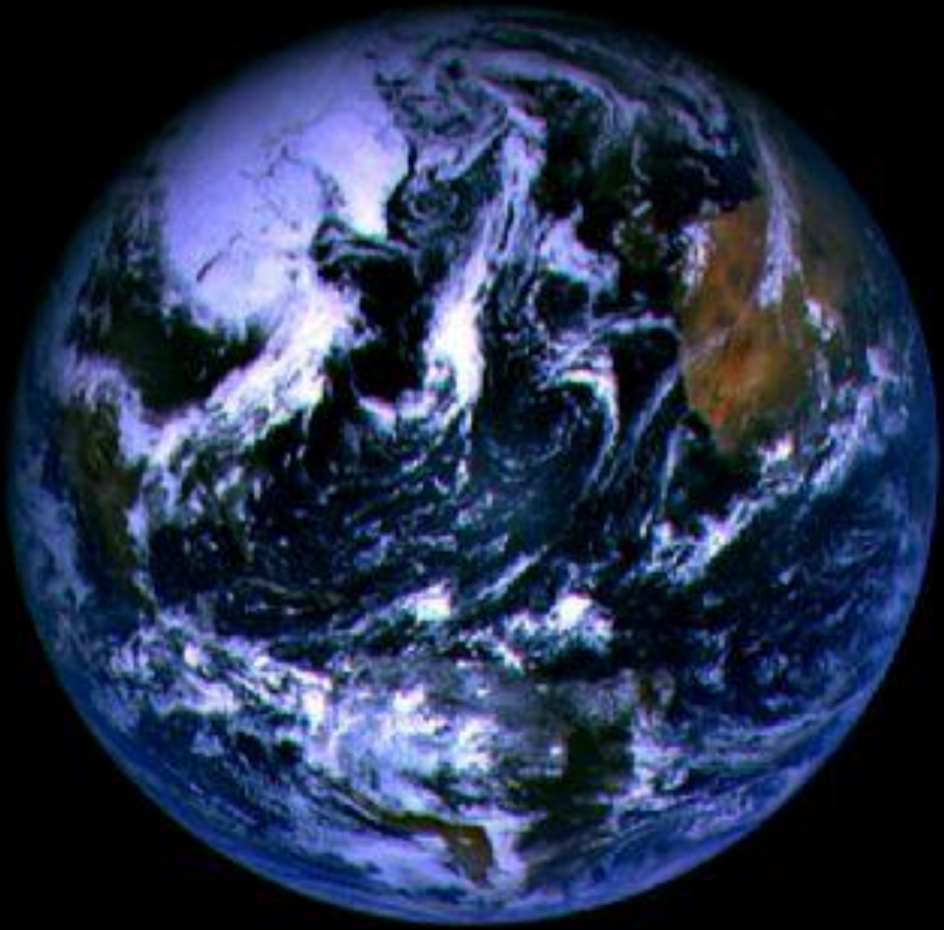
Climate Change



“Climate Change is the defining issue of our time and we are at a defining moment.” United Nations


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
HUNGER
4 QUALITY EDUCATION
5 GENDER EQUALITY
CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
10 REDUCED INEQUALITIES
CONSUMPTION
CLIMATE ACTION
LIFE
LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

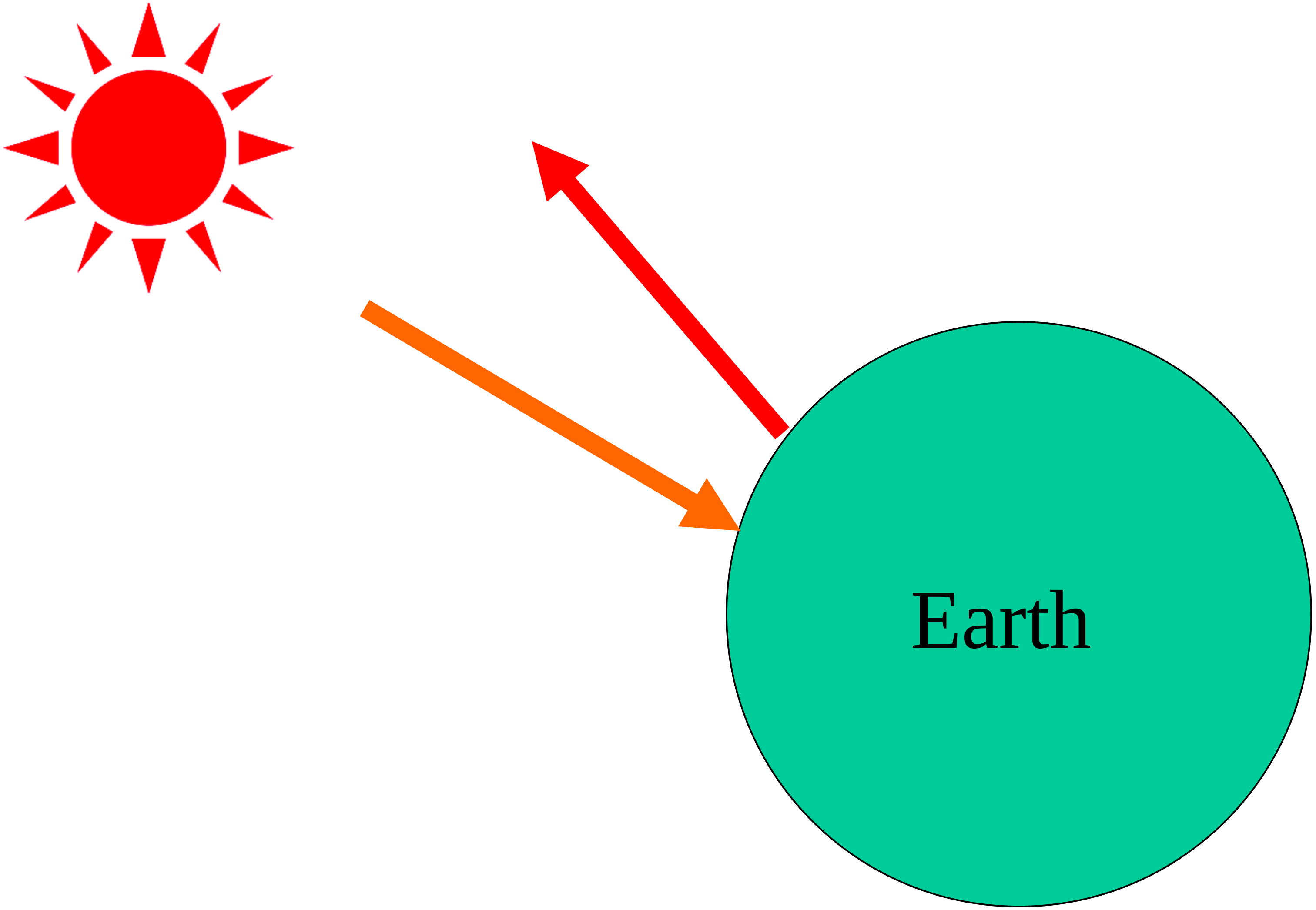
Climate Change

１． Mechanism of Climate Change

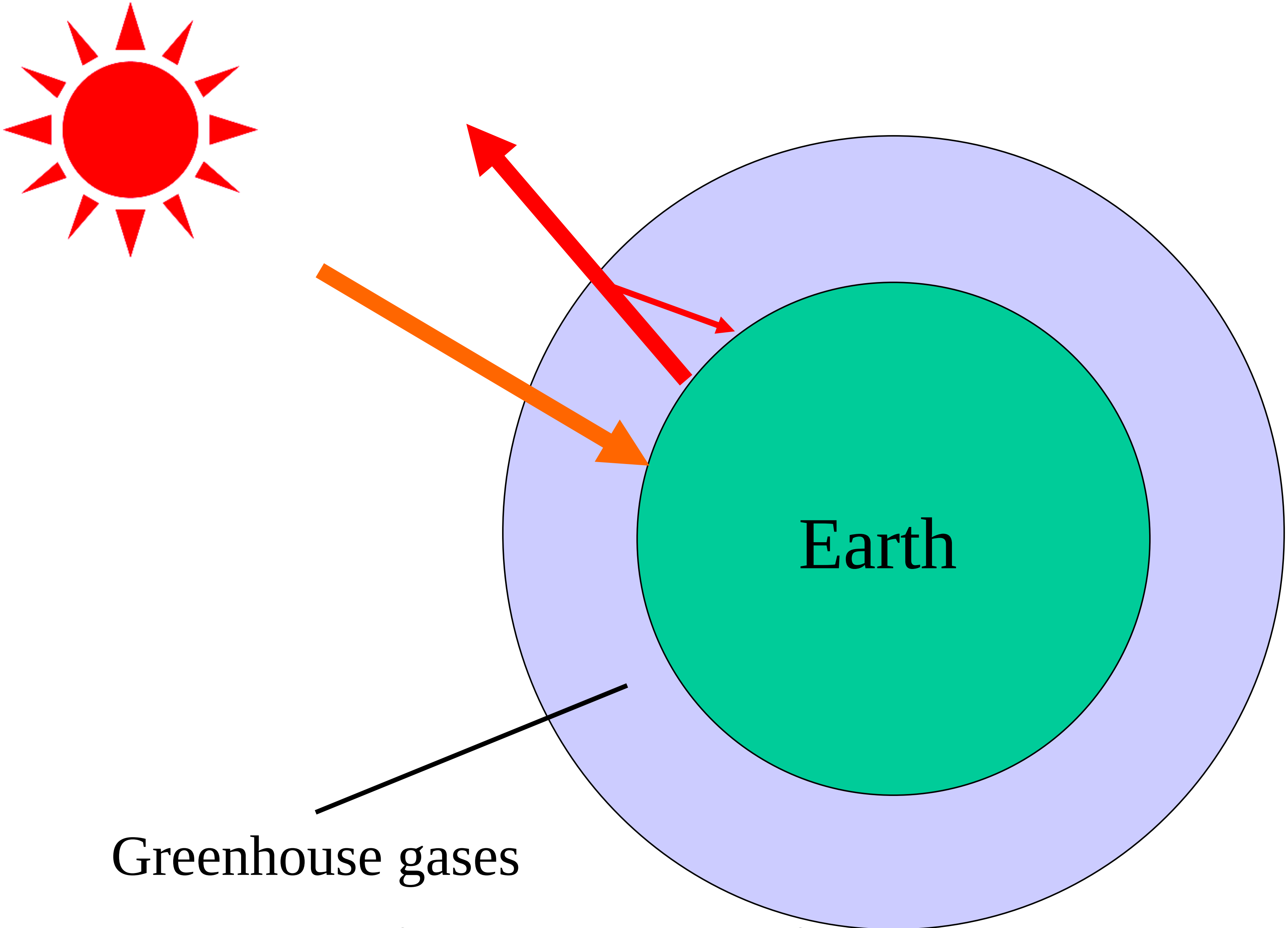
２． Impacts （present and future）

３． Kyoto Protocol

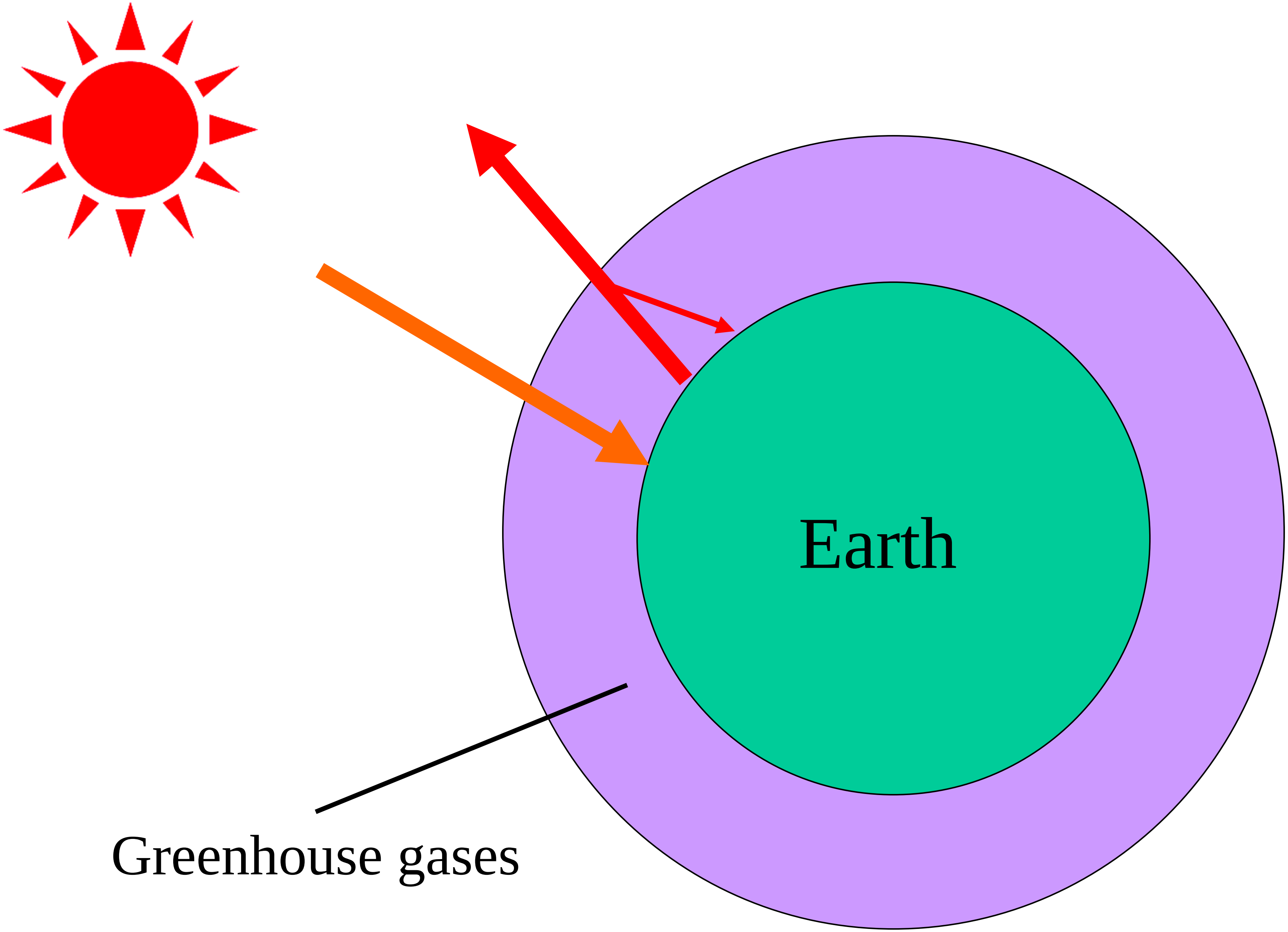
４． Post Kyoto



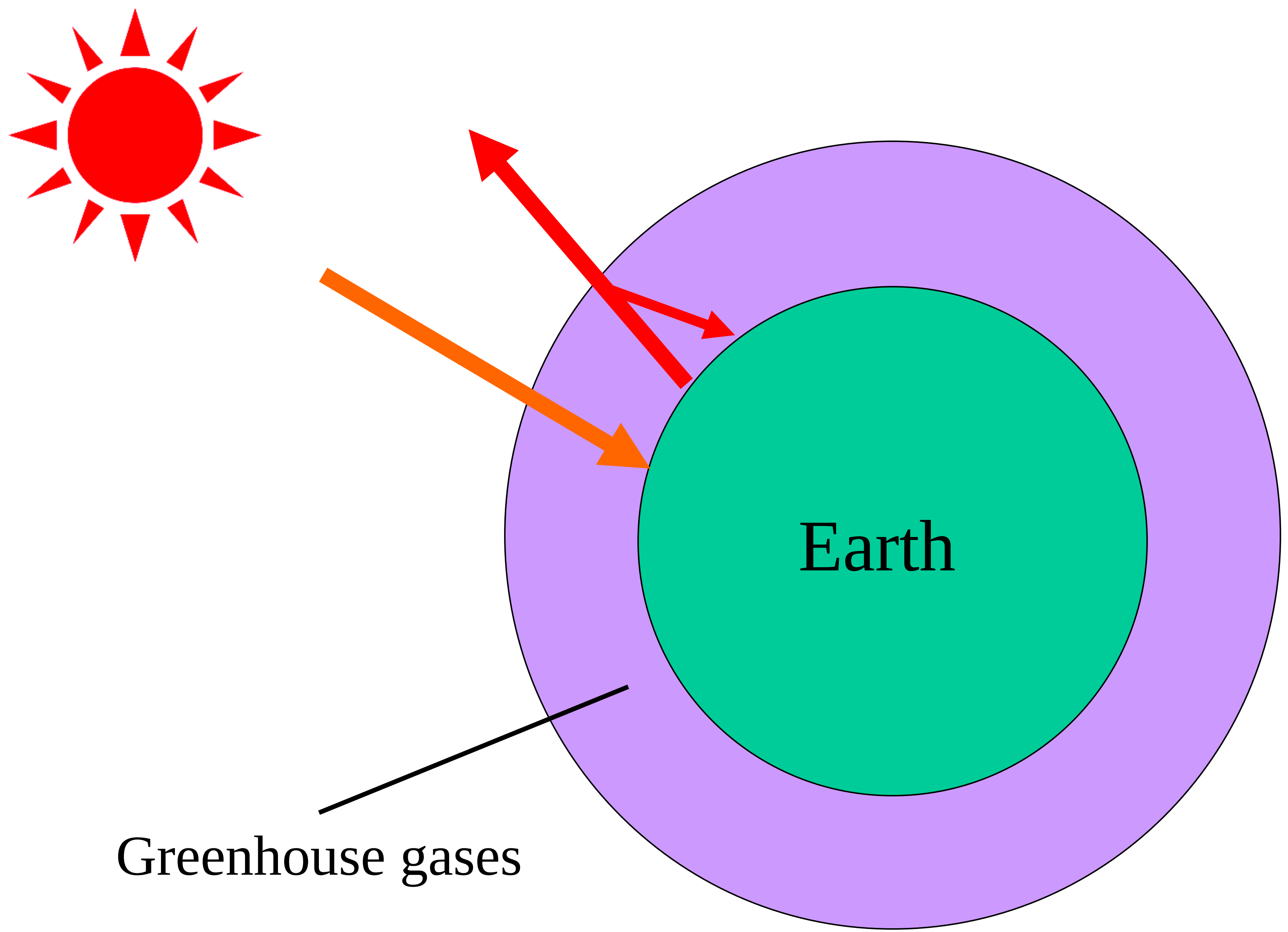
The energy is radiated back toward space as infrared ray. Without atmosphere, the Earth would be a chilly minus 18 degrees Centigrade.



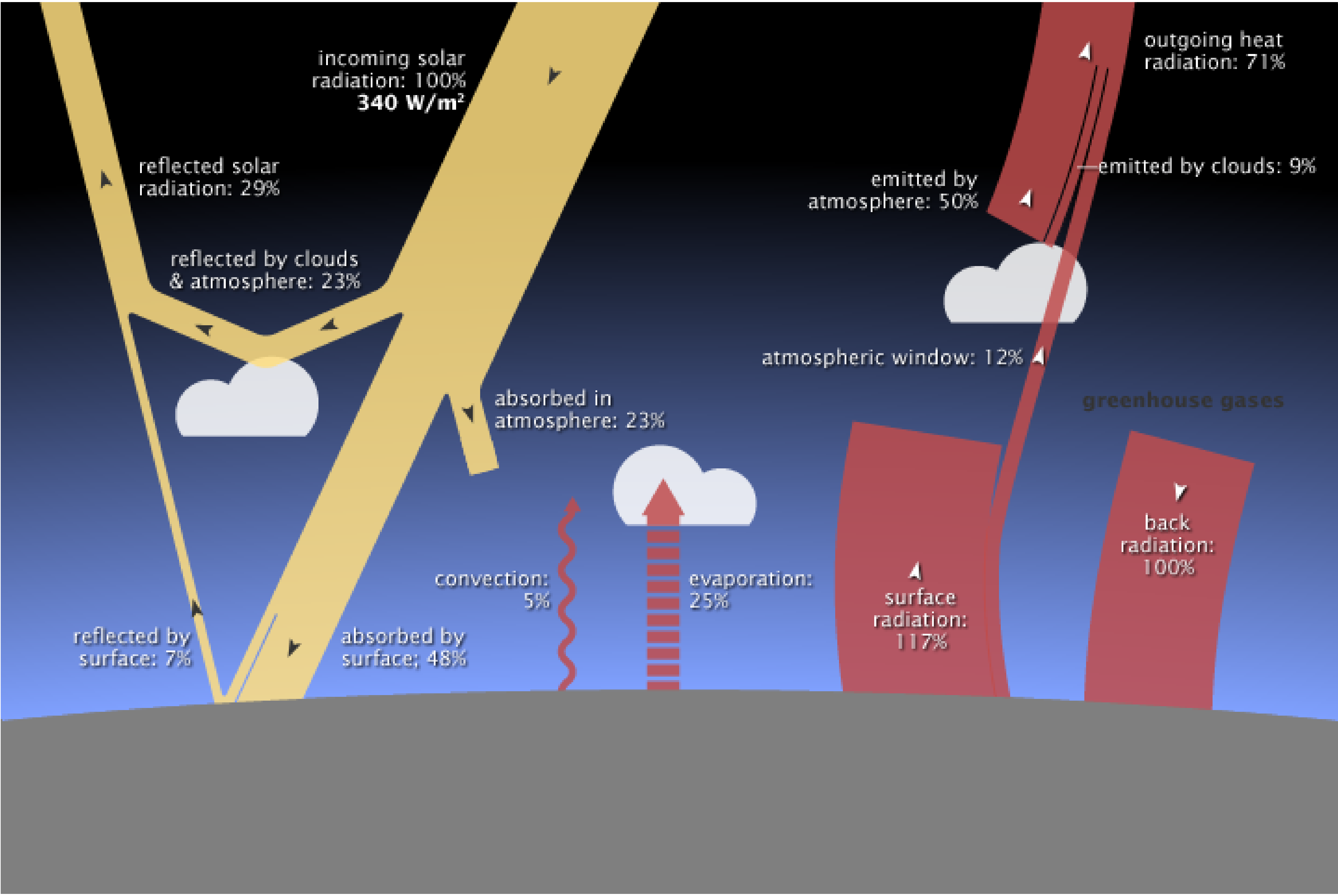
Greenhouse gases trap infrared ray (heat). Most of the outgoing heat is absorbed by greenhouse gases and re-emitted to all directions, warming the earth’s surface.



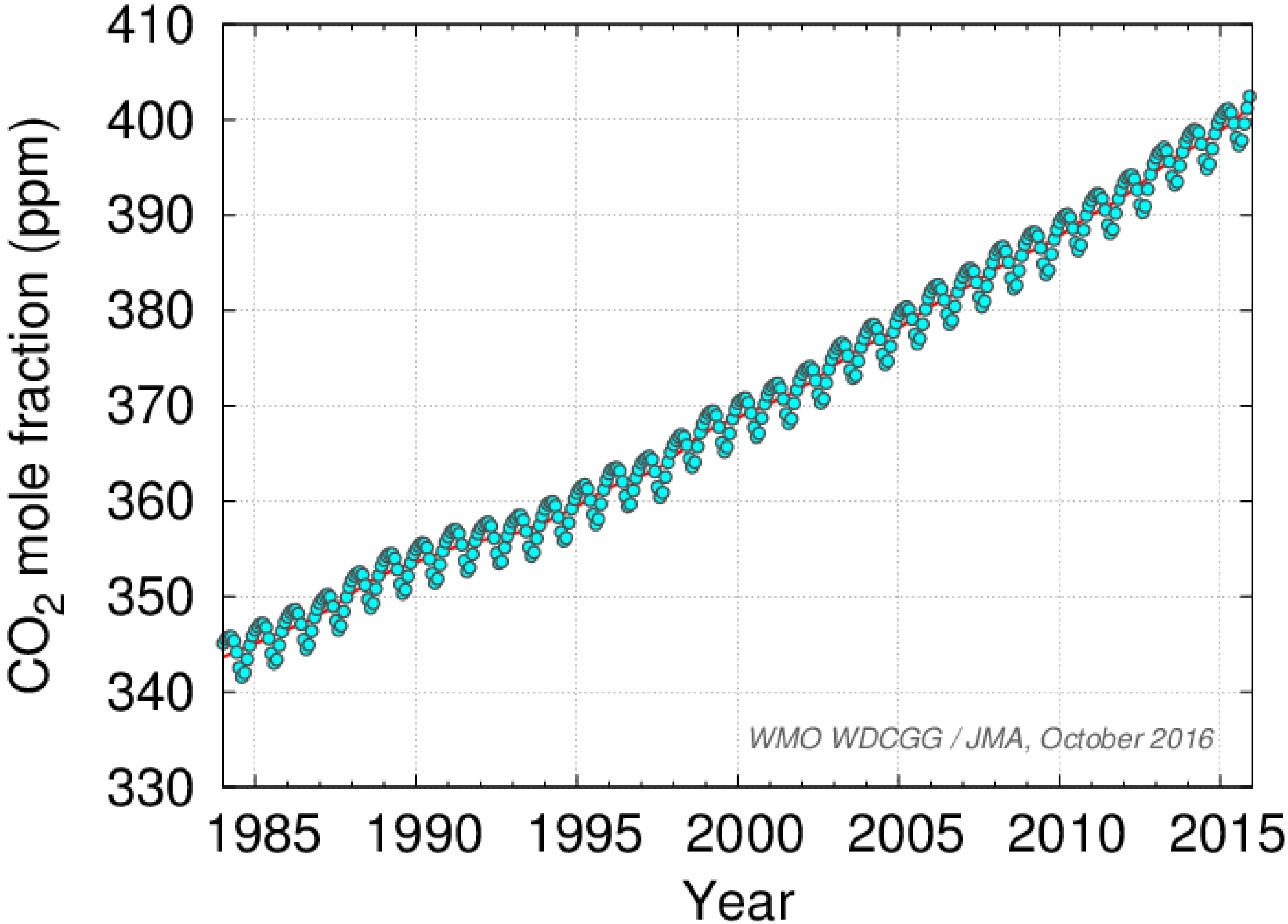
The atmosphere's current composition of greenhouse gases ensures a comfortable average temperature of 15 degrees Centigrade.



An increase in greenhouse gases causes global temperatures to rise significantly.

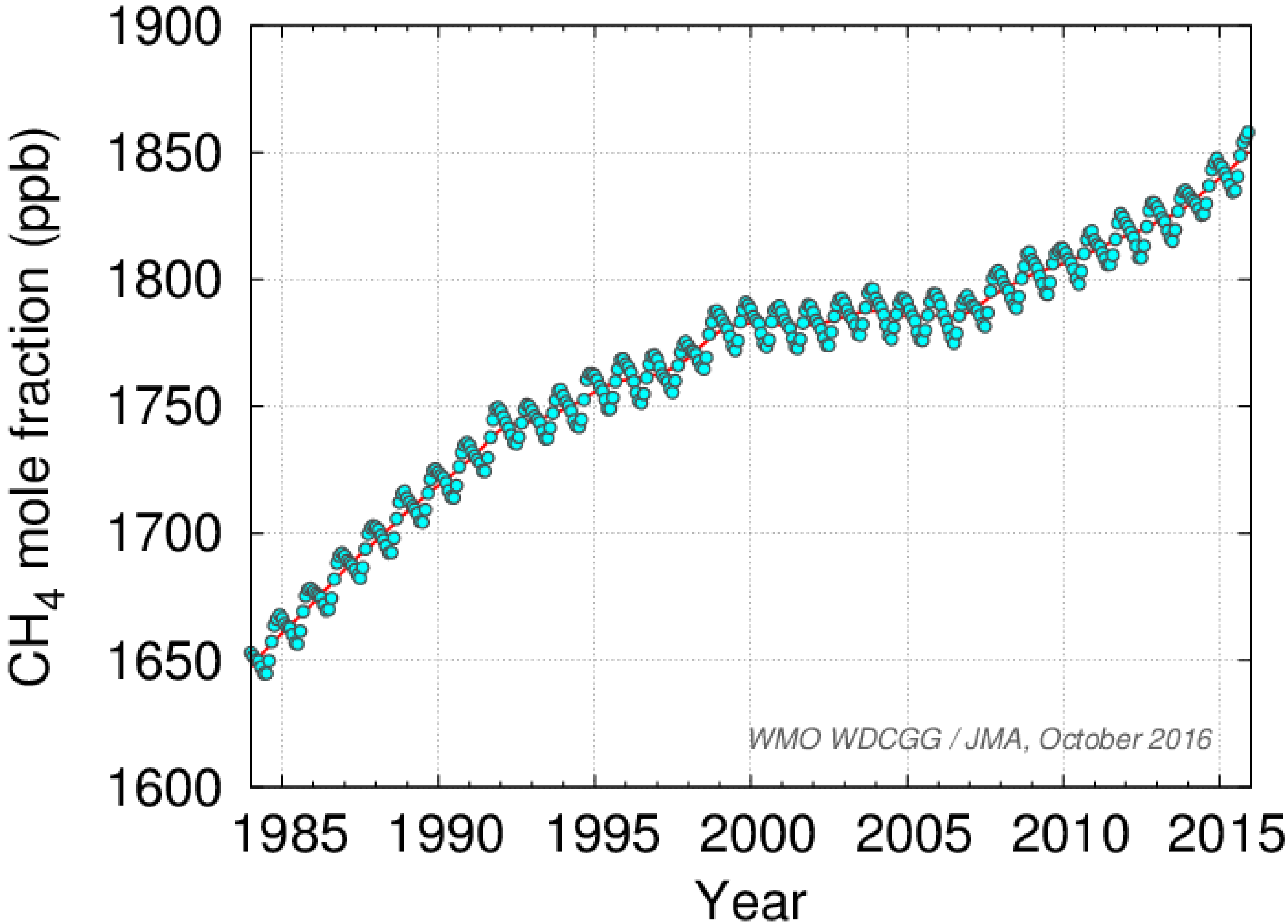


https://earthobservatory.nasa.gov/features/EnergyBalance/page6.php



Time-series representation of globally averaged CO_2 mole fractions

http://ds.data.jma.go.jp/ghg/kanshi/ghgp/co2_e.html



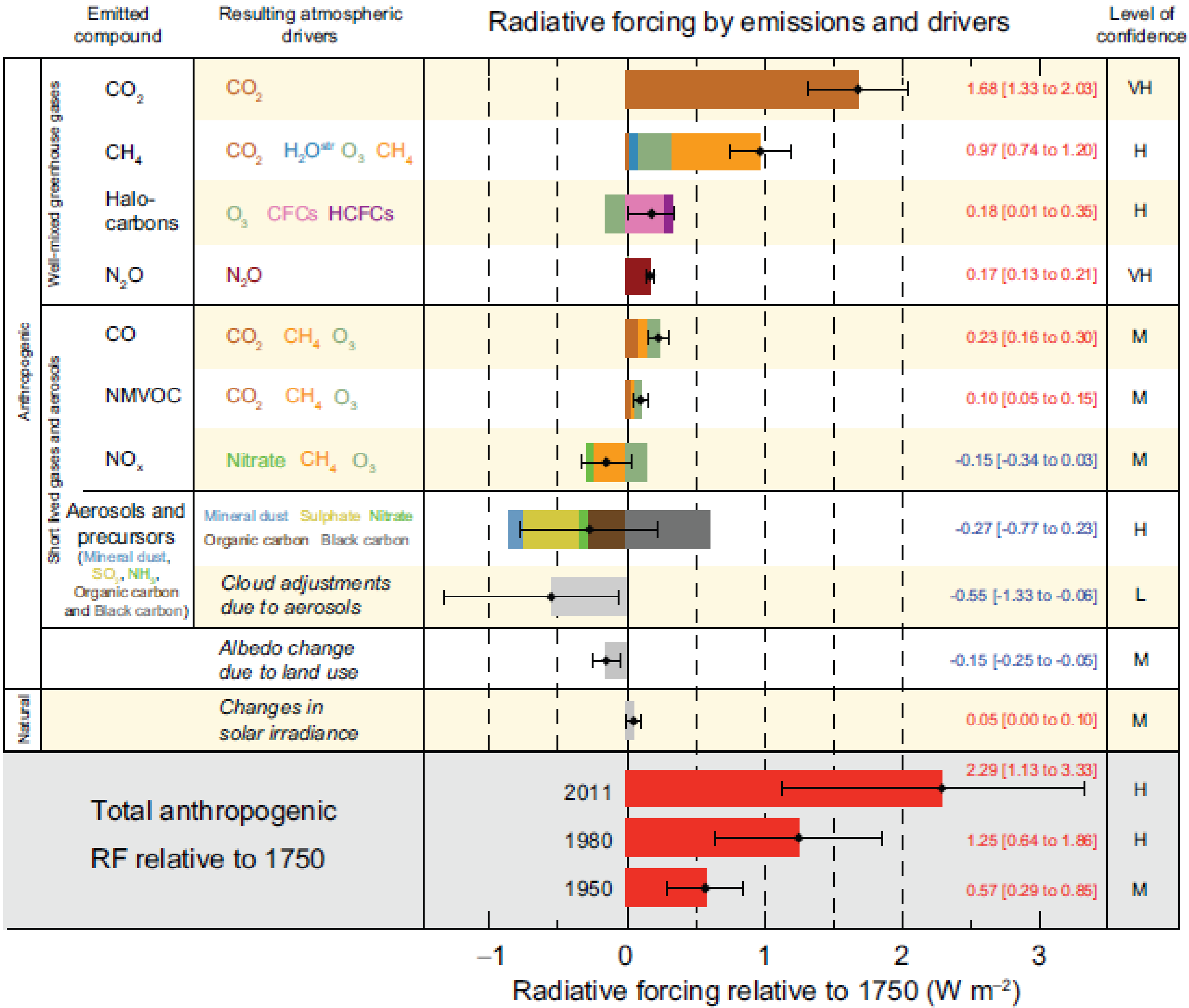
Time-series representation of globally averaged CH_4 mole fractions

http://ds.data.jma.go.jp/ghg/kanshi/ghgp/ch4_e.html

Total radiative forcing is positive, and has led to an uptake of energy by the climate system.
The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750.

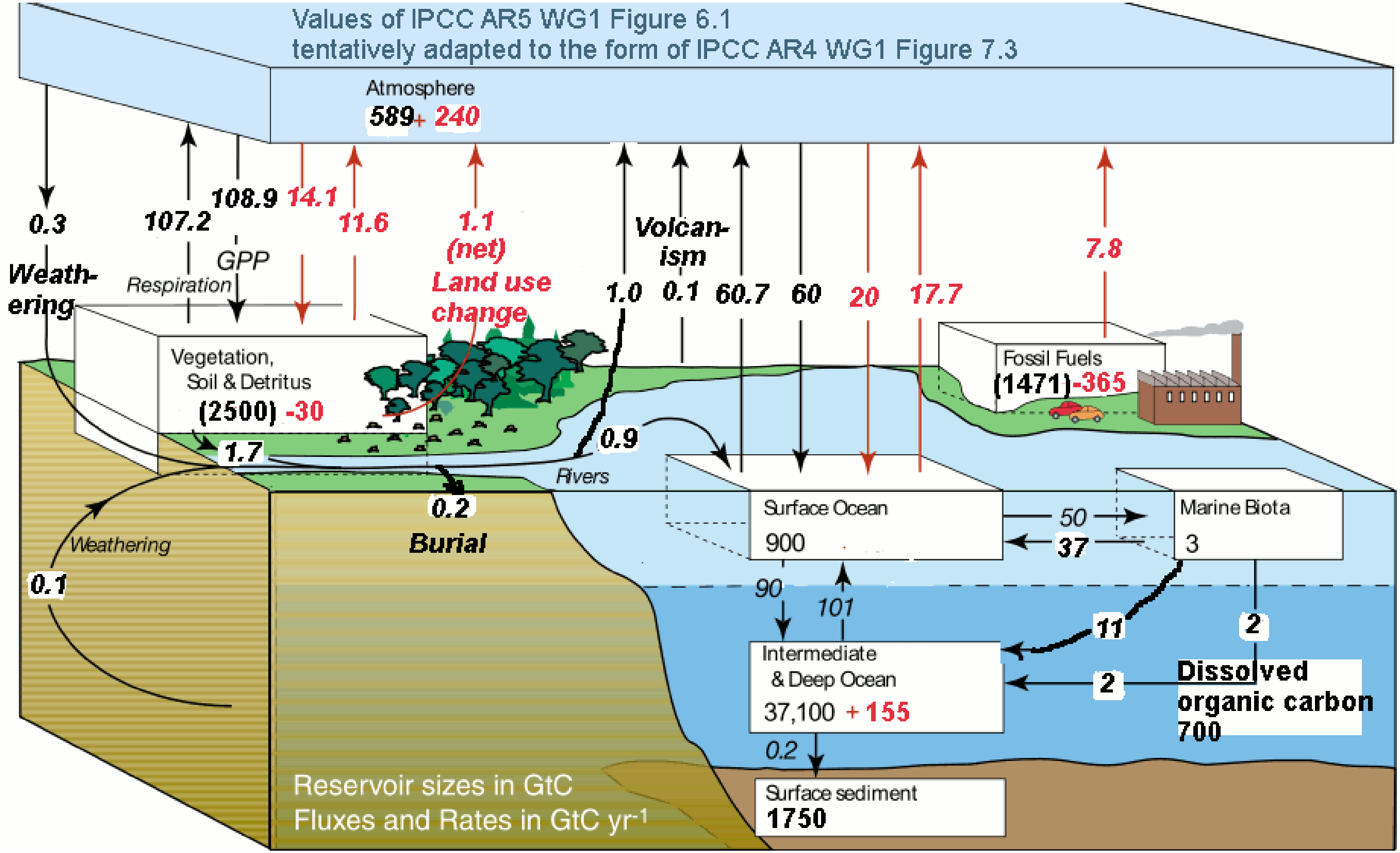
IPCC (2013) CLIMATE CHANGE 2013, The Physical Science Basis, Summary for Policymakers

Radiative forcing: the difference between insolation (sunlight) absorbed by the Earth and energy radiated back to space.



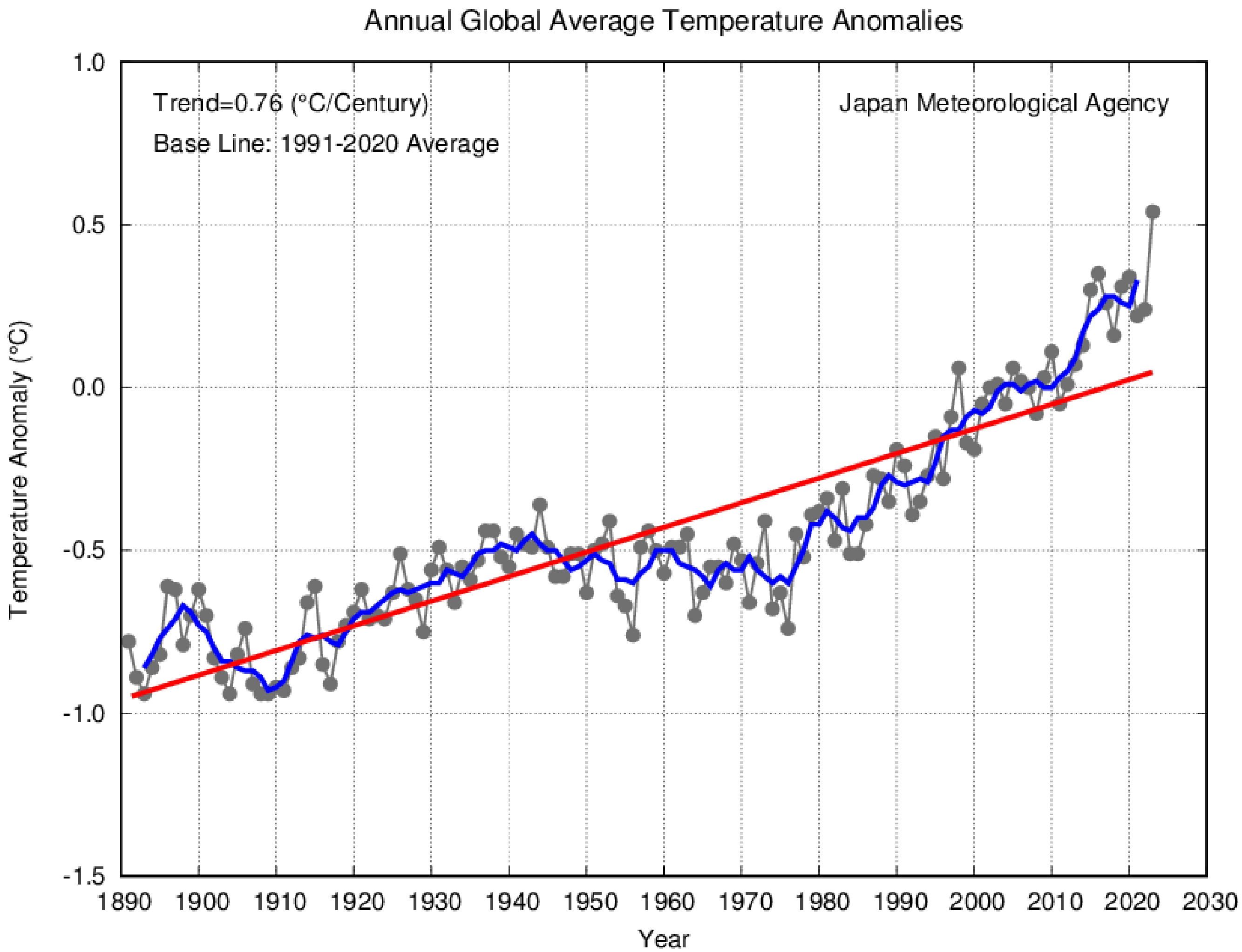
Emitted compound
Resulting atmospheric drivers
Radiative forcing by emissions and drivers
Level of confidence
Anthropogenic
Well-mixed greenhouse gases
Short lived gases and aerosols
Natural
CO2
CO2
1.68 [1.33 to 2.03]
VH
CH4
CO2 H2Ostr O3 CH4
0.97 [0.74 to 1.20]
H
Halo-carbons
O3 CFCs HCFCs
0.18 [0.01 to 0.35]
H
N2O
N2O
0.17 [0.13 to 0.21]
VH
CO
CO2 CH4 O3
0.23 [0.16 to 0.30]
M
NMVOC
CO2 CH4 O3
0.10 [0.05 to 0.15]
M
NOx
Nitrate CH4 O3
-0.15 [-0.34 to 0.03]
M
Aerosols and precursors (Mineral dust, SO2, NH3, Organic carbon and Black carbon)
Mineral dust Sulphate Nitrate Organic carbon Black carbon
-0.27 [-0.77 to 0.23]
H
Cloud adjustments due to aerosols
-0.55 [-1.33 to -0.06]
L
Albedo change due to land use
-0.15 [-0.25 to -0.05]
M
Changes in solar irradiance
0.05 [0.00 to 0.10]
M
Total anthropogenic RF relative to 1750
2011
2.29 [1.13 to 3.33]
H
1980
1.25 [0.64 to 1.86]
H
1950
0.57 [0.29 to 0.85]
M
–1
0
1
2
3
Radiative forcing relative to 1750 (W m–2)

IPCC (2013)



http://macroscope.world.coocan.jp/ja/edu/clim_sys/warming/carbon_cycle.html

Is the global temperature rising ?

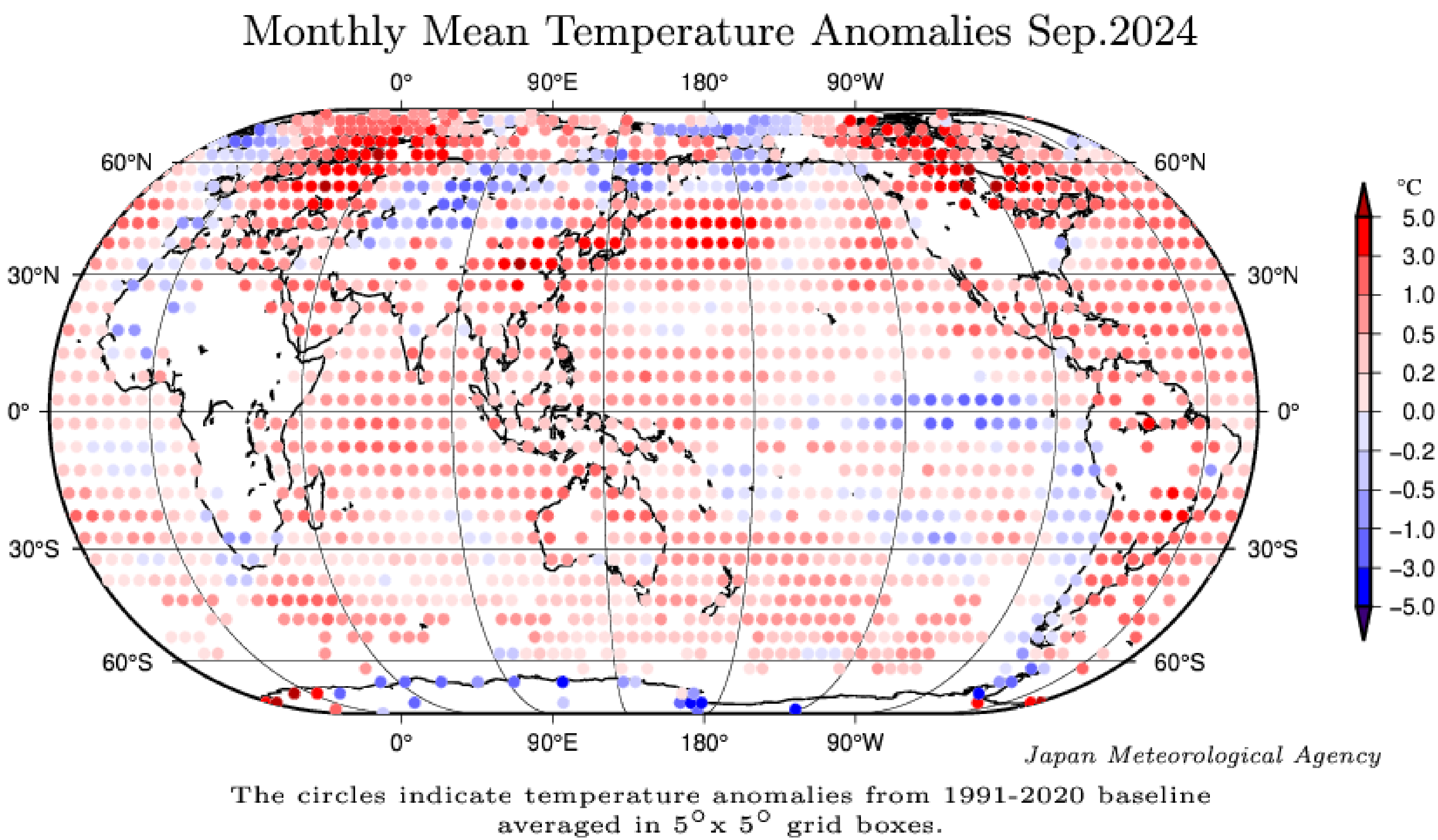


Anomalies are deviation from baseline (1991-2020 Average).
The black thin line indicates surface temperature anomaly of each year.
The blue line indicates their 5-year running mean.
The red line indicates the long-term linear trend.

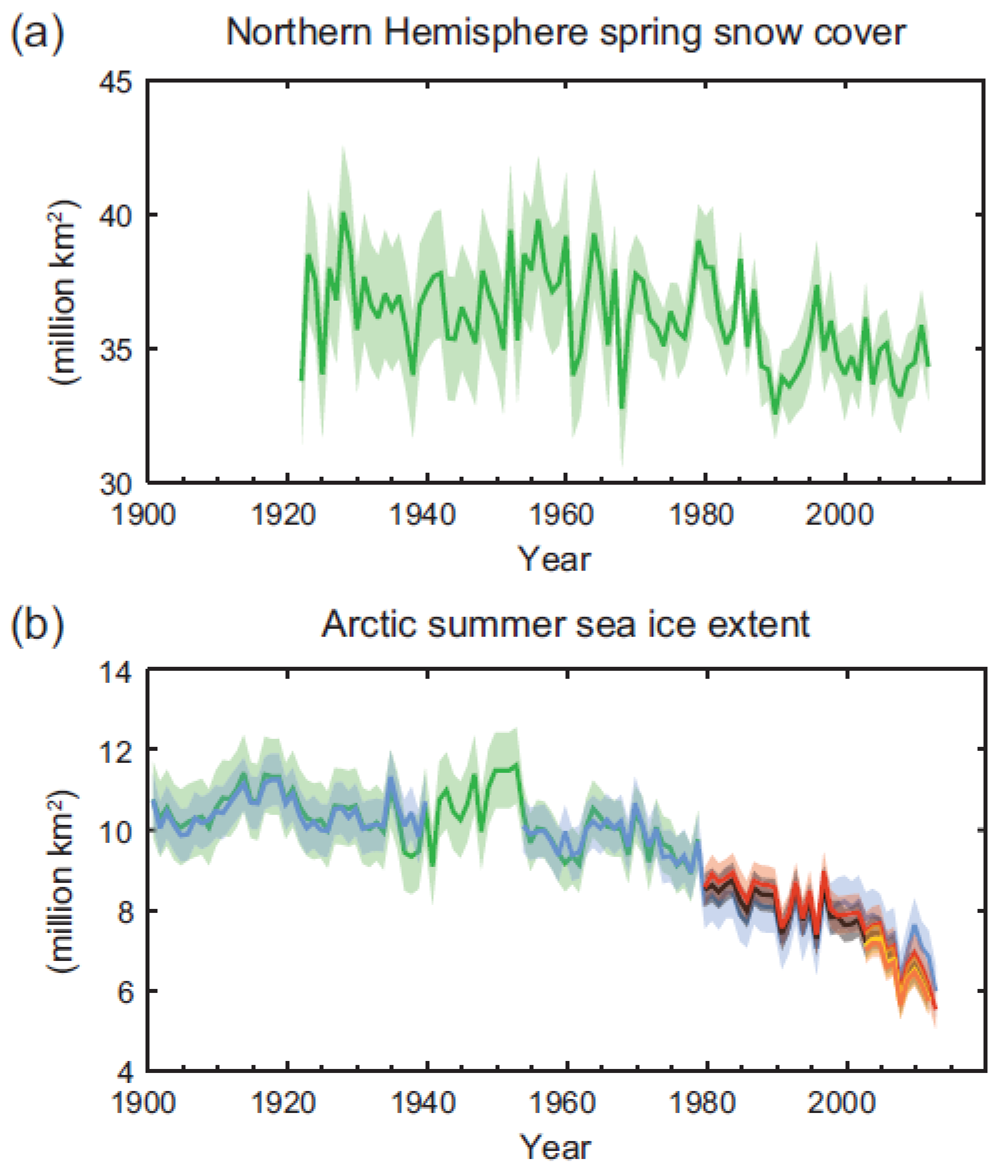
Five Warmest Years (Anomalies)

1st. 2023(+0.54° C), 2nd. 2016(+0.35° C), 3rd. 2020(+0.34° C), 4th. 2019(+0.31° C), 5th. 2015(+0.30° C)

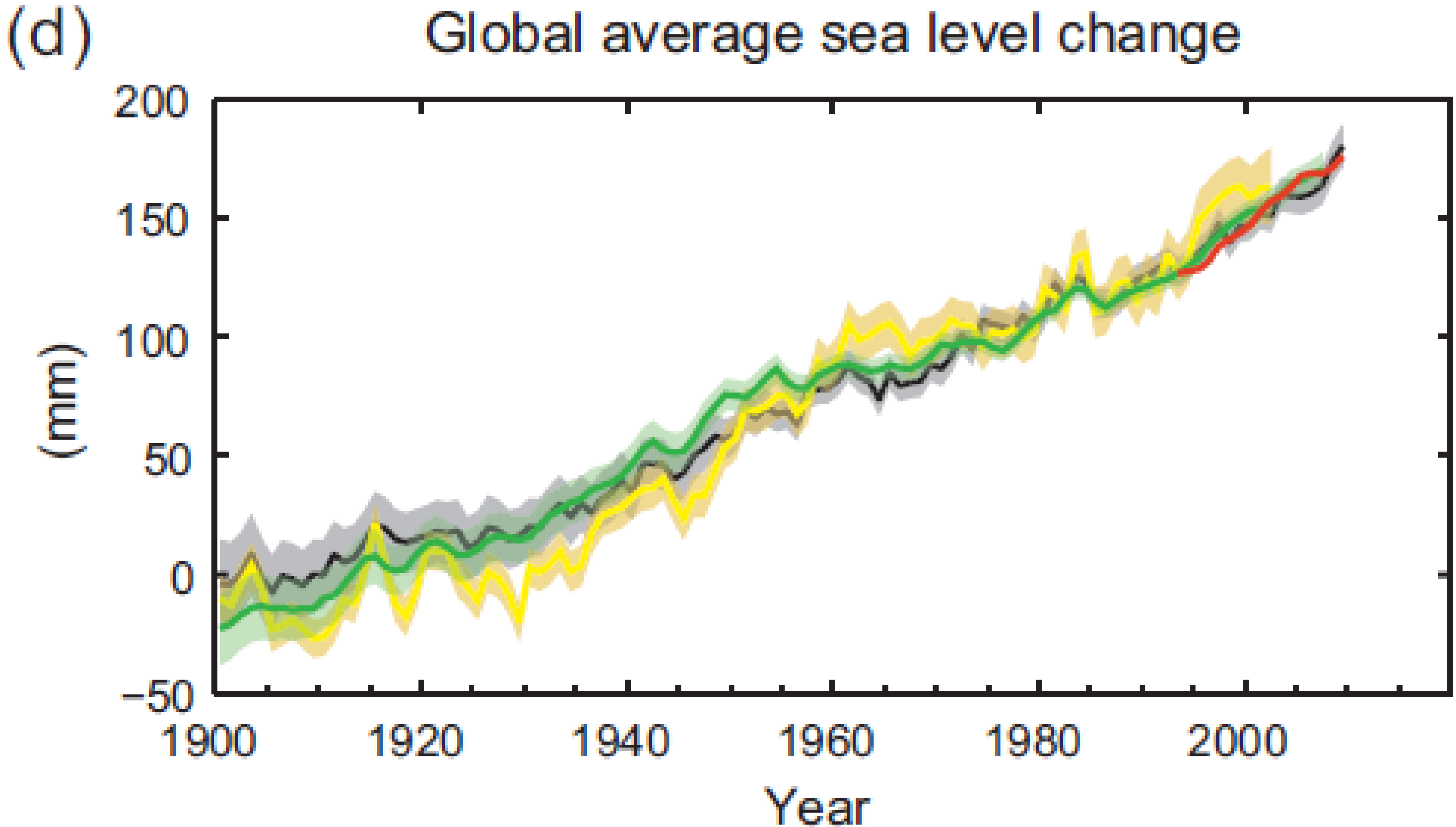
https://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/ann_wld.html



https://ds.data.jma.go.jp/tcc/tcc/products/gwp/temp/map/temp_map.html


(a)
Northern Hemisphere spring snow cover
45
40
35
30
(million km²)
1900
1920
1940
1960
1980
2000
Year
(b)
Arctic summer sea ice extent
14
12
10
8
6
4
(million km²)
1900
1920
1940
1960
1980
2000
Year

IPCC 2013


(d)
Global average sea level change
200
150
100
50
0
−50
(mm)
1900
1920
1940
1960
1980
2000
Year

IPCC 2013

Human influence
or
Natural fluctuation ?

An extensive review of recent literatures is needed to answer this question.

The task is beyond the capacity of a scientist.

There is a need to establish a special organization.

Intergovernmental Panel on Climate Change (IPCC)

is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

The IPCC does not conduct its own research.

Working Group I deals with "The Physical Science Basis of Climate Change",

Working Group II with "Climate Change Impacts, Adaptation and Vulnerability" and

Working Group III with "Mitigation of Climate Change".

The Sixth Assessment Report (AR6)
consists of three Working Group contribution and a Synthesis Report.

A. The Current State of the Climate

A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land.
Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

A.2 The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

A. The Current State of the Climate

A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5

A.4 Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3° C with a narrower range compared to AR5.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850-1900

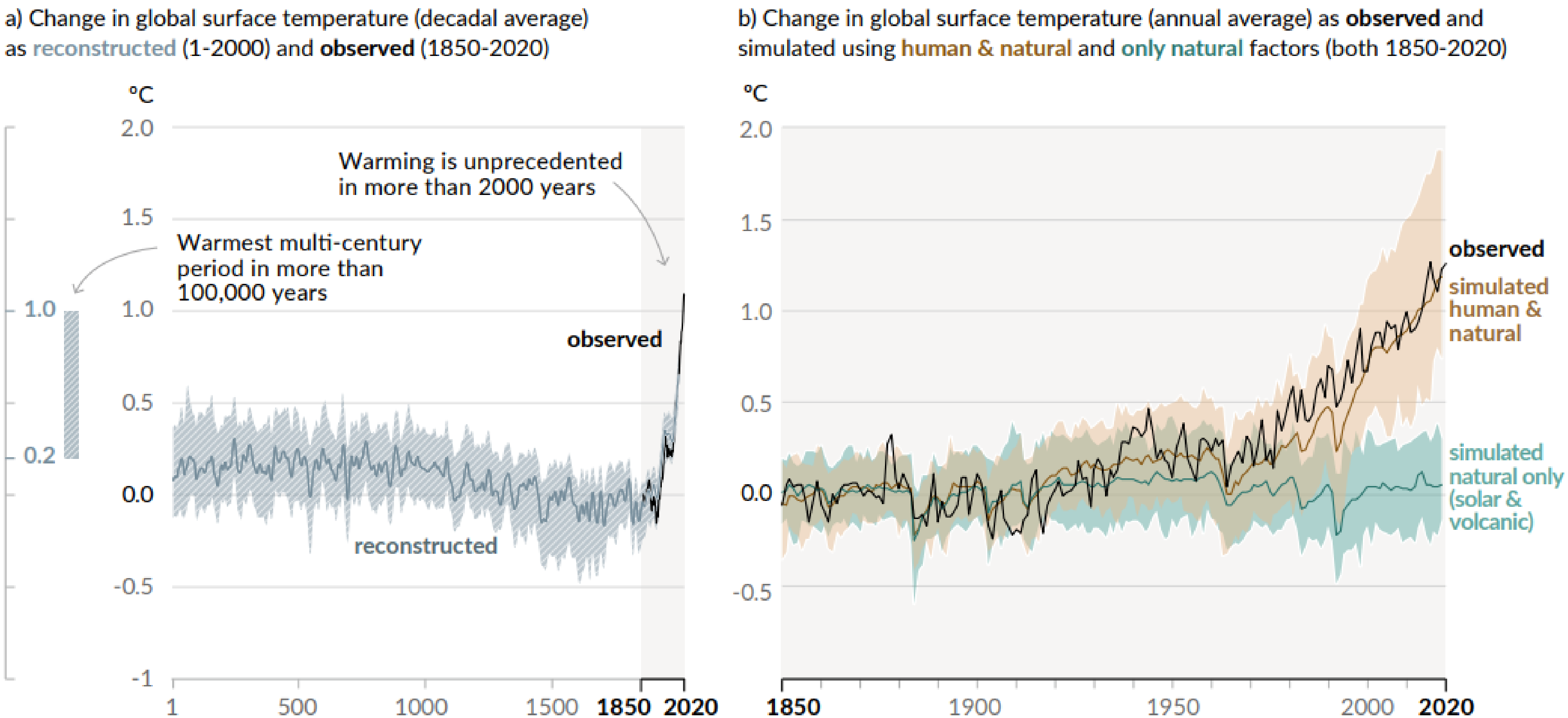


Figure SPM.1: History of global temperature change and causes of recent warming.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

B. Possible Climate Futures

B.1 Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5° C and 2° C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades.

B.2 Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, snow cover and permafrost.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

B. Possible Climate Futures

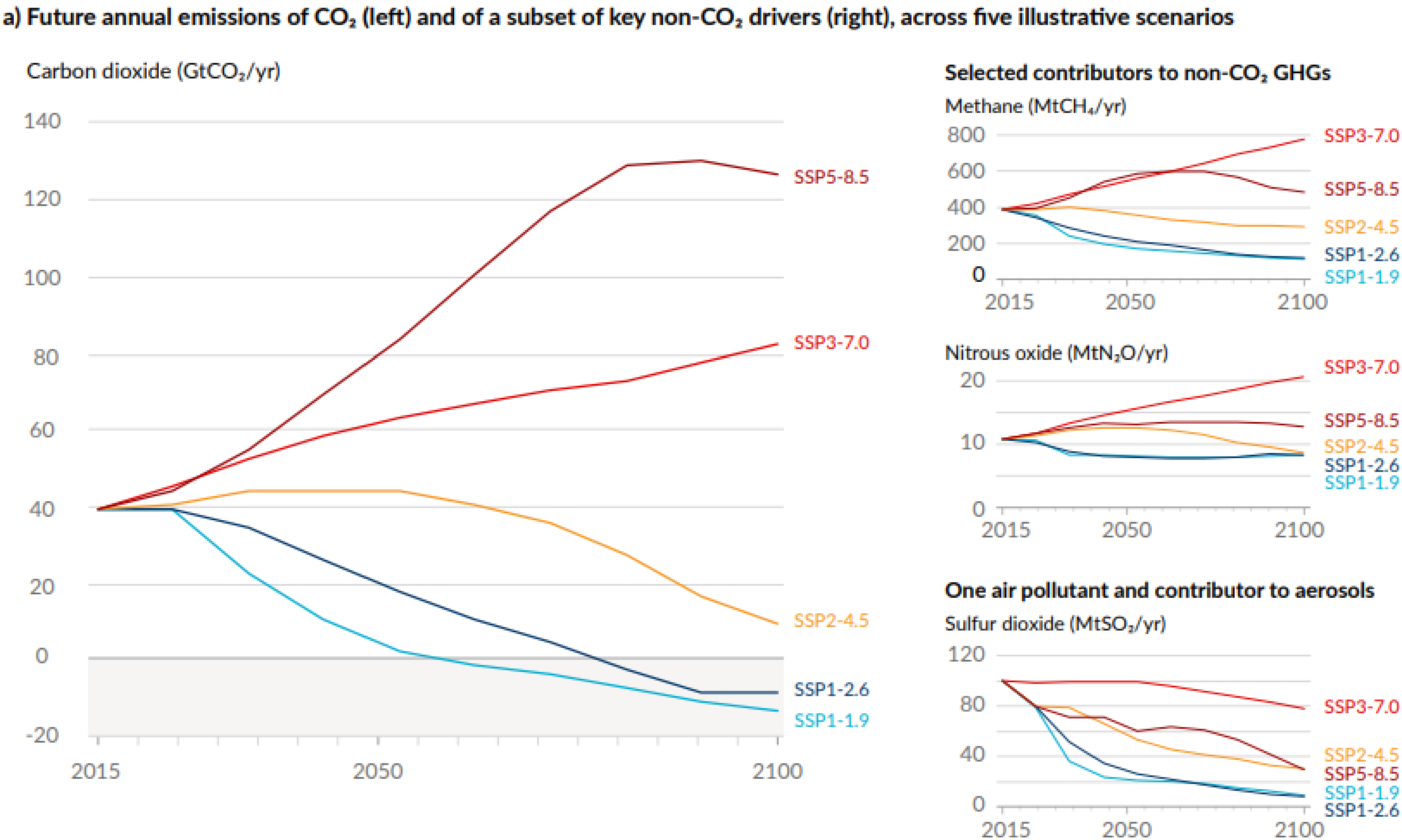
B.3 Continued global warming is projected to further intensify the global water cycle,
including its variability, global monsoon precipitation and the severity of wet and dry events.

B.4 Under scenarios with increasing CO2 emissions, the ocean and land carbon sinks are
projected to be less effective at slowing the accumulation of CO2 in the atmosphere.

B.5 Many changes due to past and future greenhouse gas emissions are irreversible for
centuries to millennia, especially changes in the ocean, ice sheets and global sea level.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

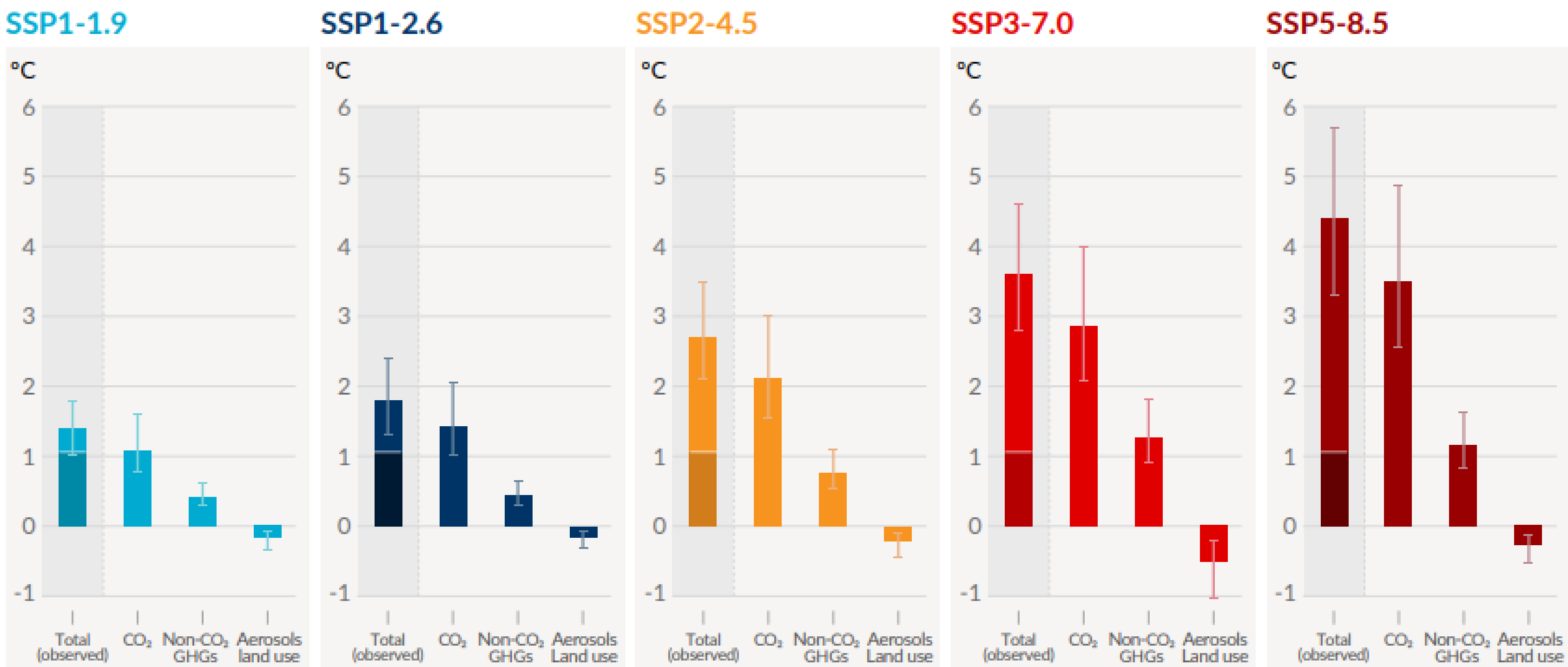
Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions



IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO_2 emissions

Change in global surface temperature in 2081-2100 relative to 1850-1900 (°C)



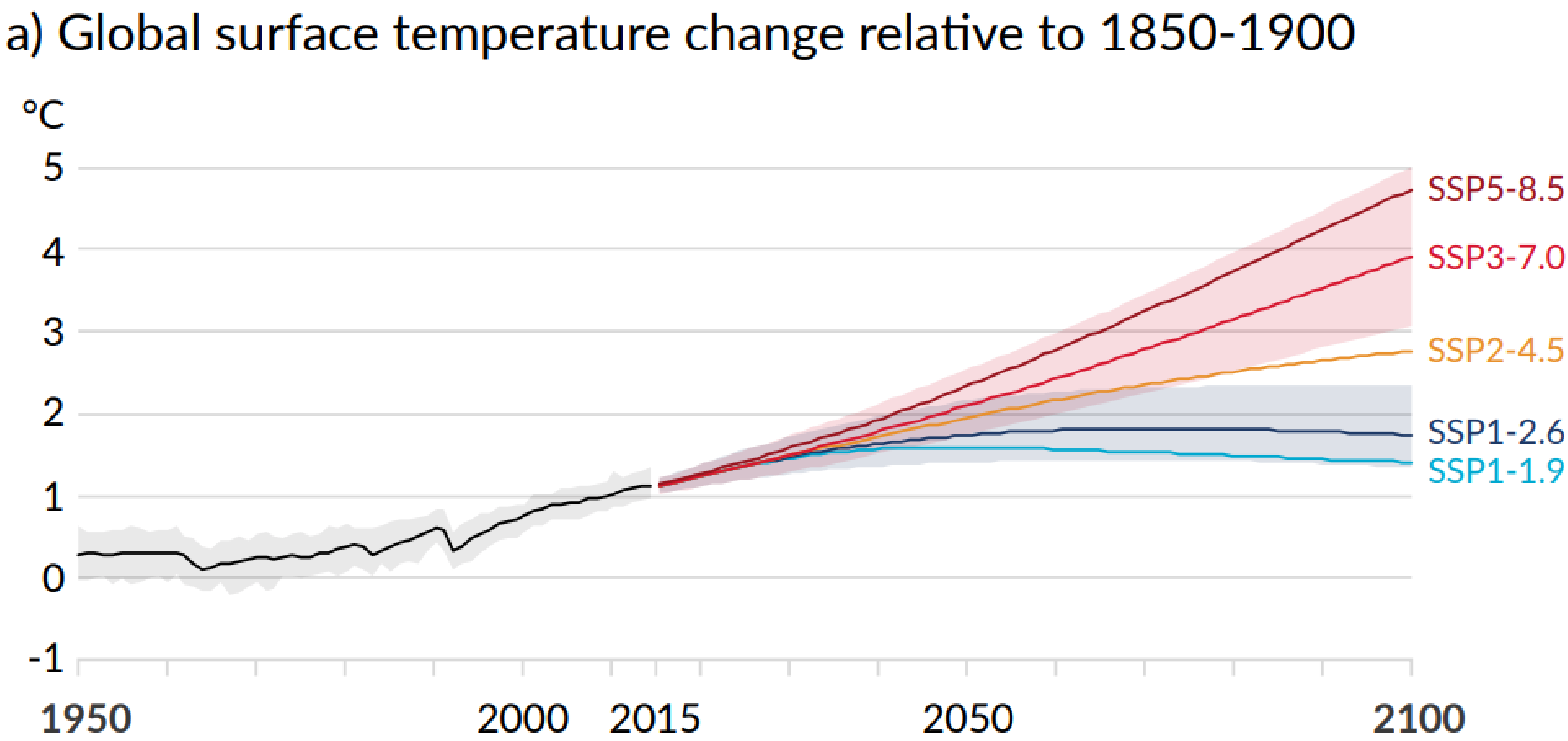
Total warming (observed warming to date in darker shade), warming from CO_2, warming from non-CO_2 GHGs and cooling from changes in aerosols and land use

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

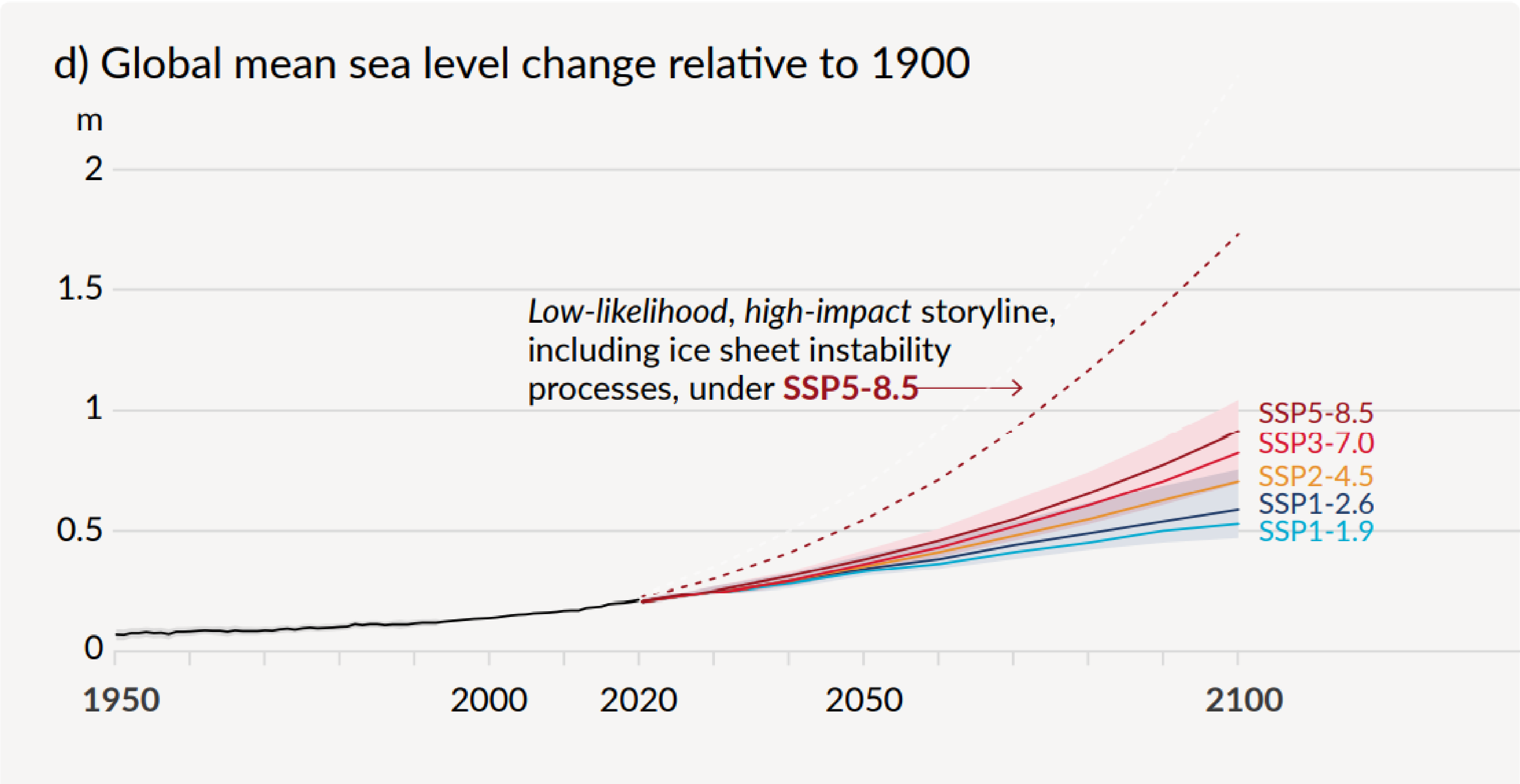
Table SPM.1: Changes in global surface temperature, which are assessed based on multiple lines of evidence, for selected 20-year time periods and the five illustrative emissions scenarios considered. Temperature differences relative to the average global surface temperature of the period 1850–1900 are reported in ° C. This includes the revised assessment of observed historical warming for the AR5 reference period 1986–2005, which in AR6 is higher by 0.08 [–0.01 to 0.12] ° C than in the AR5 (see footnote 10). Changes relative to the recent reference period 1995–2014 may be calculated approximately by subtracting 0.85° C, the best estimate of the observed warming from 1850–1900 to 1995–2014.{Cross-Chapter Box 2.3, 4.3, 4.4, Cross-Section Box TS.1}

	Near term, 2021–2040		**Mid-term, 2041–2060**		**Long term, 2081–2100**	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change



IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change



IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Observed Impacts from Climate Change

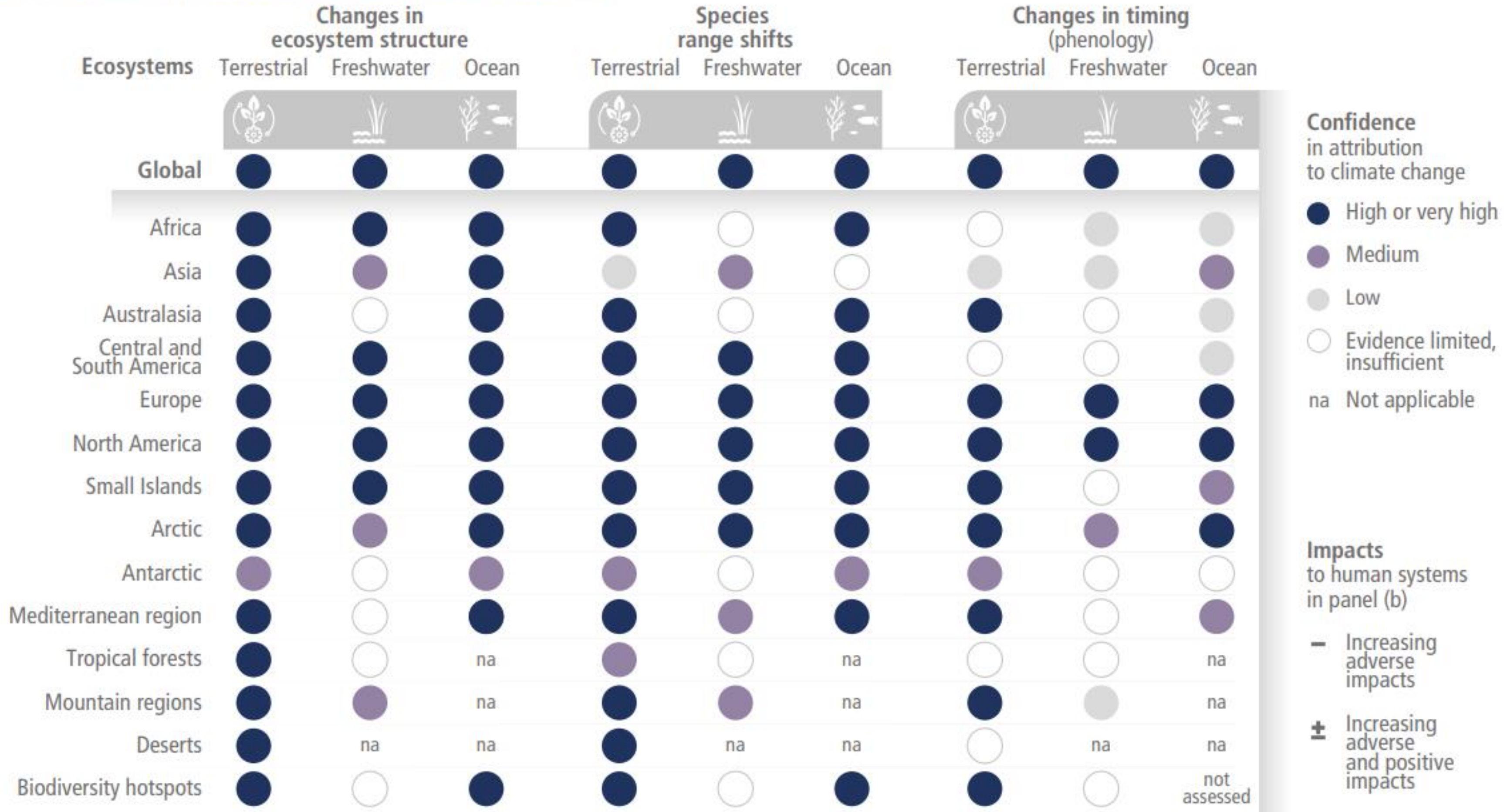
B.1 Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability.

Some development and adaptation efforts have reduced vulnerability. Across sectors and regions the most vulnerable people and systems are observed to be disproportionately affected. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt. (*high confidence*) (Figure SPM.2)

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

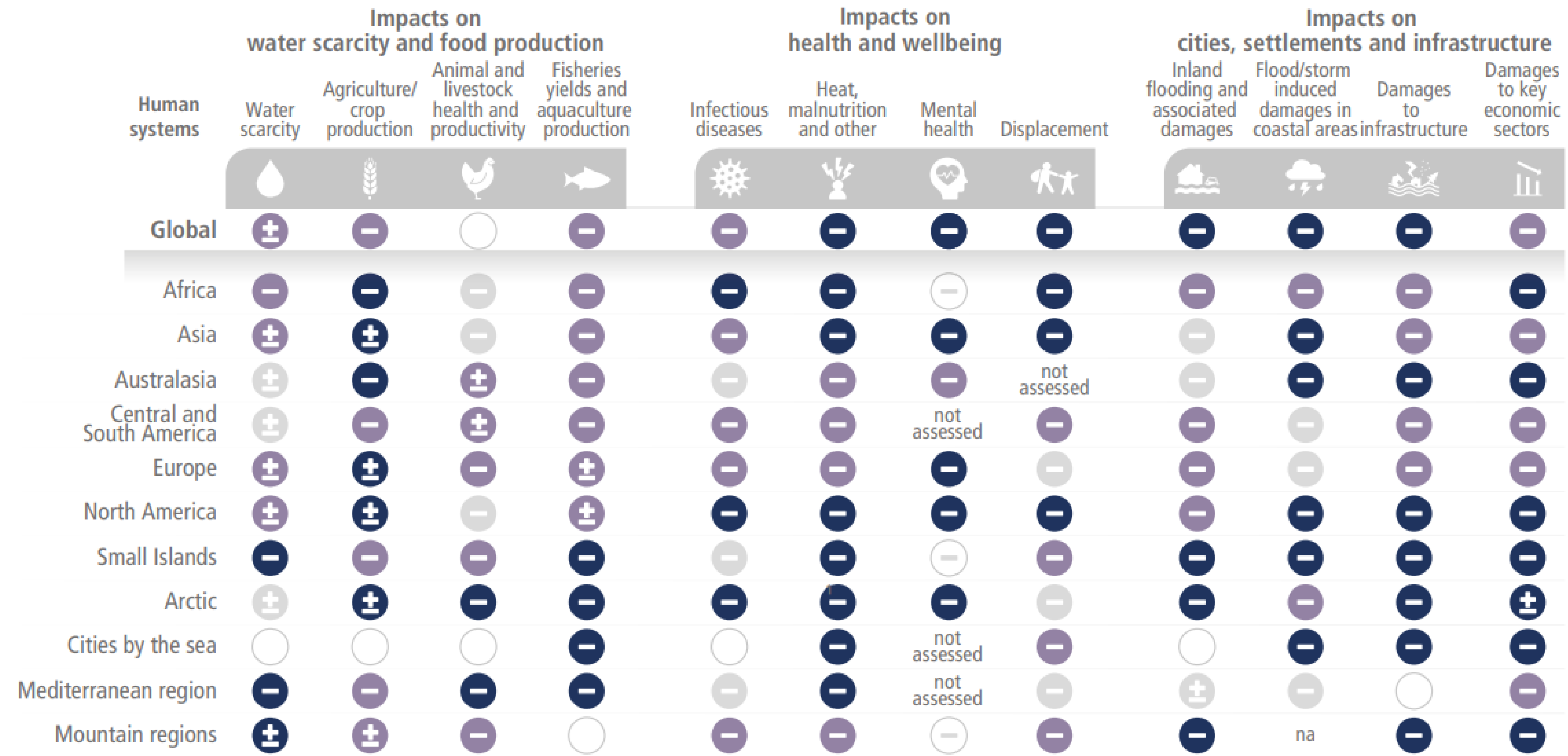
Impacts of climate change are observed in many ecosystems and human systems worldwide

(a) Observed impacts of climate change on ecosystems



IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

(b) Observed impacts of climate change on human systems



IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Vulnerability and Exposure of Ecosystems and People

B.2 Vulnerability of ecosystems and people to climate change differs substantially among and within regions (*very high confidence*), driven by patterns of intersecting socioeconomic development, unsustainable ocean and land use, inequity, marginalization, historical and ongoing patterns of inequity such as colonialism, and governance (*high confidence*).

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Vulnerability and Exposure of Ecosystems and People (cont.)

Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change (*high confidence*).

A high proportion of species is vulnerable to climate change (*high confidence*). Human and ecosystem vulnerability are interdependent (*high confidence*).

Current unsustainable development patterns are increasing exposure of ecosystems and people to climate hazards (*high confidence*).

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Risks in the near term (2021–2040)

B.3 Global warming, reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans (*very high confidence*).

The level of risk will depend on concurrent nearterm trends in vulnerability, exposure, level of socioeconomic development and adaptation (*high confidence*).

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Risks in the near term (2021–2040) (cont.)

Near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems, compared to higher warming levels, but cannot eliminate them all (*very high confidence*).

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Mid to Long-term Risks (2041–2100)

B.4 Beyond 2040 and depending on the level of global warming, climate change will lead to numerous risks to natural and human systems (*high confidence*).

For 127 identified key risks, assessed mid- and long-term impacts are up to multiple times higher than currently observed (*high confidence*).

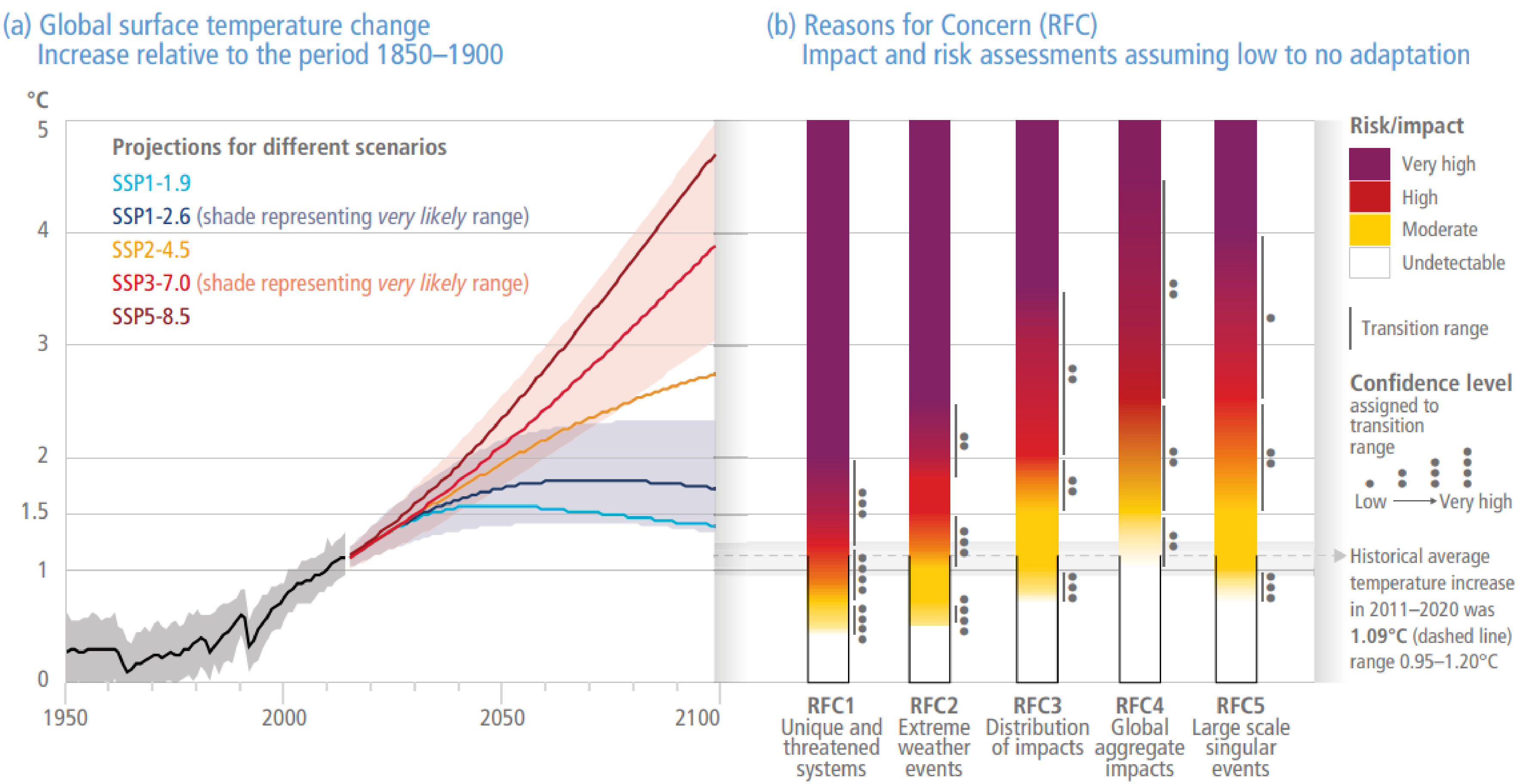
IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Mid to Long-term Risks (2041–2100) (cont.)

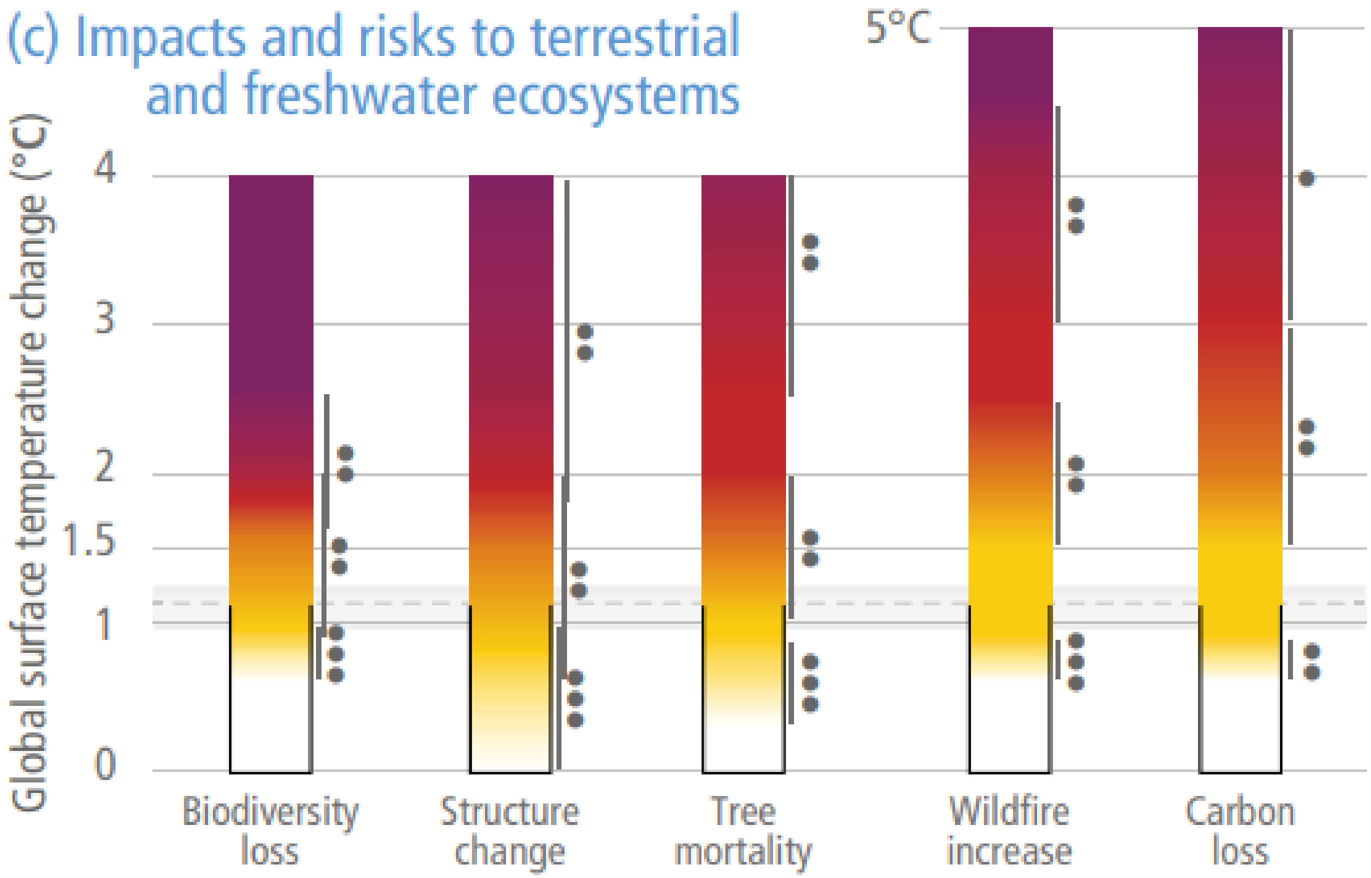
The magnitude and rate of climate change and associated risks depend strongly on near-term mitigation and adaptation actions, and projected adverse impacts and related losses and damages escalate with every increment of global warming (*very high confidence*). (Figure SPM.3)

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Global and regional risks for increasing levels of global warming



IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change



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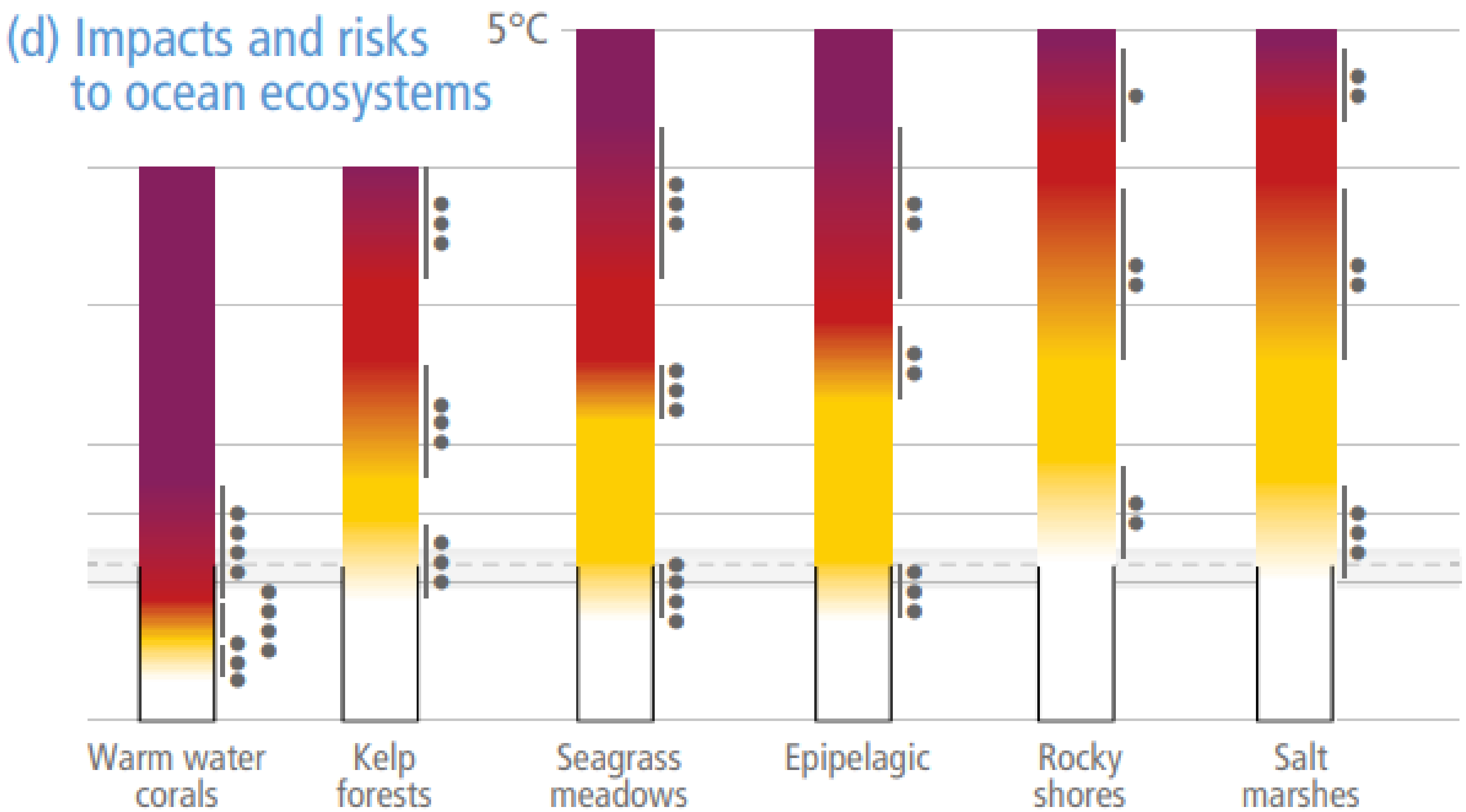


IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Conditions for Climate Resilient Development

D.1 Evidence of observed impacts, projected risks, levels and trends in vulnerability, and adaptation limits, demonstrate that worldwide climate resilient development action is more urgent than previously assessed in AR5.

Comprehensive, effective, and innovative responses can harness synergies and reduce trade-offs between adaptation and mitigation to advance sustainable development. (*very high confidence*)

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

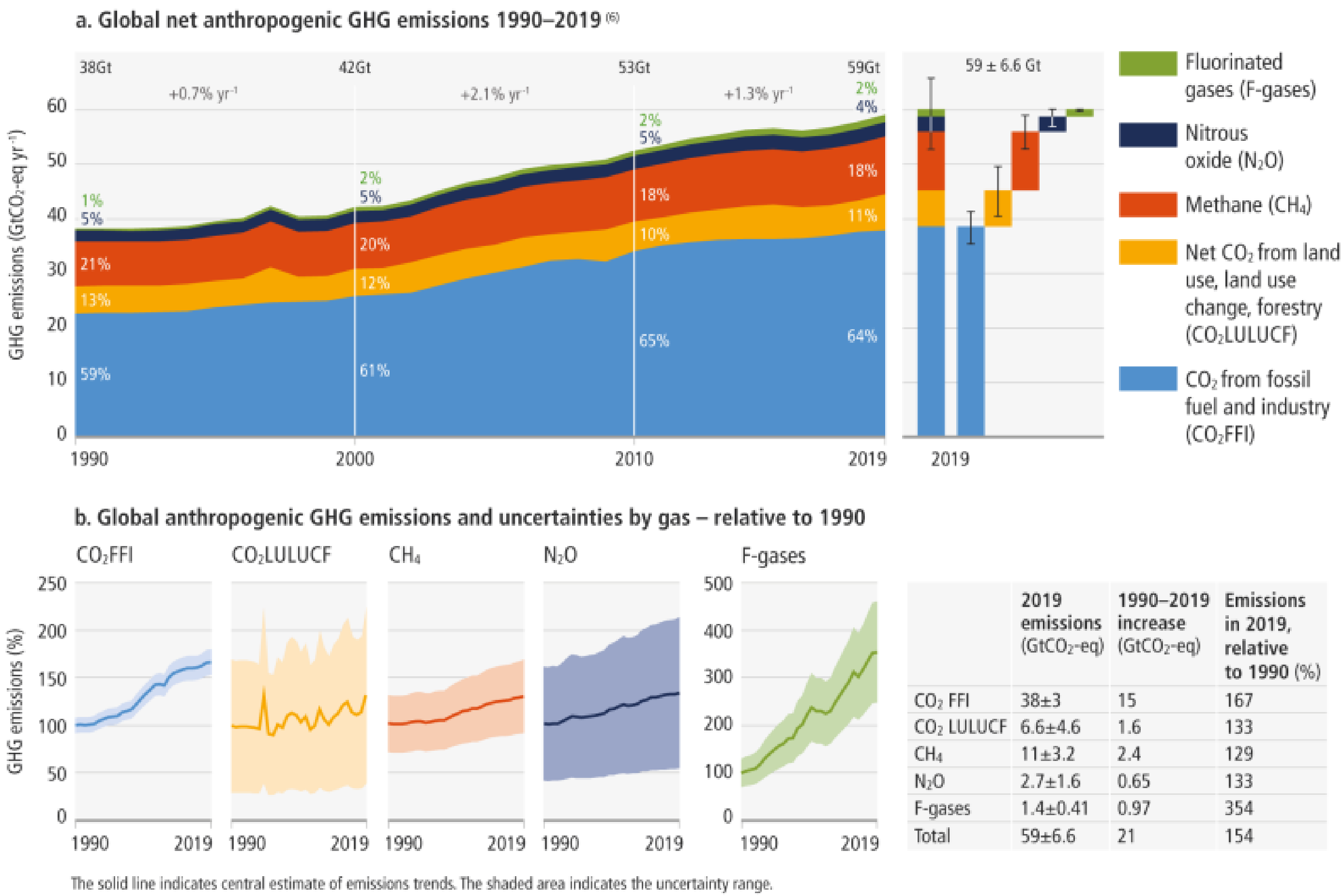
B. Recent Developments and Current Trends

B.1 Total net anthropogenic GHG emissions have continued to rise during the period 2010–2019, as have cumulative net CO2 emissions since 1850.

Average annual GHG emissions during 2010–2019 were higher than in any previous decade, but the rate of growth between 2010 and 2019 was lower than that between 2000 and 2009. (*high confidence*) (Figure SPM.1)

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Global net anthropogenic emissions have continued to rise across all major groups of greenhouse gases.



	2019 emissions ($GtCO_2$-eq)	1990–2019 increase ($GtCO_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO_2 FFI	38±3	15	167
CO_2 LULUCF	6.6±4.6	1.6	133
CH_4	11±3.2	2.4	129
N_2O	2.7±1.6	0.65	133
F-gases	1.4±0.41	0.97	354
Total	59±6.6	21	154

Figure SPM.1: Global net anthropogenic GHG emissions ($GtCO_2$-eq yr^{-1}) 1990–2019

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

B.4 The unit costs of several low-emission technologies have fallen continuously since 2010. Innovation policy packages have enabled these cost reductions and supported global adoption. Both tailored policies and comprehensive policies addressing innovation systems have helped overcome the distributional, environmental and social impacts potentially associated with global diffusion of low-emission technologies. Innovation has lagged in developing countries due to weaker enabling conditions. Digitalisation can enable emission reductions, but can have adverse side effects unless appropriately governed. (high confidence) (Figure SPM.3)

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

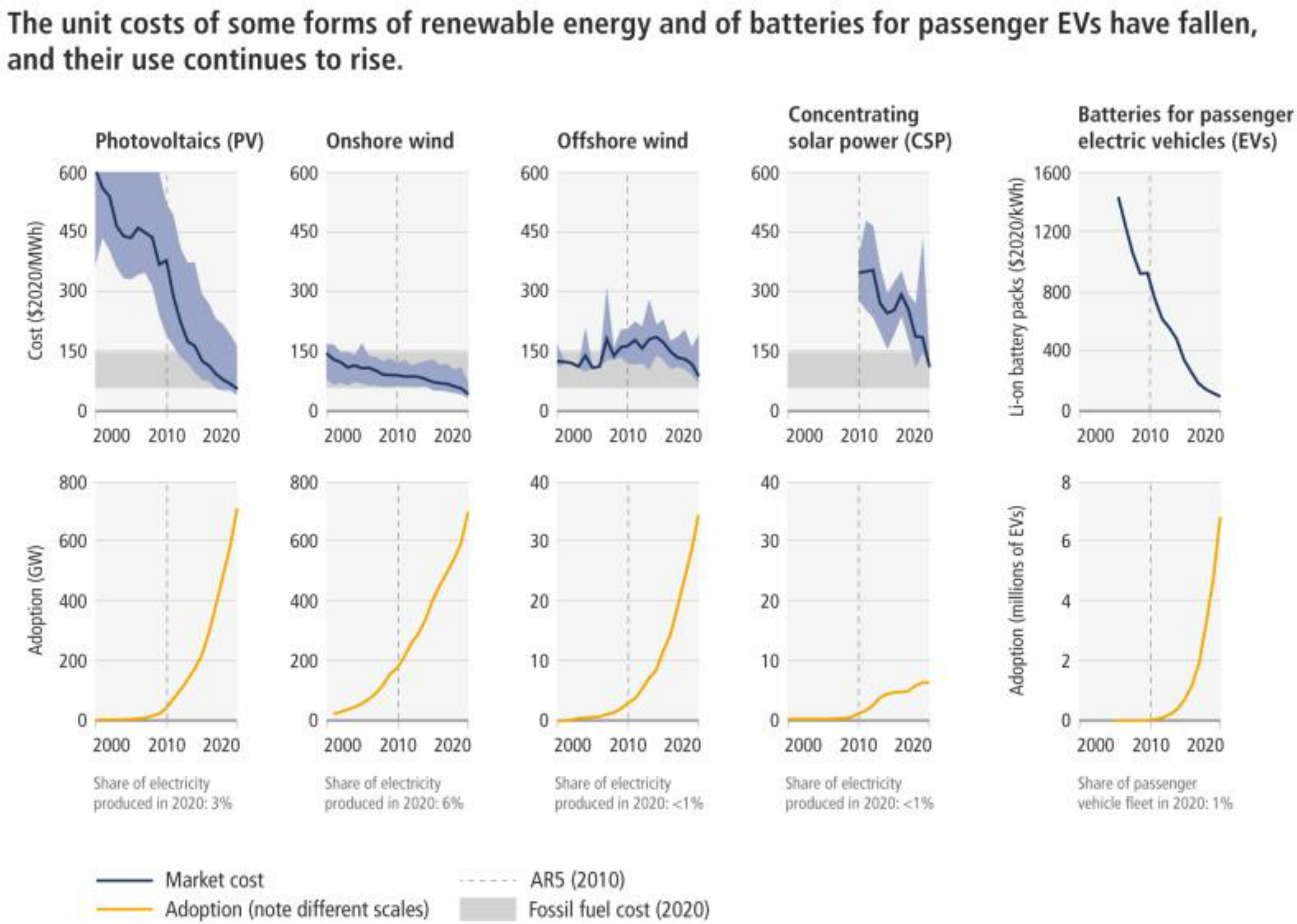
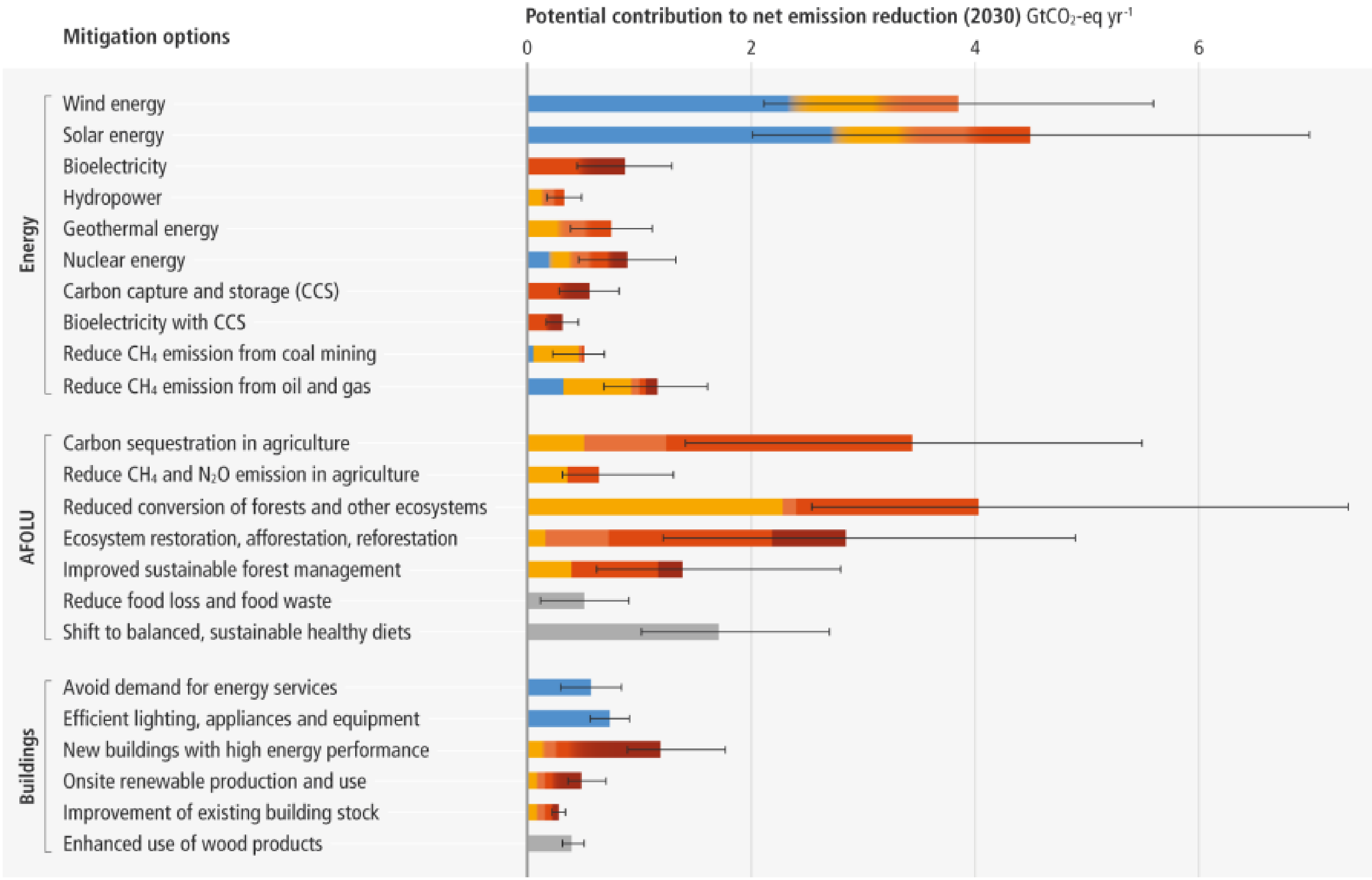


Figure SPM.3: Unit cost reductions and use in some rapidly changing mitigation technologies

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

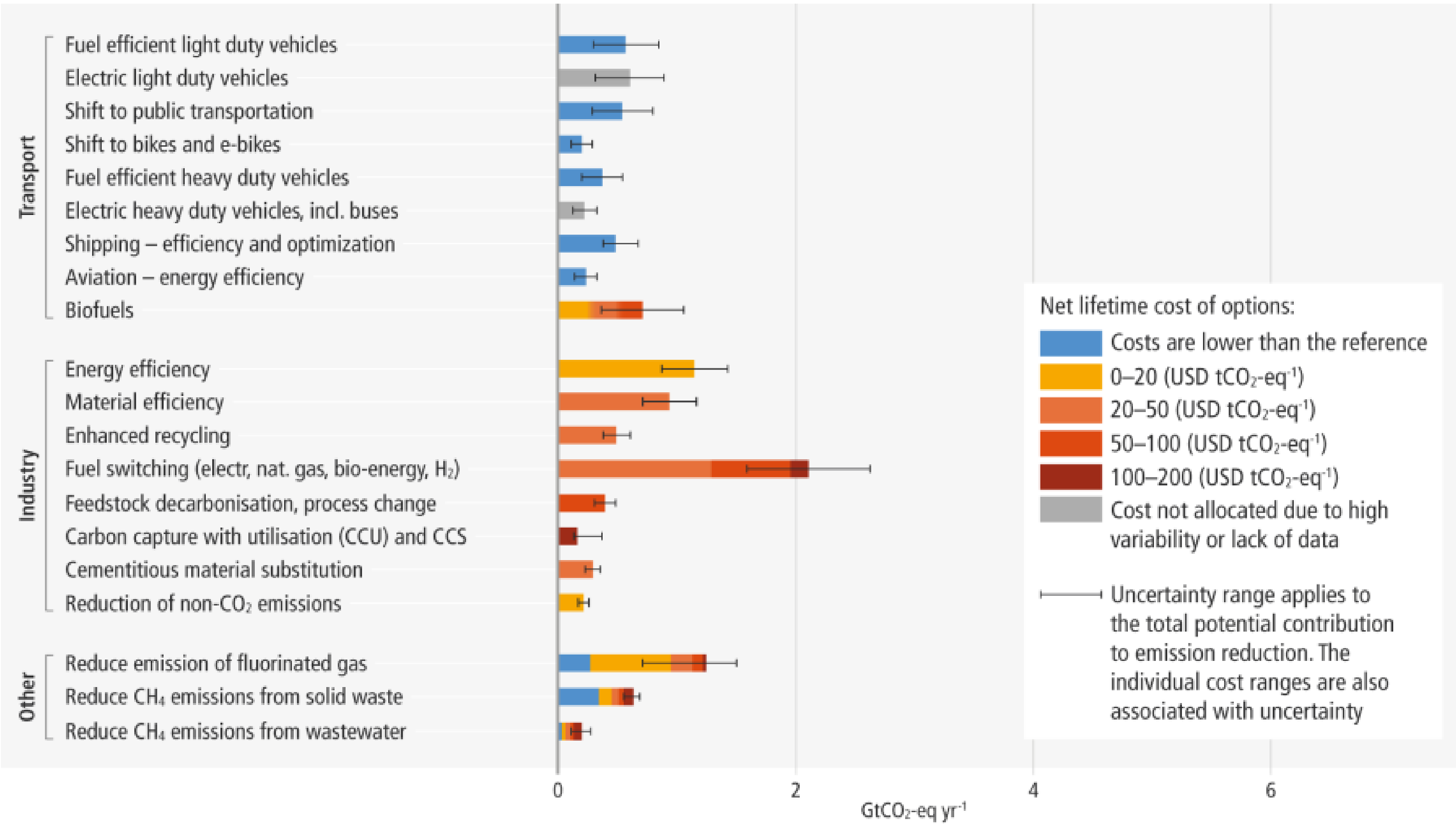


Figure SPM.7: Overview of mitigation options and their estimated ranges of costs and potentials in 2030.

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

The Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3)

December 1997

1. Emission targets

Green house gases

Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Sulphur hexafluoride (SF_6), Hydrofluorocarbons (HFCs) , Perfluorocarbons (PFCs)

Base year 1990 (or 1995 for HFC, PFC and SF_6)

Annex I countries collectively agreed to reduce their greenhouse gas emissions by 5.2% on average for the period 2008-2012, relative to their annual emissions in a base year, usually 1990.

Annex I parties are industrialized nations and are legally bound to reduce greenhouse gas emissions once they have ratified the agreement.

2. Flexible mechanisms

International Emissions Trading (IET)

IET allows Annex I Parties to "trade" their emissions

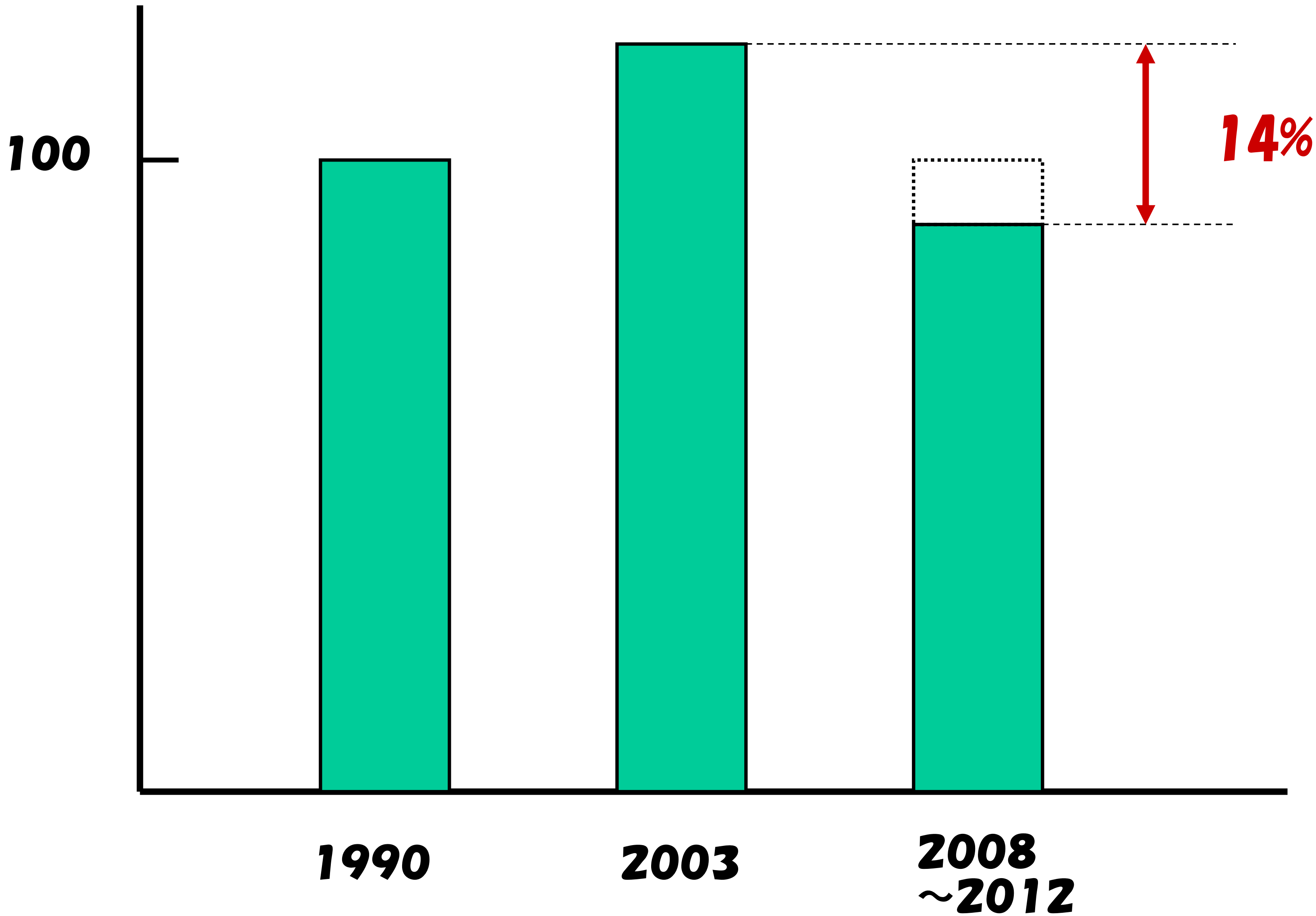
Joint Implementation (JI)

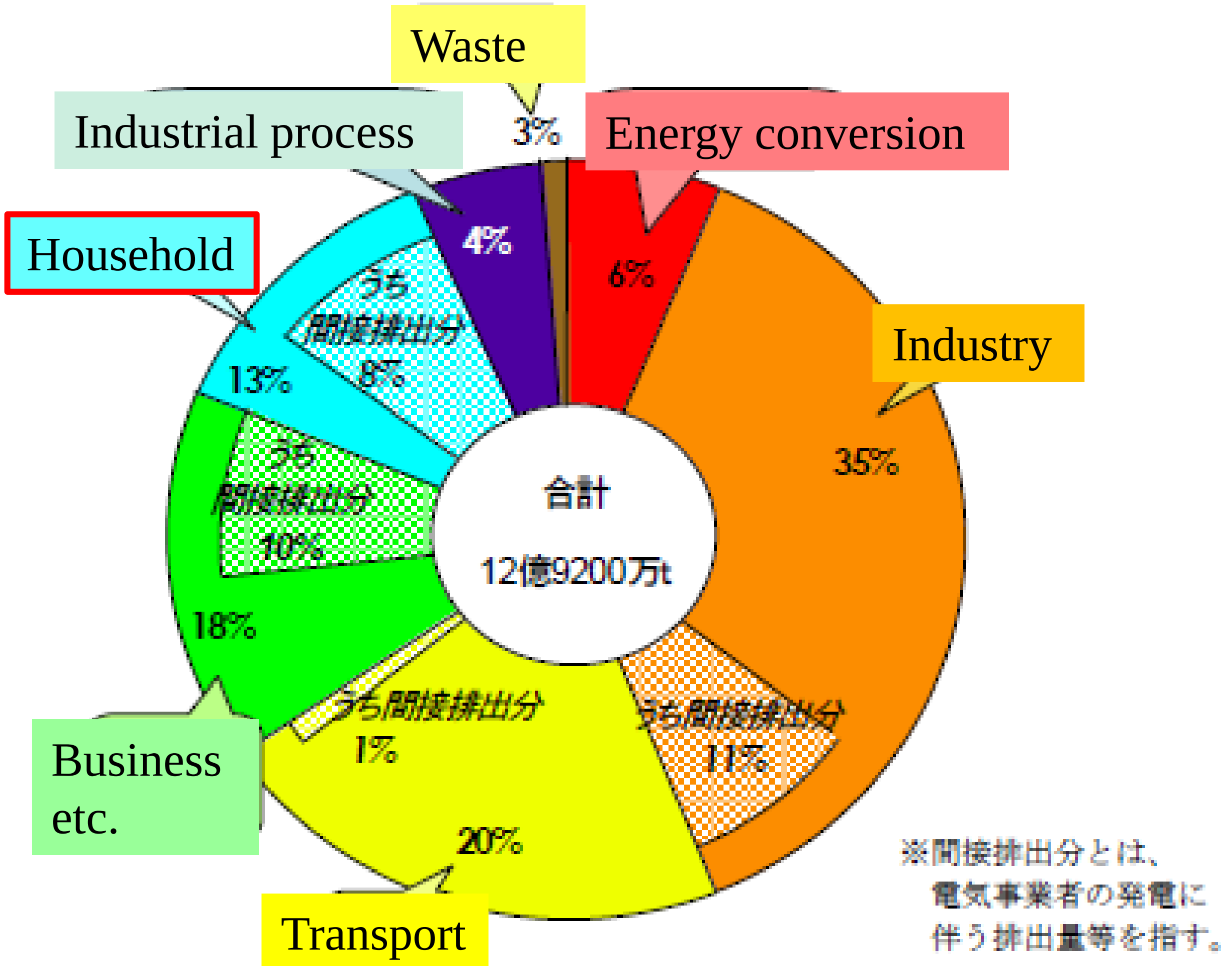
JI encourages production of emission reductions in Annex I Parties by projects.

Clean Development Mechanism (CDM)

CDM is designed to encourage production of emission reductions in non-Annex I Parties by emission reduction projects.

Japan must reduce its greenhouse gas emissions by 6% on average for the period 2008-2012, relative to their annual emissions in the base year.


100
14%
1990
2003
2008
～2012



CO_2 emission by sector in Japan (fiscal year 2005)

改定京都議定書目標達成計画(閣議決定)の概要より　2008年3月28日

The Kyoto Protocol

was adopted in Kyoto, on 11 December 1997

and entered into force on 16 February 2005.

Japan ratified the protocol in June 2002.

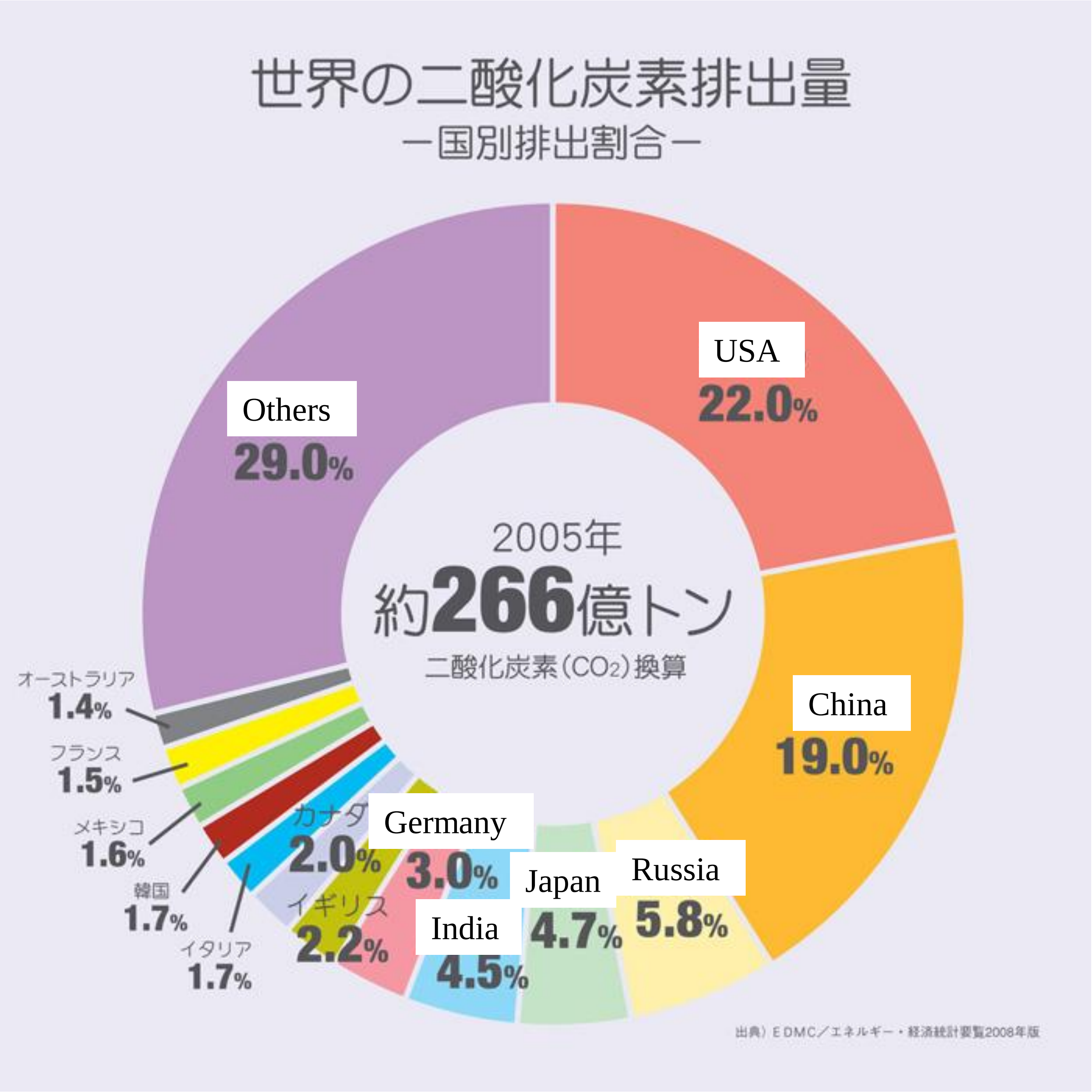
GHGs emission of Japan in Fiscal Year 2012 (Preliminary Figures)

Total GHGs 1,341 million tonnes as CO_2

+6.3% compared with the amount in 1990

−8.2% including CDM etc.

(average of FY2008–FY2012)

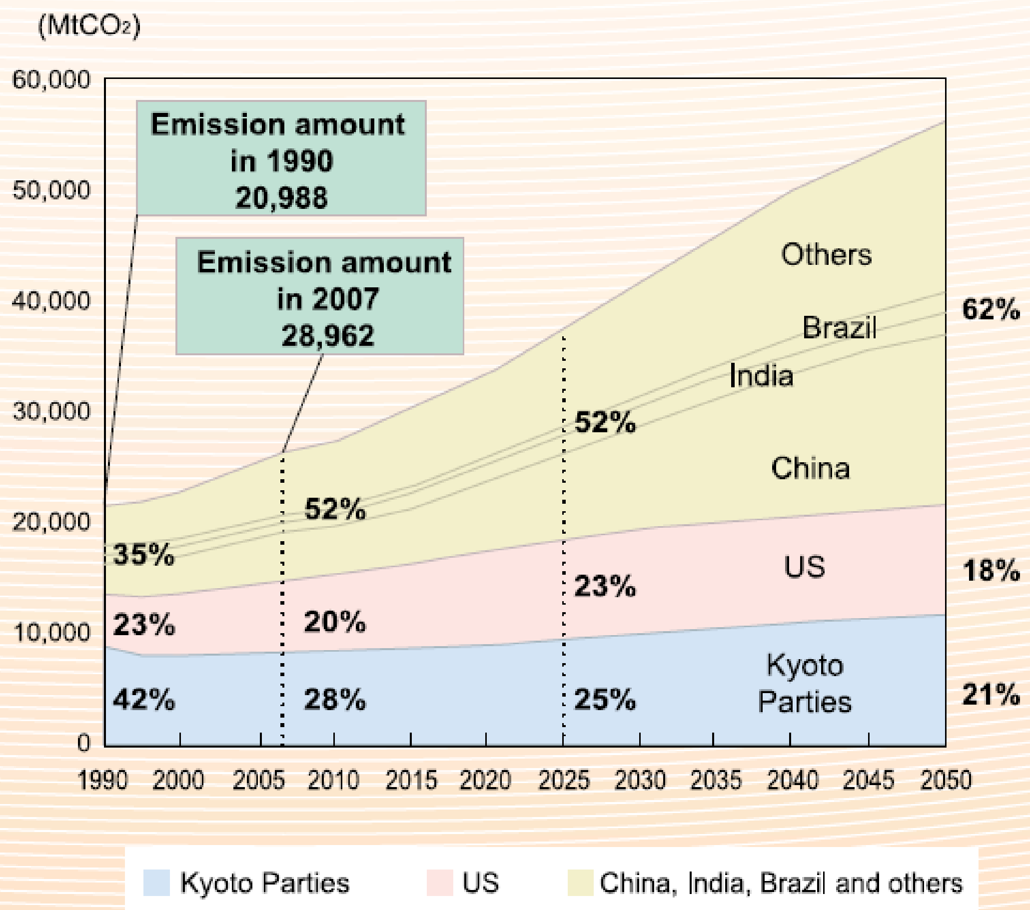


世界の二酸化炭素排出量
ー国別排出割合ー
2005年
約266億トン
二酸化炭素（CO2）換算
USA
22.0%
China
19.0%
Russia
5.8%
Japan
4.7%
India
4.5%
Germany
3.0%
イギリス
2.2%
カナダ
2.0%
イタリア
1.7%
韓国
1.7%
メキシコ
1.6%
フランス
1.5%
オーストラリア
1.4%
Others
29.0%
出典）EDMC／エネルギー・経済統計要覧2008年版

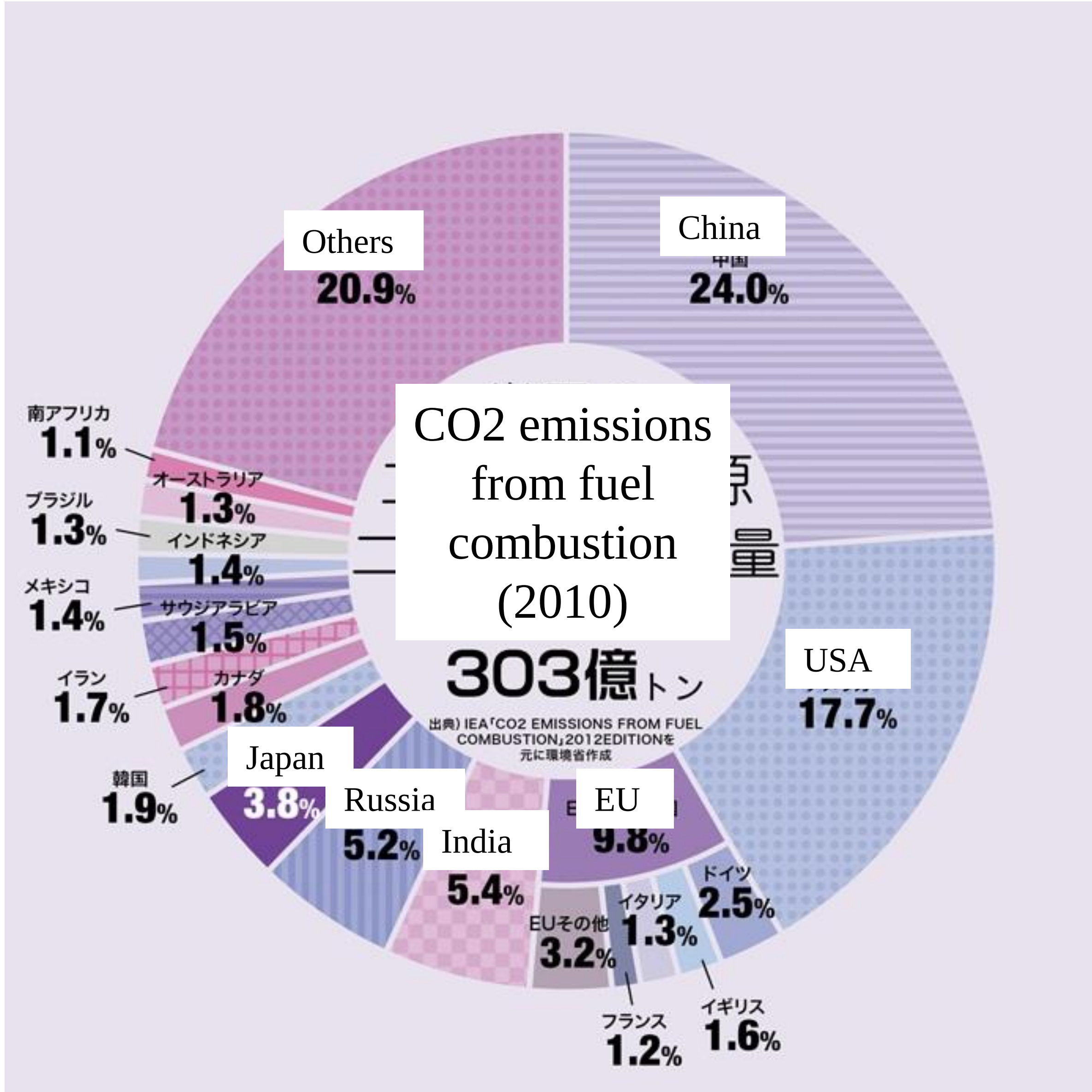
Increasing emission amount of developing nations

■ Long-term outlook for the CO_2 emissions (Figure 23)

Source: Research Institute of Innovative Technology for the Earth (RITE)

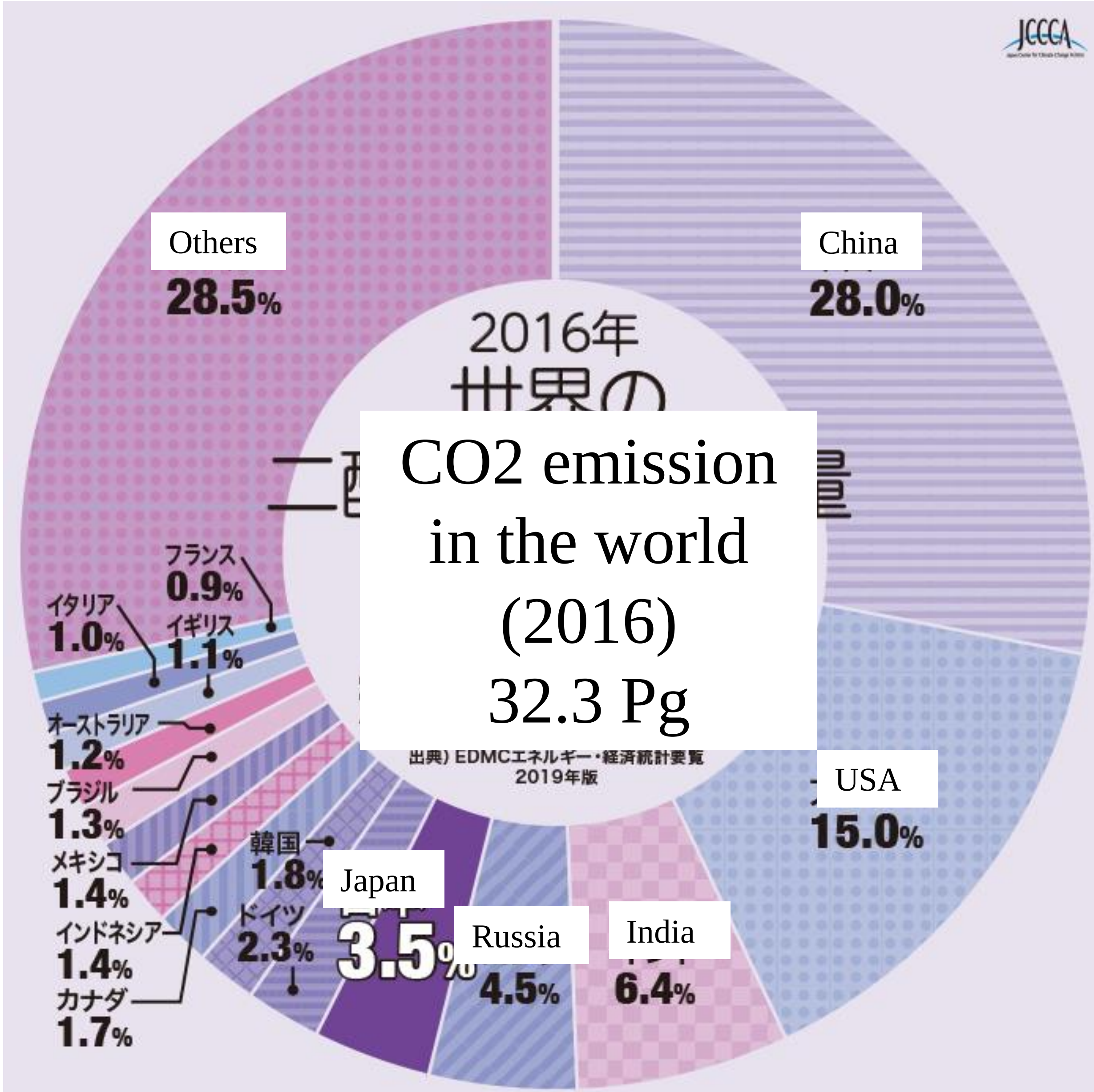


Energy in Japan 2010, Agency for Natural Resources and Energy



出典) IEA「CO2 EMISSIONS FROM FUEL COMBUSTION」2012EDITIONを元に環境省作成

全国地球温暖化防止活動推進センターウェブサイト（http://www.jccca.org/）より



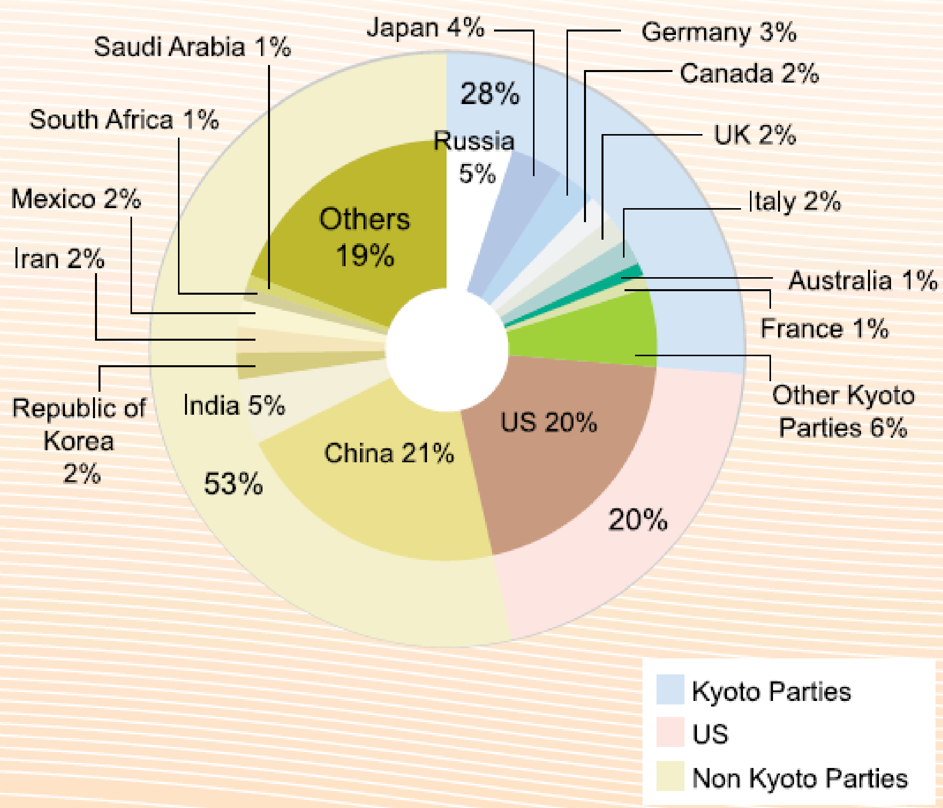
出典)EDMC／エネルギー・経済統計要覧2019年版
全国地球温暖化防止活動推進センターウェブサイト（http://www.jccca.org/）より

Emission amount of the reduction-obligated nations accounting for less than 30% of the world total

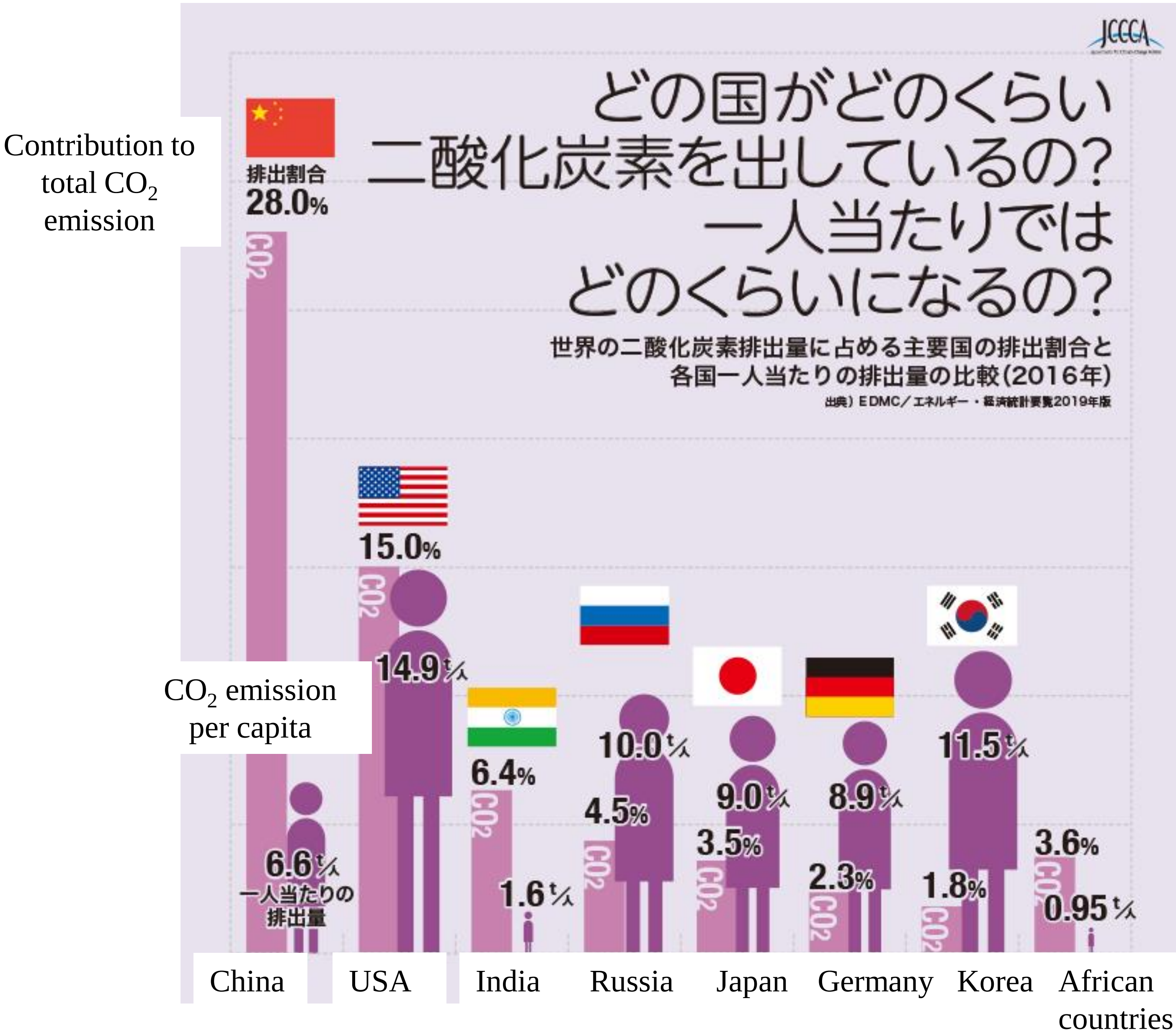
■ **Energy-originated CO_2 emission amount in the world (2007) (Figure 22)**

Source: IEA, CO_2 Emissions from Fuel Combustion (2009 edition)

Emission amount of the countries obligated for reduction under the Kyoto Protocol accounts for 28% of the total.



Energy in Japan 2010, Agency for Natural Resources and Energy



出典) EDMC/エネルギー・経済統計要覧2019年版
全国地球温暖化防止活動推進センターウェブサイト(http://www.jccca.org/)より

Paris Agreement

On 12 December 2015, 195 countries adopt the first universal climate agreement at the 21th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21)

・This agreement confirms the target of keeping the rise in temperature below 2℃ . It establishes, for the first time, that we should be aiming for 1.5° C, to protect island states.

・The Paris agreement asks all countries to review these contributions every five years from 2020; they will not be able to lower their targets and are encouraged to raise them.

・The agreement establishes an obligation for industrialized countries to fund climate finance for poor countries, while developing countries are invited to contribute on a voluntary basis.

・The agreement will be open for signing by the countries on 22 April in New York. The agreement can only enter into force once it has been ratified by 55 countries, representing at least 55% of emissions.

Intergovernmental Panel on Climate Change (IPCC) published the Special Report Global Warming of 1.5 ºC on 8 October 2018.

Climate models project robust differences in regional climate characteristics between present-day and global warming of 1.5° , and between 1.5° C and 2° . These differences include increases in: mean temperature in most land and ocean regions (*high confidence*), hot extremes in most inhabited regions (*high confidence*), heavy precipitation in several regions (*medium confidence*), and the probability of drought and precipitation deficits in some regions (*medium confidence*).