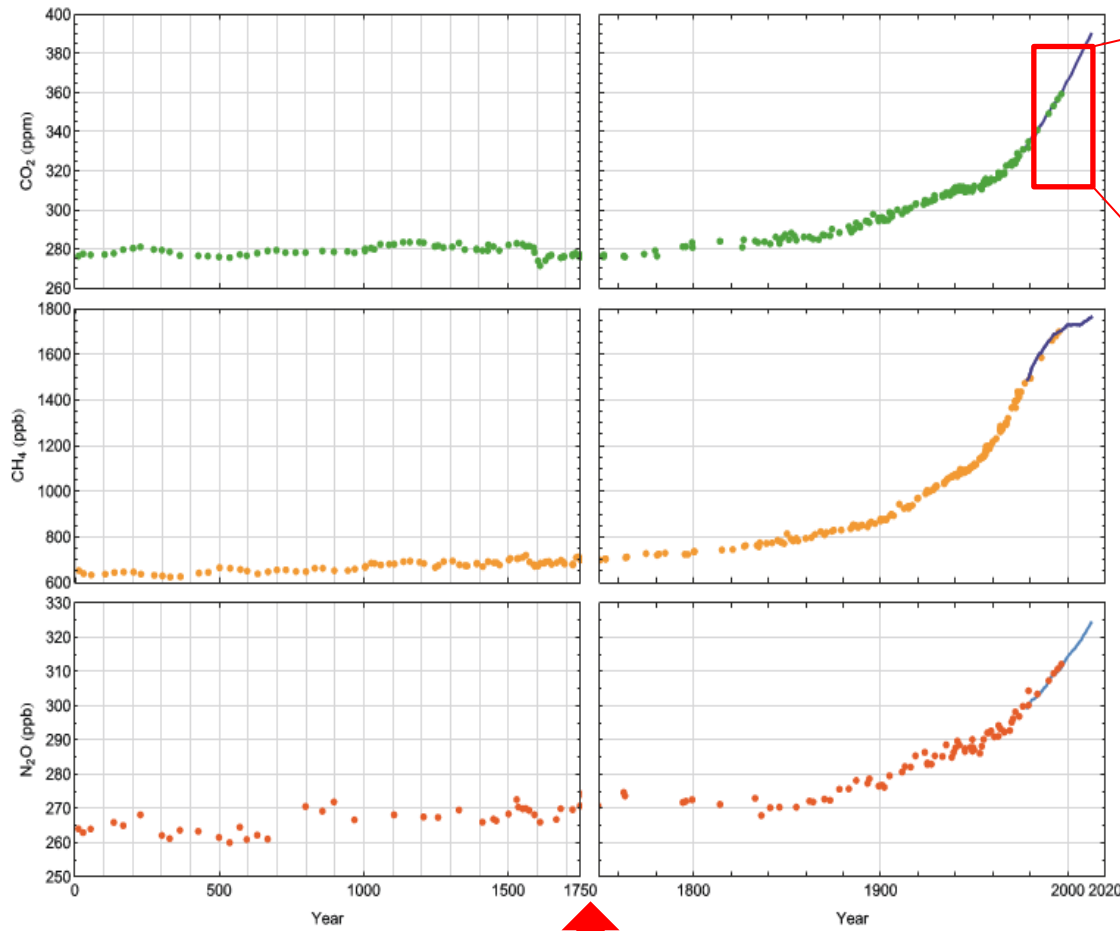
Anthropogenic Factor

- Change of land use
- Emission of greenhouse gases

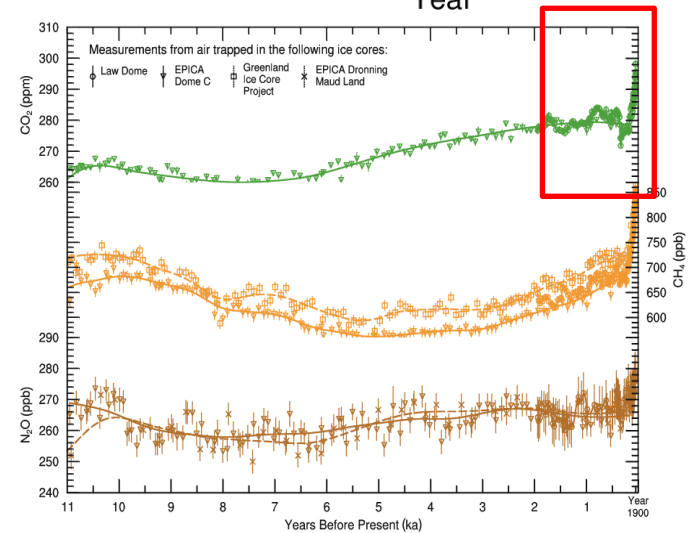
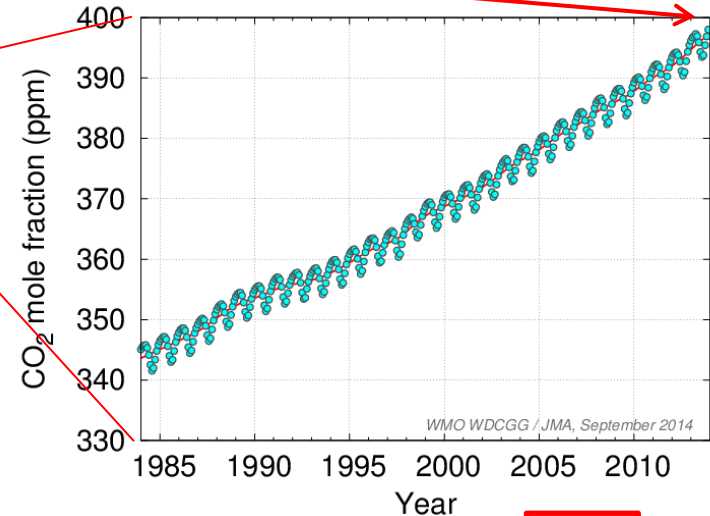


Long-term change of CO₂ concentration

the amount of CO₂ in the atmosphere reached 396.0 parts per million (ppm) in 2013.



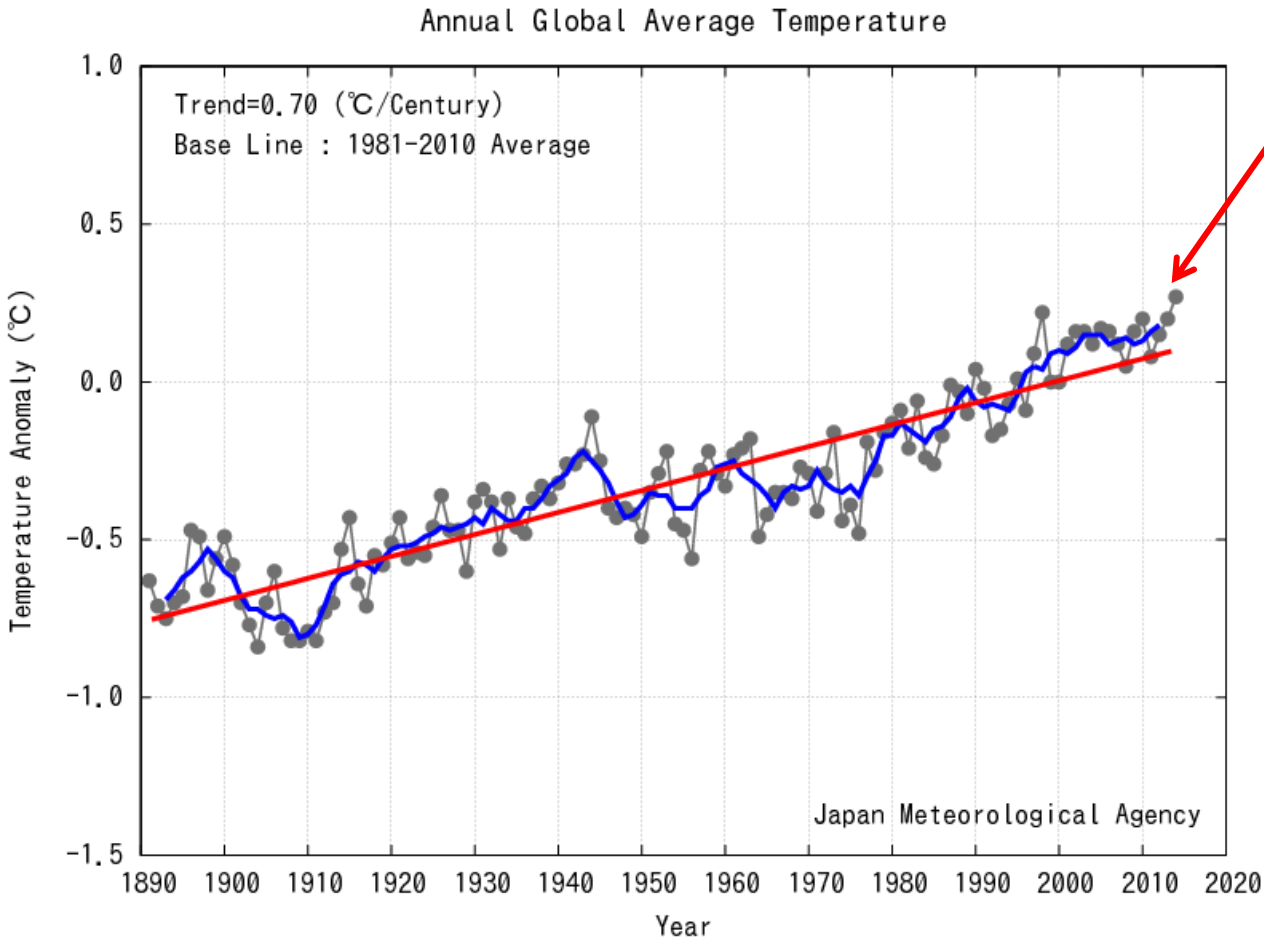
industrial revolution



https://www.wmo.int/pages/mediacentre/press_releases/pr_1002_en.html

IPCC Fifth Assessment Report (WG1 Figure 6.7, 6.11)

Long-term change of global temperature



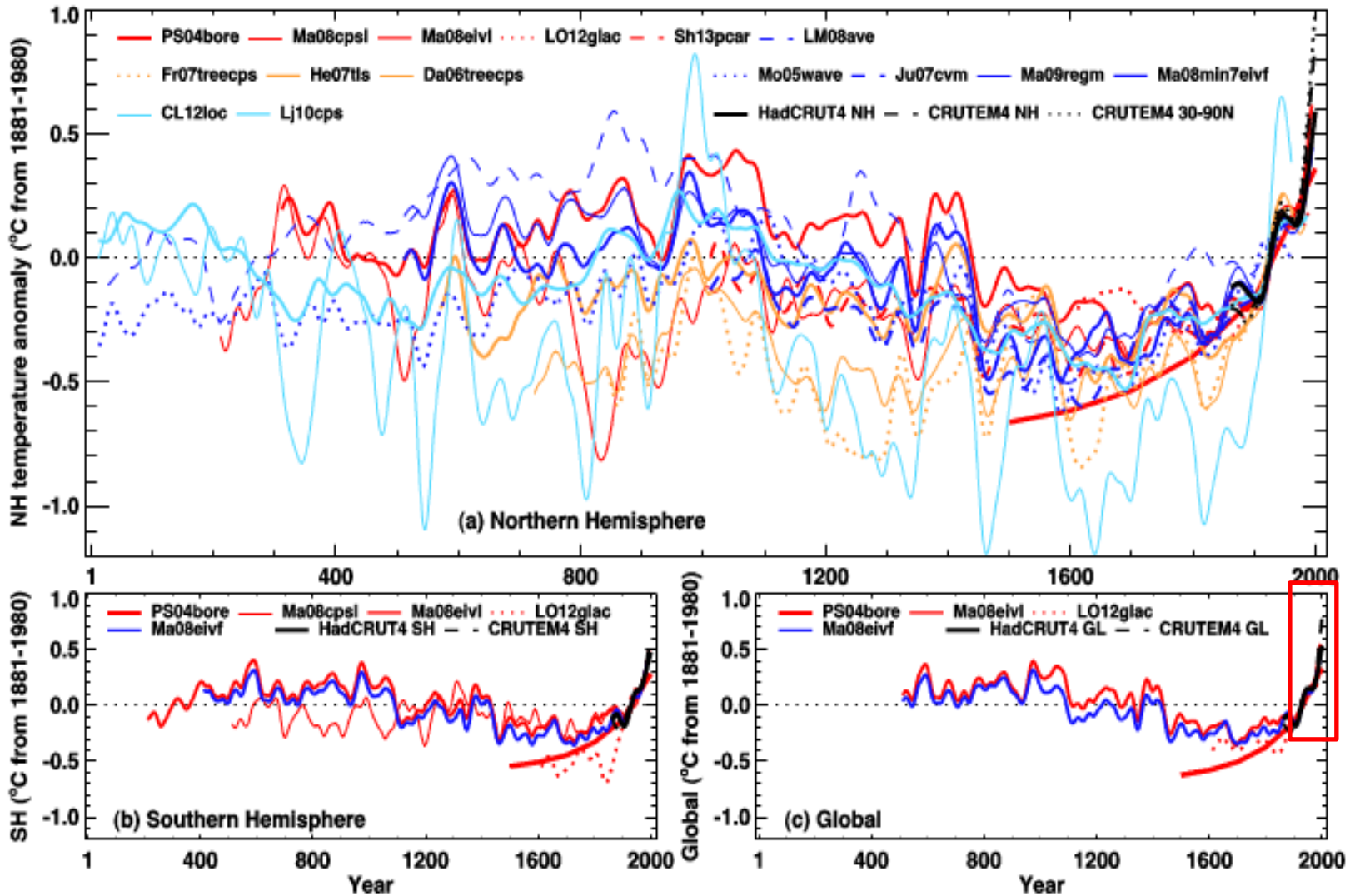
2014 : Highest since 1891

Annual global average temperature for 2014 is likely to become the warmest record for the 124-year period since 1891.

Annual global average temperature increases at a rate of about 0.70°C per century.

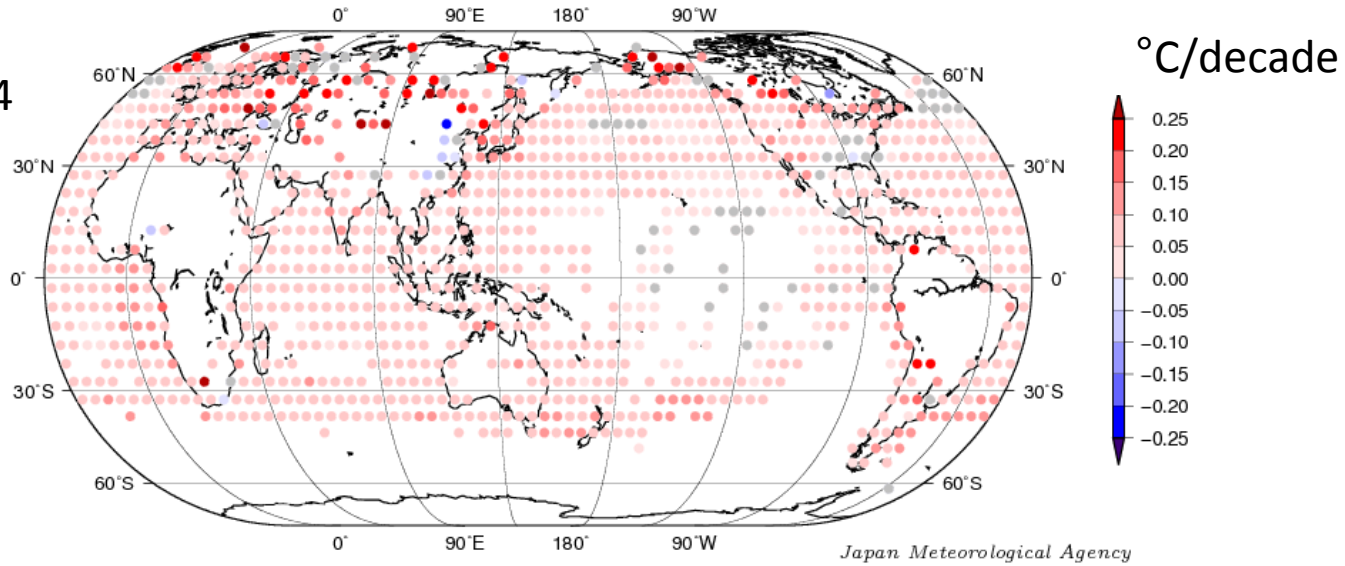
Anomalies are deviation from baseline (1981-2010 Average).
The black thin line indicates surface temperature anomaly of each year.
The blue line indicates their 5-year running mean.
The red line indicates the long-term linear trend.

Long-term change of global temperature

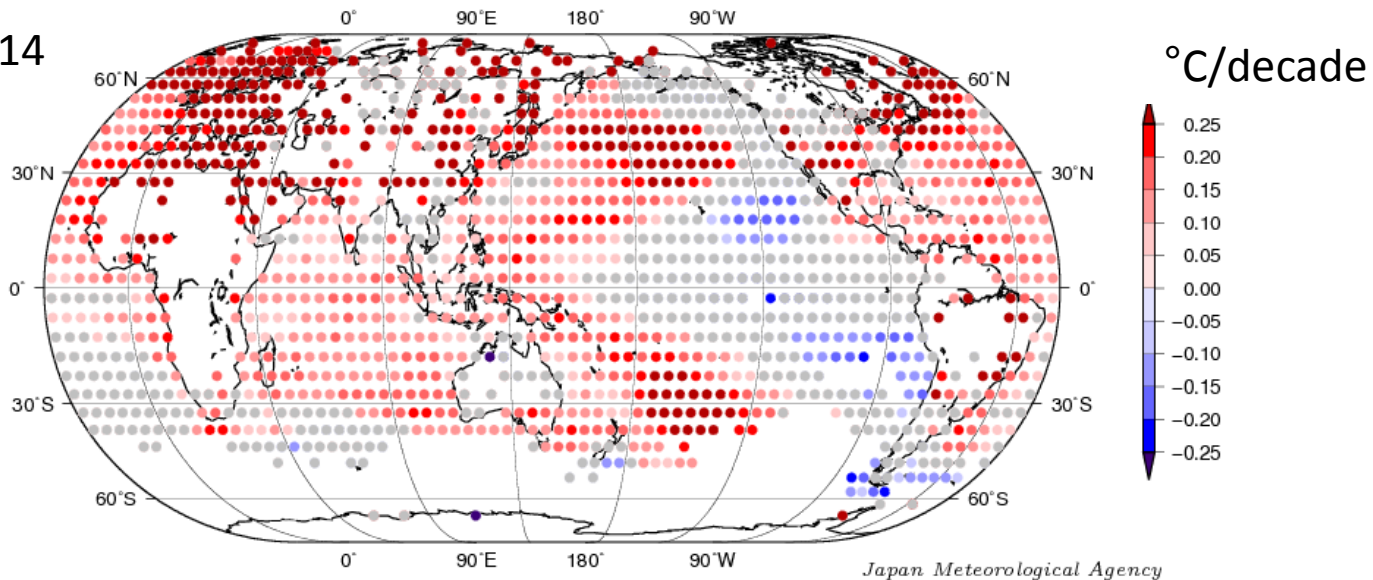


Long-term trend of annual temperature

1891-2014



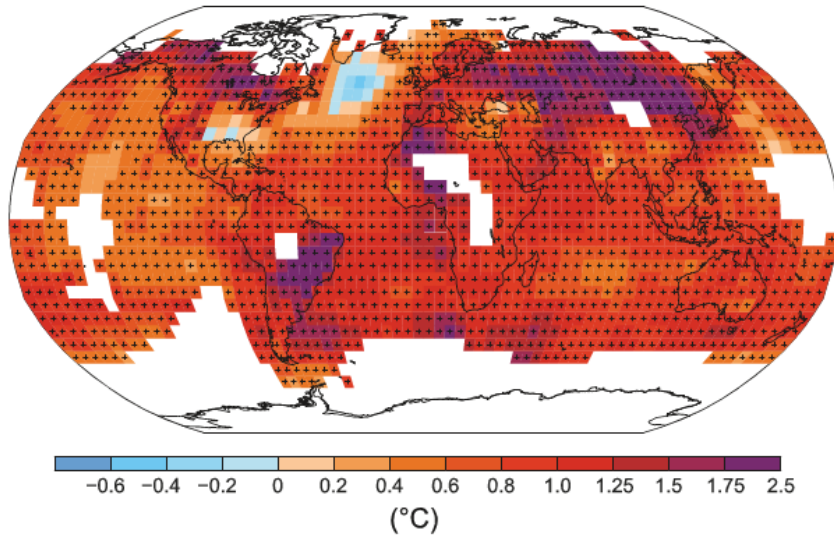
1979-2014



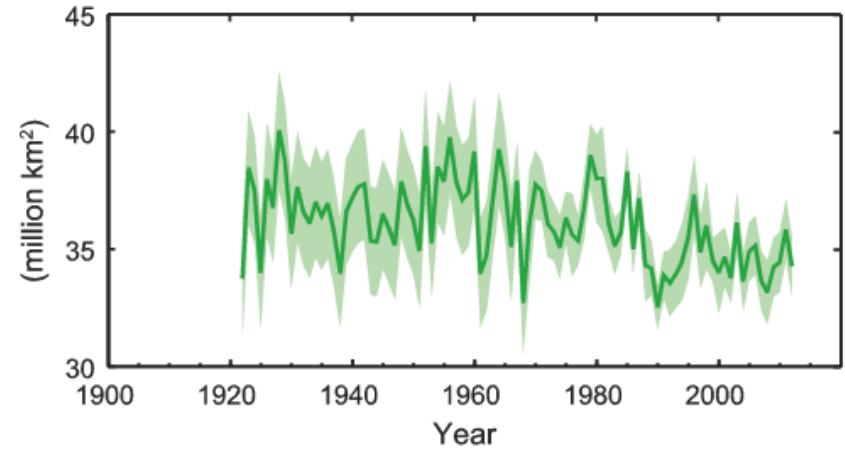
Grey : statistically insignificant at the confidence level of 90%

Observed Climate Change

Observed change in surface temperature 1901–2012

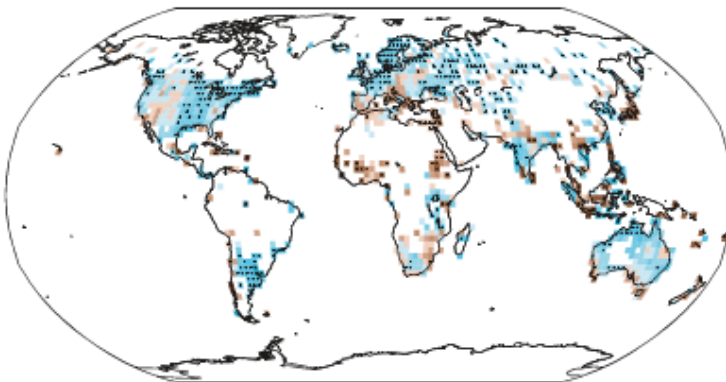


(a) Northern Hemisphere spring snow cover

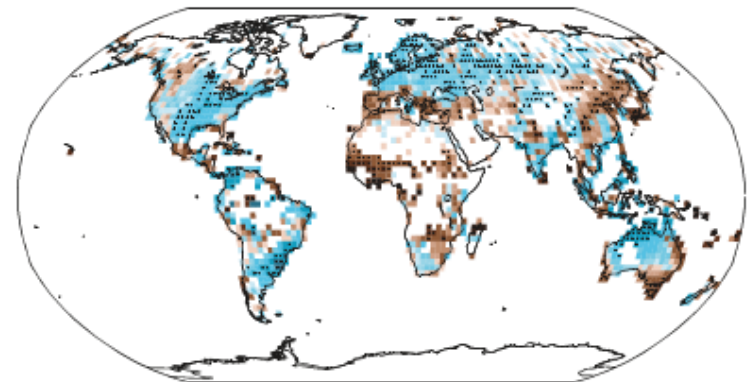


Observed change in annual precipitation over land

1901–2010



1951–2010

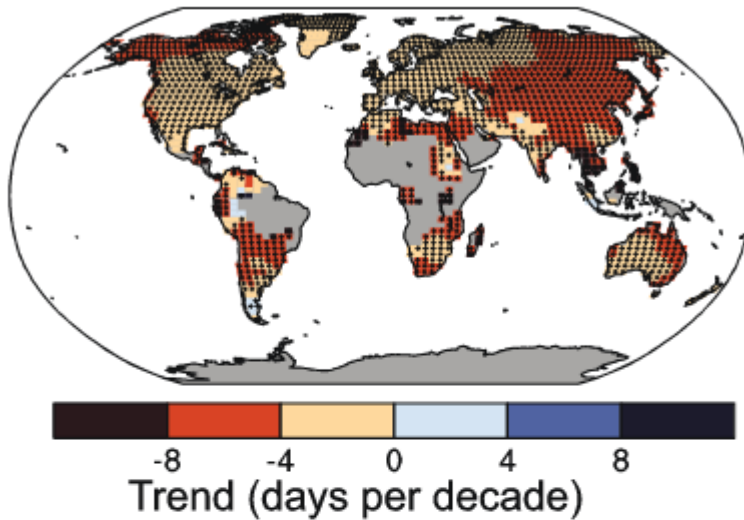


-100 -50 -25 -10 -5 -2.5 0 2.5 5 10 25 50 100

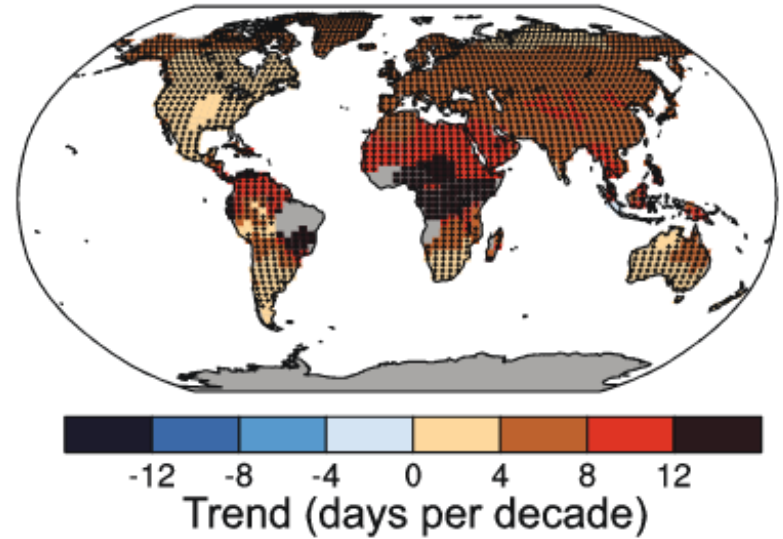
(mm yr⁻¹ per decade)

Observed Climate Change (1951-2010)

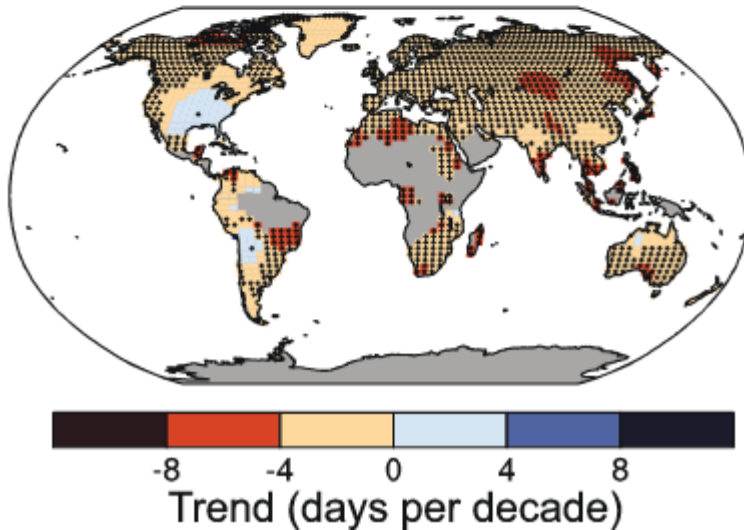
(a) Cold Nights



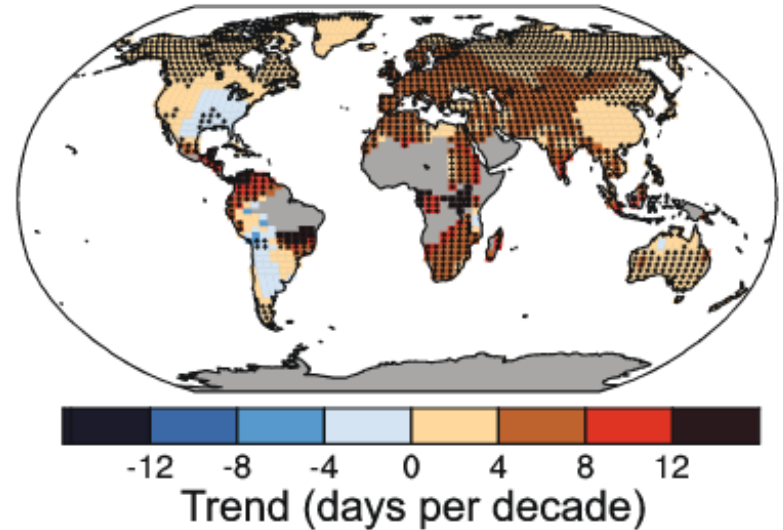
(c) Warm Nights



(b) Cold Days

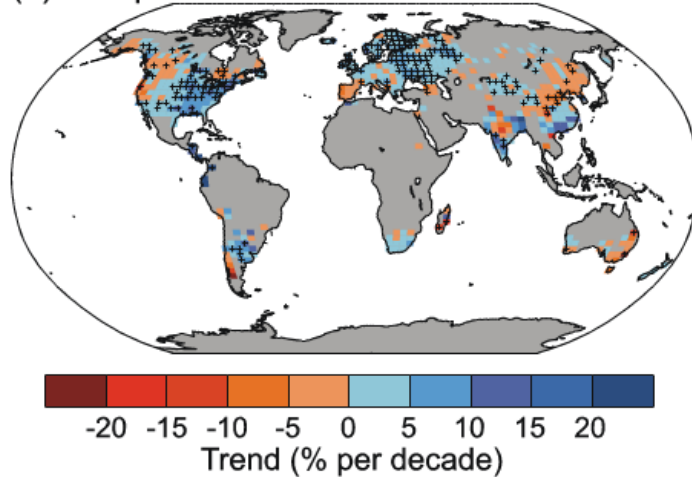


(d) Warm Days

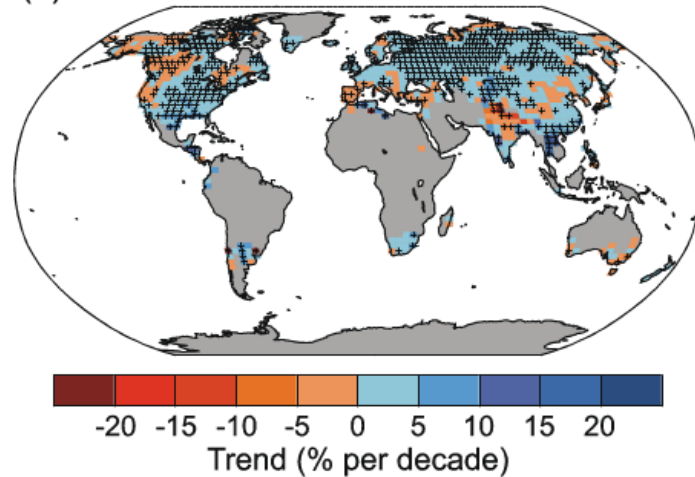


Observed Climate Change

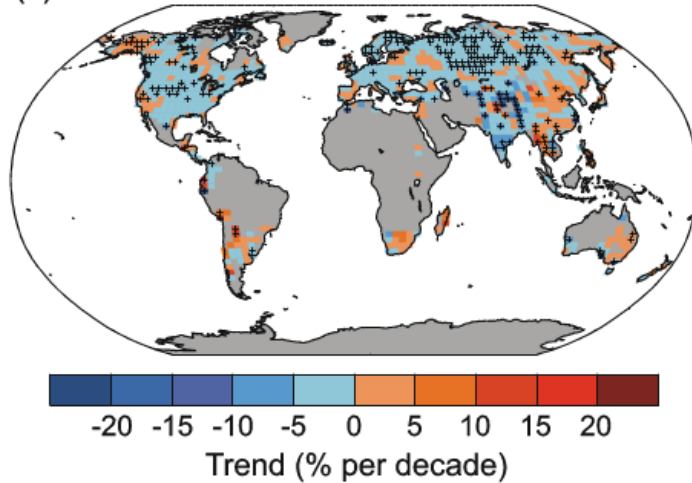
(a) R95p 1951-2010



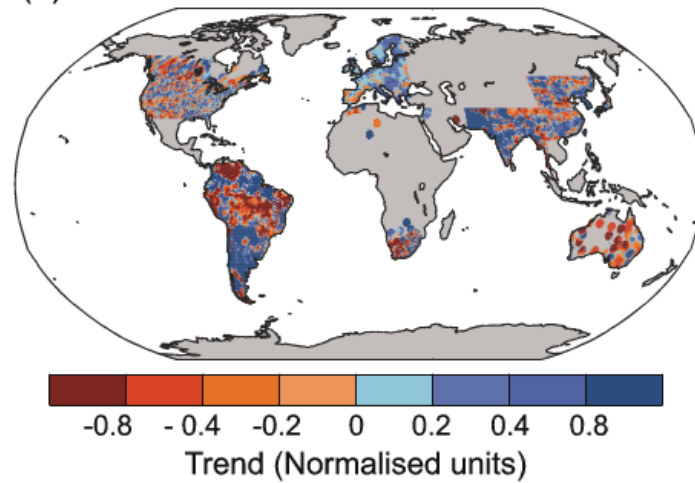
(b) SDII 1951-2010



(c) CDD 1951-2010











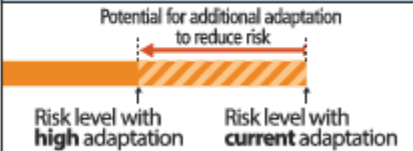


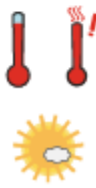


(d) HY-INT 1976-2000

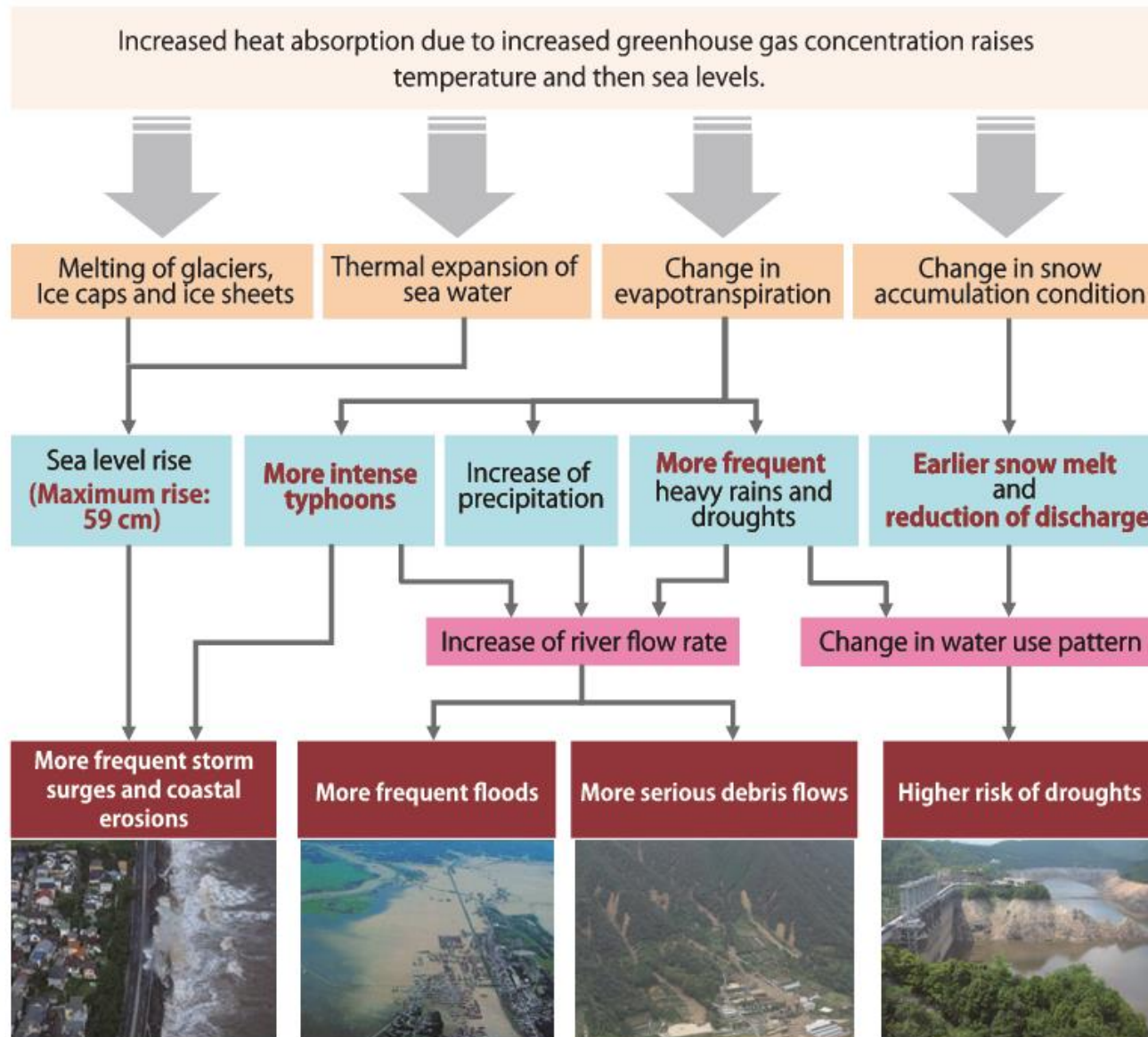


(a) annual amount of precipitation from days >95th percentile (R95p), (b) daily precipitation intensity (SDII), (c) frequency of the annual maximum number of consecutive dry days (CDD), (d) hydroclimatic intensity (HY-INT)

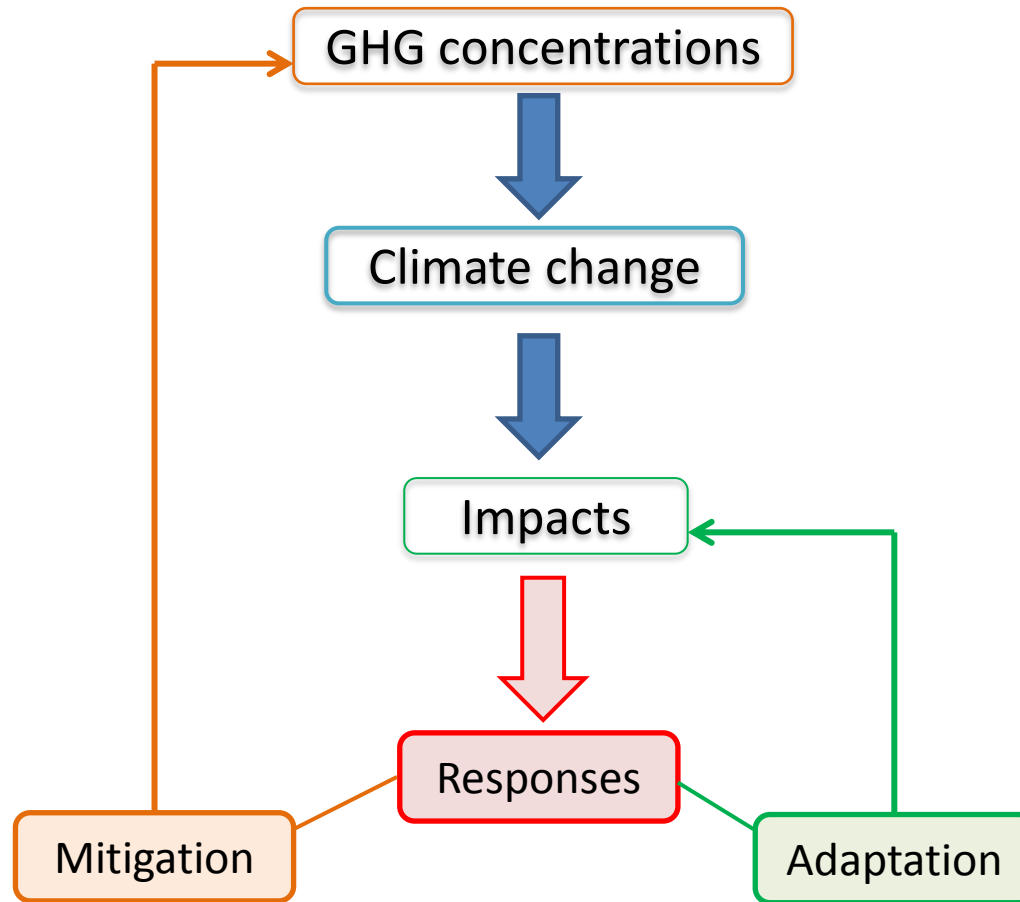
Key Regional Risks in Asia

Climate-related drivers of impacts										Level of risk & potential for adaptation	
 Warming trend	 Extreme temperature	 Drying trend	 Extreme precipitation	 Precipitation	 Snow cover	 Damaging cyclone	 Sea level	 Ocean acidification	 Carbon dioxide fertilization		
Asia											
Key risk	Adaptation issues & prospects					Climatic drivers	Timeframe	Risk & potential for adaptation			
Increased riverine, coastal, and urban flooding leading to widespread damage to infrastructure, livelihoods, and settlements in Asia (<i>medium confidence</i>) [24.4]	<ul style="list-style-type: none"> Exposure reduction via structural and non-structural measures, effective land-use planning, and selective relocation Reduction in the vulnerability of lifeline infrastructure and services (e.g., water, energy, waste management, food, biomass, mobility, local ecosystems, telecommunications) Construction of monitoring and early warning systems; Measures to identify exposed areas, assist vulnerable areas and households, and diversify livelihoods Economic diversification 							Very low	Medium	Very high	
							Present	[Risk level bar]			
							Near term (2030–2040)	[Risk level bar]			
							Long term (2080–2100)	2°C	[Risk level bar]		
			4°C	[Risk level bar]							
Increased risk of heat-related mortality (<i>high confidence</i>) [24.4]	<ul style="list-style-type: none"> Heat health warning systems Urban planning to reduce heat islands; Improvement of the built environment; Development of sustainable cities New work practices to avoid heat stress among outdoor workers 							Very low	Medium	Very high	
							Present	[Risk level bar]			
							Near term (2030–2040)	[Risk level bar]			
							Long term (2080–2100)	2°C	[Risk level bar]		
			4°C	[Risk level bar]							
Increased risk of drought-related water and food shortage causing malnutrition (<i>high confidence</i>) [24.4]	<ul style="list-style-type: none"> Disaster preparedness including early-warning systems and local coping strategies Adaptive/integrated water resource management Water infrastructure and reservoir development Diversification of water sources including water re-use More efficient use of water (e.g., improved agricultural practices, irrigation management, and resilient agriculture) 							Very low	Medium	Very high	
							Present	[Risk level bar]			
							Near term (2030–2040)	[Risk level bar]			
							Long term (2080–2100)	2°C	[Risk level bar]		
			4°C	[Risk level bar]							

Global warming threatens the water sector



Adaptation and Mitigation



A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Actions and strategies intended to minimize the effects that global warming will have on humans and nature.

History of Global Warming

1824 Joseph Fourier indicated the existence of greenhouse effect.

1859 John Tyndall verified the existence of greenhouse effect.

1896 Svante August Arrhenius estimated the future temperature change due to global warming.

1957~58 International Geophysical Year

CO₂, aurora, cosmic rays, geomagnetism, gravity, solar activity and so on.

1980s Improvement of simulation technique for global warming projection

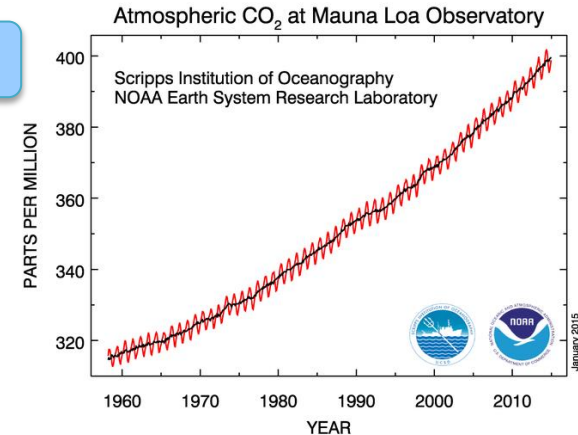
1988 IPCC (Intergovernmental Panel on Climate Change)

⇒ Next lecture

Scientific intergovernmental body under the auspices of the United Nations, and established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). IPCC reports cover "the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation." The 2007 Nobel Peace Prize was shared between the IPCC and Al Gore.

1992 UNFCCC (United Nations Framework Convention on Climate Change)

International environmental treaty negotiated at the "Earth Summit" held in Rio de Janeiro in June 1992. The objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (Article 2)".



<http://www.esrl.noaa.gov/gmd/obop/mlo/>



<https://unfccc.int/2860.php>

IPCC Fifth Assessment Report (AR5)

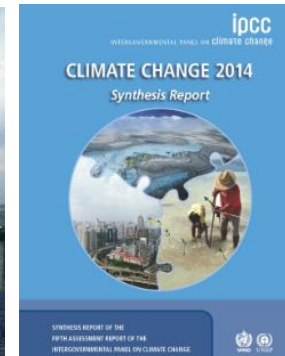
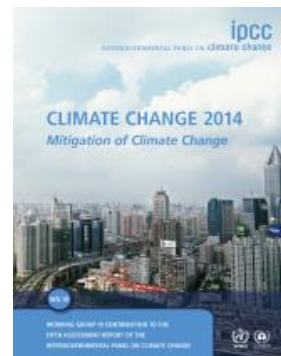
Working Group I Report (the first part of AR5)



The Summary for Policymakers (SPM) of the IPCC WGI AR5 was approved at the Twelfth Session of IPCC Working Group I meeting in Stockholm, Sweden, 23 to 26 September 2013 and was released on 27 September.



SPM of Working Group II Report (on 31 March 2014)
SPM of Working Group III Report (on 13 April 2014)
SPM of Synthesis Report (on 2 November 2014)



38th Session of IPCC at Yokohama on 25-29 March 2014



Pacifico Yokohama



Opening Ceremony



Discussion



Closing Ceremony (30 March!!)

Major Discussions in International Negotiation

COP (Conference of the Parties) is annually held in the framework of the UNFCCC.

Kyoto Protocol
(COP3, 1997)

KP applies to only developed countries.

2008

KP First
commitment
period

2012

2013

KP second
commitment
period

2020

Cancun Agreements
(COP16, 2010)

This agreement calls on
Developed countries to reduce their emissions,
Developing countries to plan to reduce their
emissions.

independent efforts!

2013

2020



Durban Platform
(COP17, 2011)

New and universal greenhouse
gas reduction protocol, legal
instrument or other outcome
with legal force by 2015 for the
period beyond 2020

COP21, 2015

<http://www.cop21.gouv.fr/en>

2020



PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Pictures of COP meetings



Additional meetings in Bonn, German

COP18 (26 November- 6 December 2012 in Doha, Qatar)



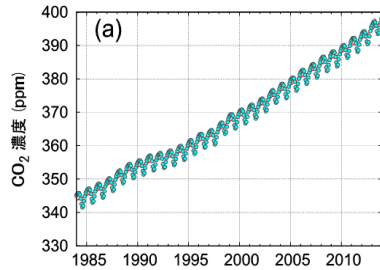
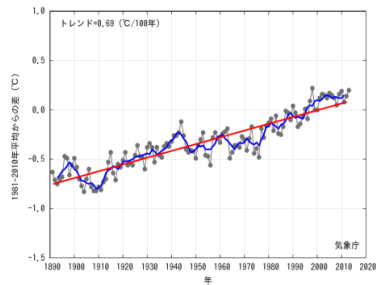
Additional meetings in Bangkok, Thailand



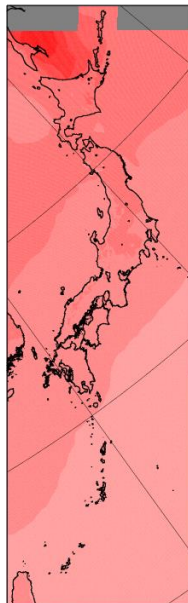
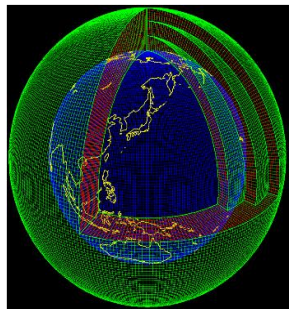
COP19 (11-22 November 2013 in Warsaw, Poland)

Role of JMA

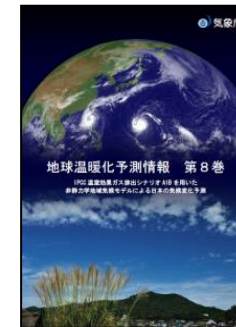
Observation and Monitoring



Projection and analysis



Provision of data and information Training

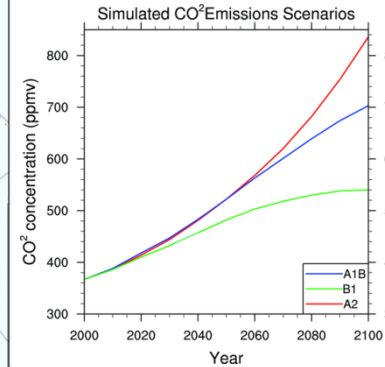
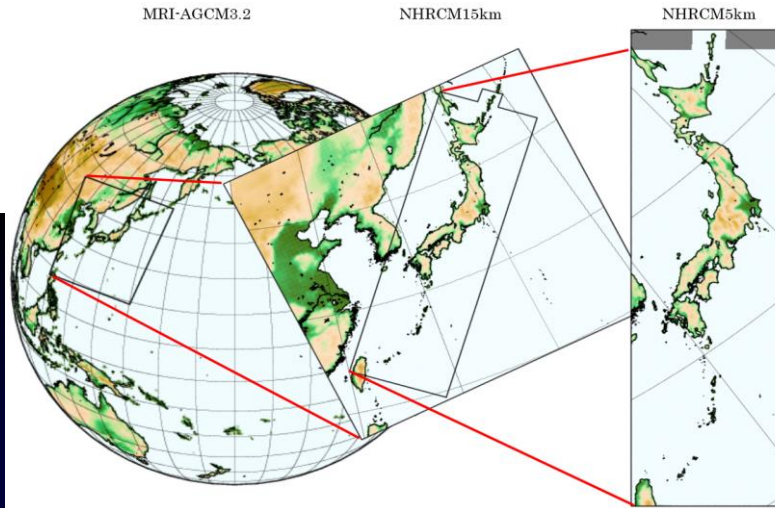
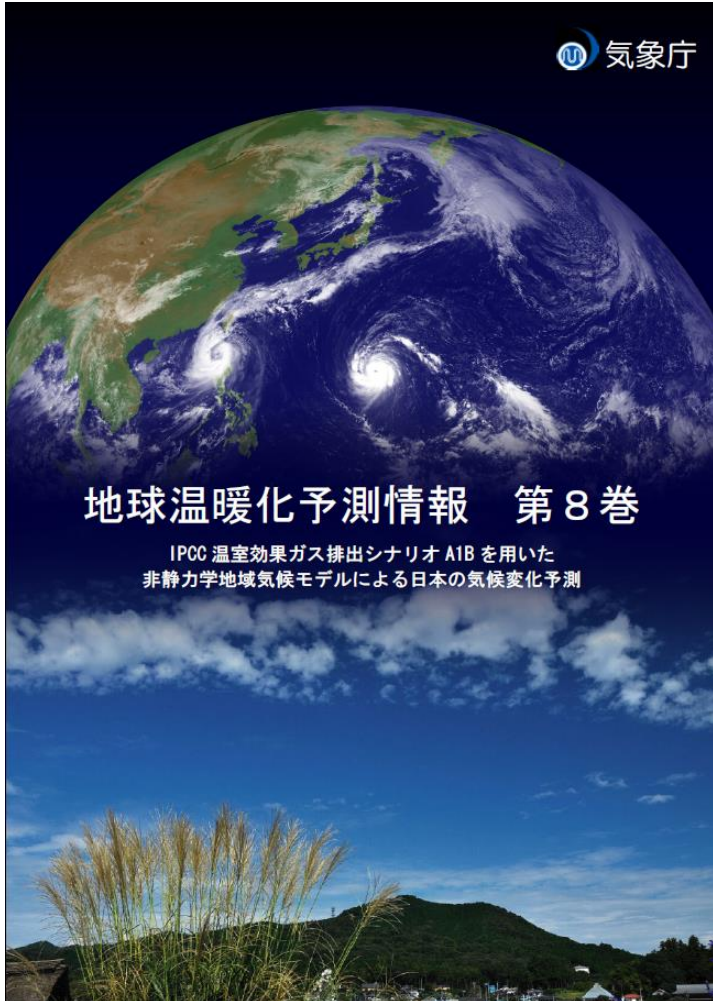


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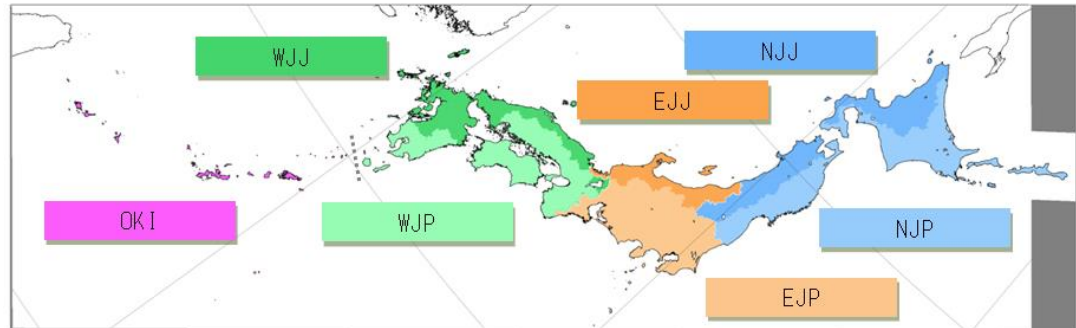
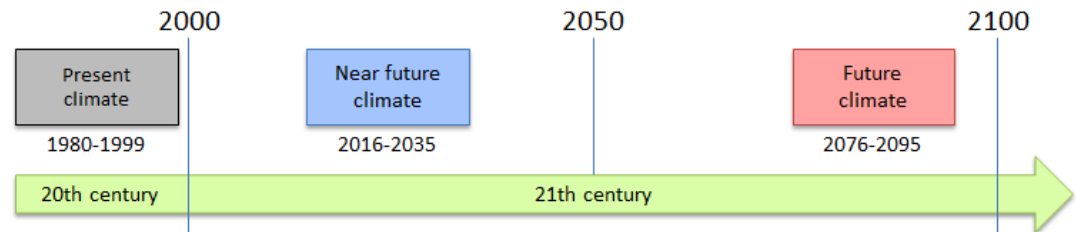
118 # Arctic scaled coordinates
119 3.000 0.000 0.000
120 1.4800 0.2695 0.4374 1.3300 0.9020 0.5169 0.3761 1.3749 0.5190 1.1107
121 0.7952 0.4479 0.2510 1.4800 0.4800 0.4329 0.7222 2.4674 0.4848 0.8926
122 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773 0.1486
123 0.5121 0.2710 0.0414 0.8000 0.4329 0.4611 0.7190 0.0616 0.0606
124 0.5714 0.4189 0.4000 0.3000 0.7069 0.4349 0.2251 0.1486 0.1191
125 0.3749 0.7958 0.2684 0.2300 0.5310 0.1034 0.0726 0.4902 0.9807
126 0.4611 0.1718 0.2000 0.3000 0.5647 0.3100 0.4010 0.1010 0.1486
127 2.0157 0.3761 0.3761 0.5740 0.0414 0.3100 0.7849 0.4976 0.2907
128 0.4800 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
129 0.8902 0.2329 0.7190 0.5349 0.2570 0.1090 0.4760 0.1814 0.0504
130 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
131 1.3904 0.4814 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
132 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
133 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
134 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
135 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
136 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
137 0.4187 0.2684 0.4374 0.3300 0.5310 0.1034 0.0726 0.4902 0.9807
138 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
139 0.4374 0.7958 0.2684 0.2300 0.5310 0.1034 0.0726 0.4902 0.9807
140 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
141 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
142 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
143 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
144 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
145 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
146 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
147 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
148 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
149 0.0620 0.3600 0.7070 0.5679 0.8000 0.0100 0.2307 0.7815 0.2126
150 0.1523 0.4501 0.1704 0.3300 0.4000 0.4000 0.7069 0.1010 0.1773
    
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JMA's latest Global Warming Projection

Global Warming Projection volume 8 (JMA, 2013)

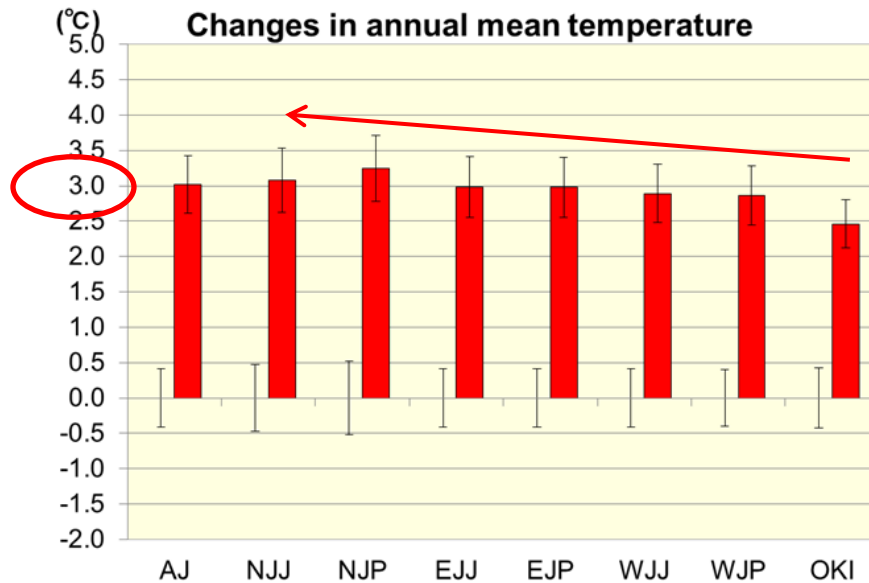


Greenhouse gas emission scenario : SRES A1B

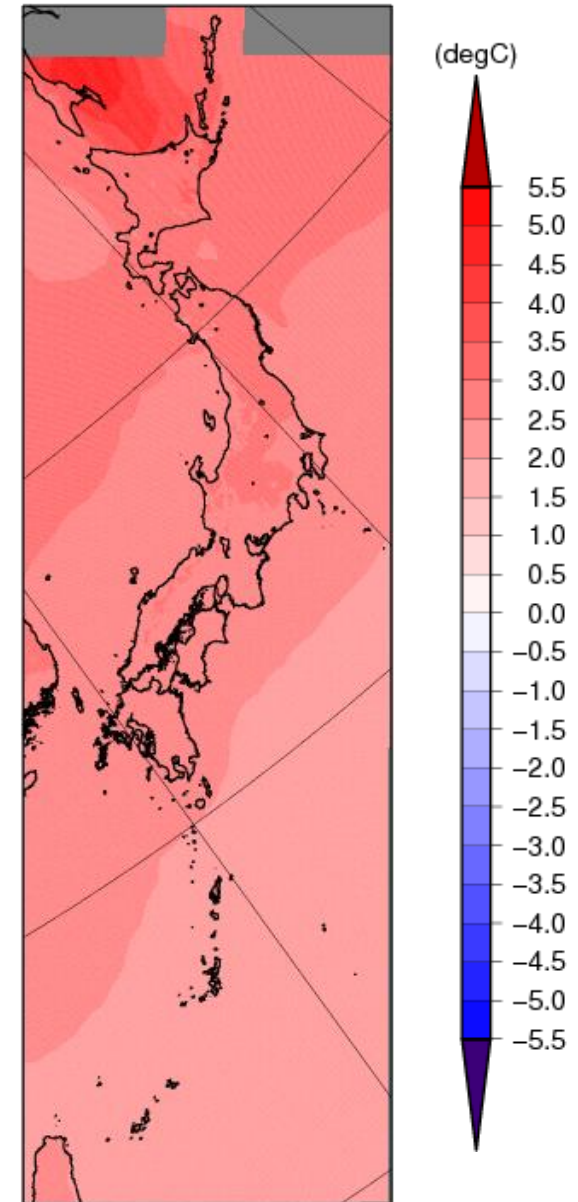


Future change in annual mean temperature

The annual mean temperature is projected to increase by about 3°C in all regions.
In particular, the northern part of Japan is expected to see the most significant rise (more than 3°C).

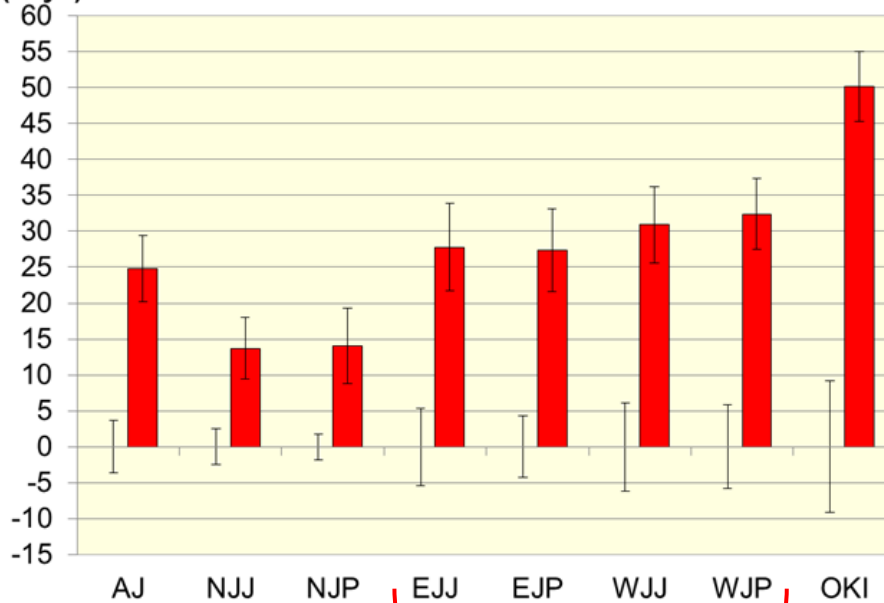


Red bar : future change
Black bar : standard deviation of interannual variability



Future change in the annual number of days with daily maximum temperatures above 30°C

(days) Changes in annual number of days with daily maximum temperature above 30°C



Increase of 30 days

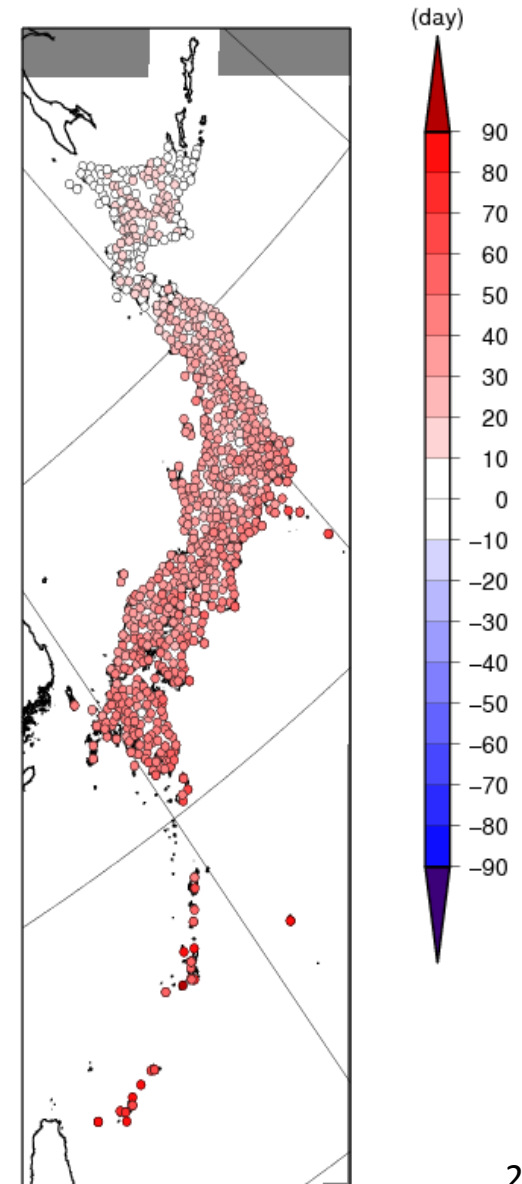
Increase of 50 days

Red bar : future change

Black bar : standard deviation of interannual variability



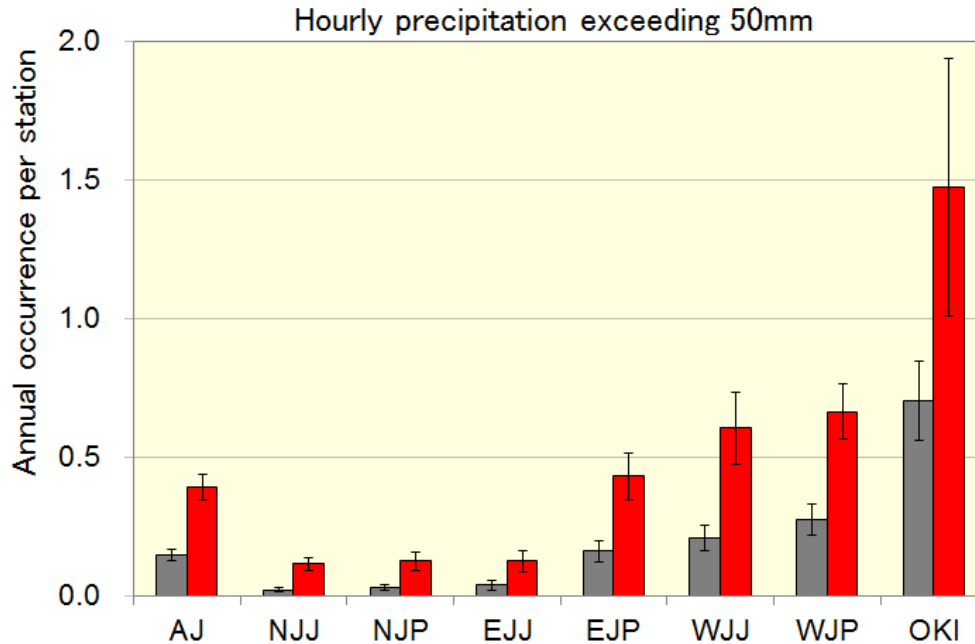
crucial for estimating the risk of heat stroke



Future change in annual frequency of hourly precipitation exceeding 50 mm

The frequency of intense precipitation is projected to increase in most regions.

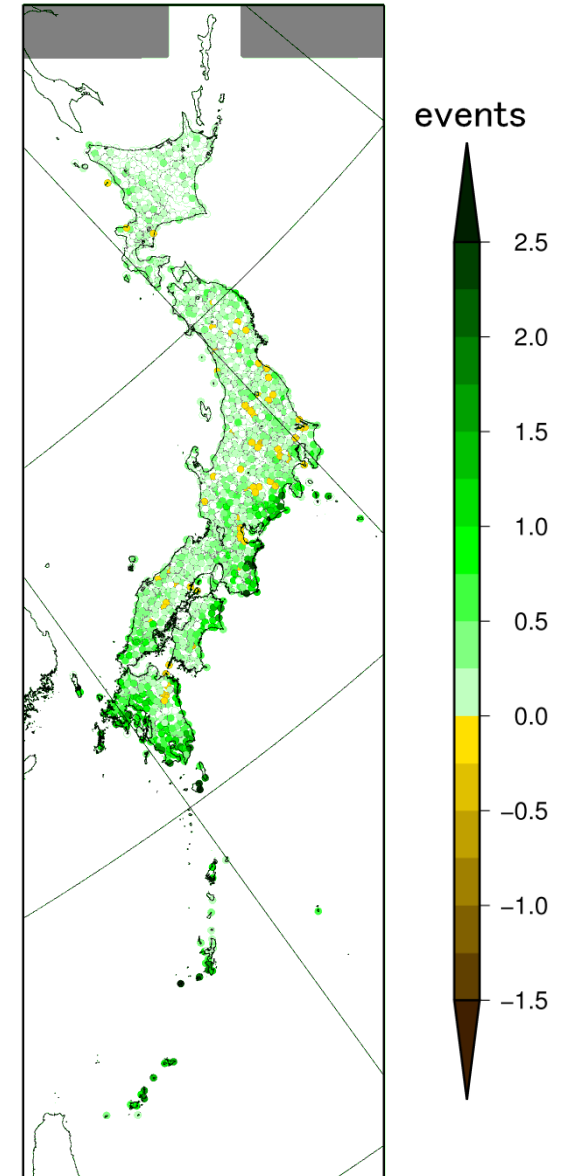
➔ crucial for saving our lives from natural disasters



Grey bar : present climate

Red bar : future climate

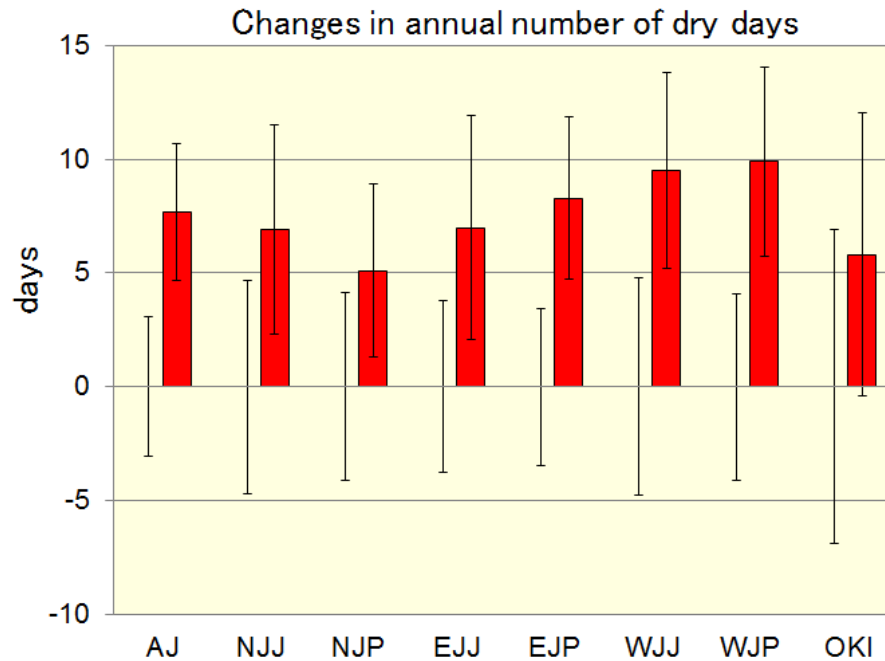
Black bar : standard deviation of interannual variability



Future change of annual number of dry days with daily precipitation of less than 1mm

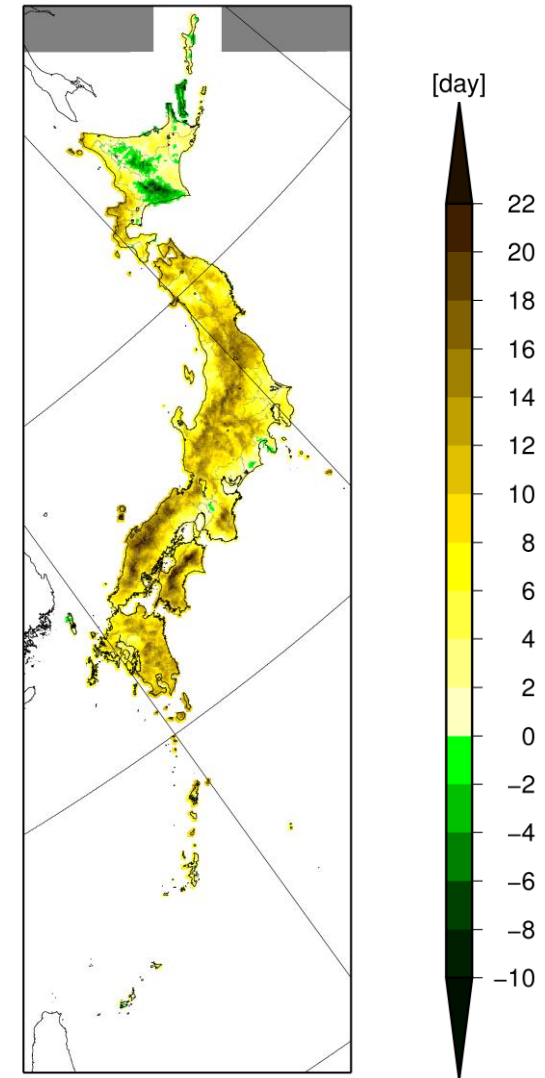
The number of dry days with daily precipitation of less than 1 mm is also expected to rise.

➡ crucial for water resource management



Red bar : future change

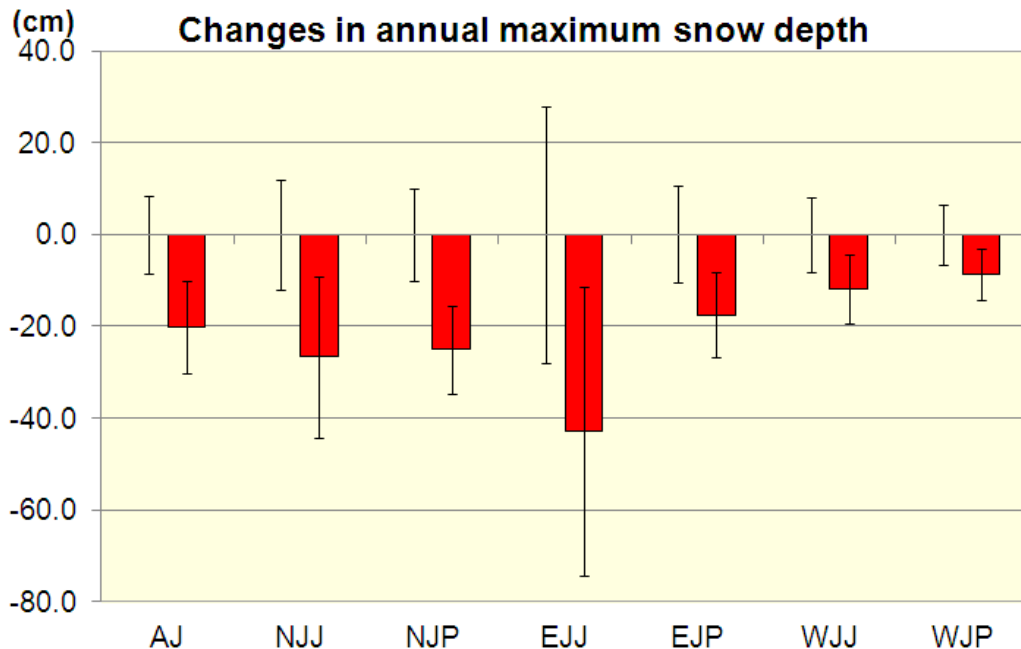
Black bar : standard deviation of interannual variability



Future Change in annual maximum snow depth

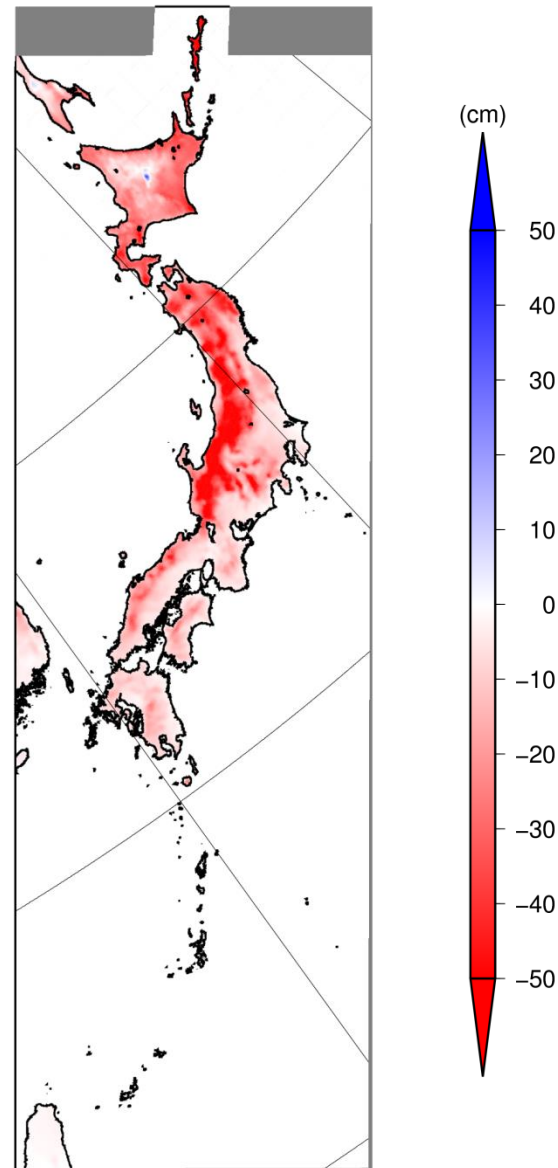
The annual maximum snow depth is projected to decrease in most regions, although it may increase in colder areas such as inland Hokkaido.

➔ crucial especially for water resource management and rice cultivation.



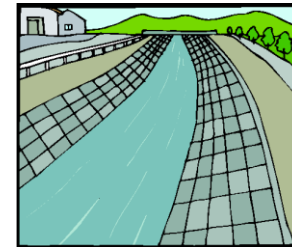
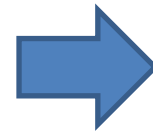
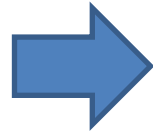
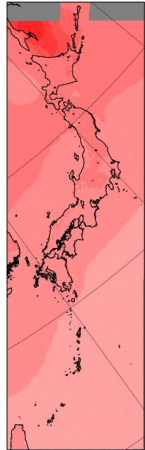
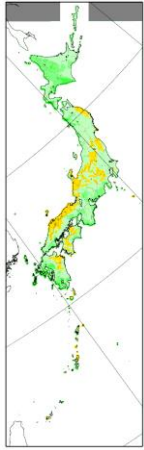
Red bar : future change

Black bar : standard deviation of interannual variability



Role of Global Warming Projection Information

Basic data for adaptations

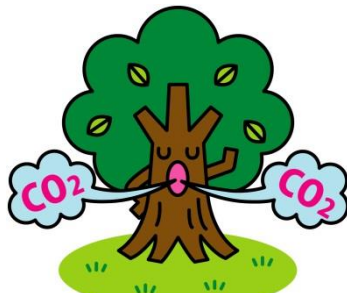
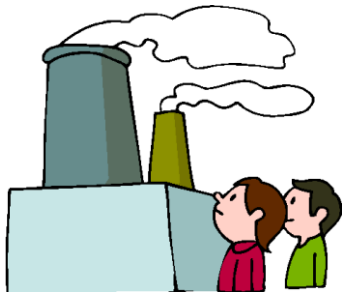


Detailed climate change projection information

Detailed estimation for impacts on each sector

Appropriate adaptations

Basic data for mitigations



GHG emission reduction target
Planning our future society

Educational activities



Promotion of people's eco-friendly activity and understanding of the government's efforts
Environmental education

Thank you for your attention!

