
Climate Change 2013: The Physical Science Basis
Working Group I contribution to the IPCC Fifth Assessment Report
IPCC WG1 AR5 Report & its relevance to Southeast Asia region
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IPCC WG1 Vice-Chair
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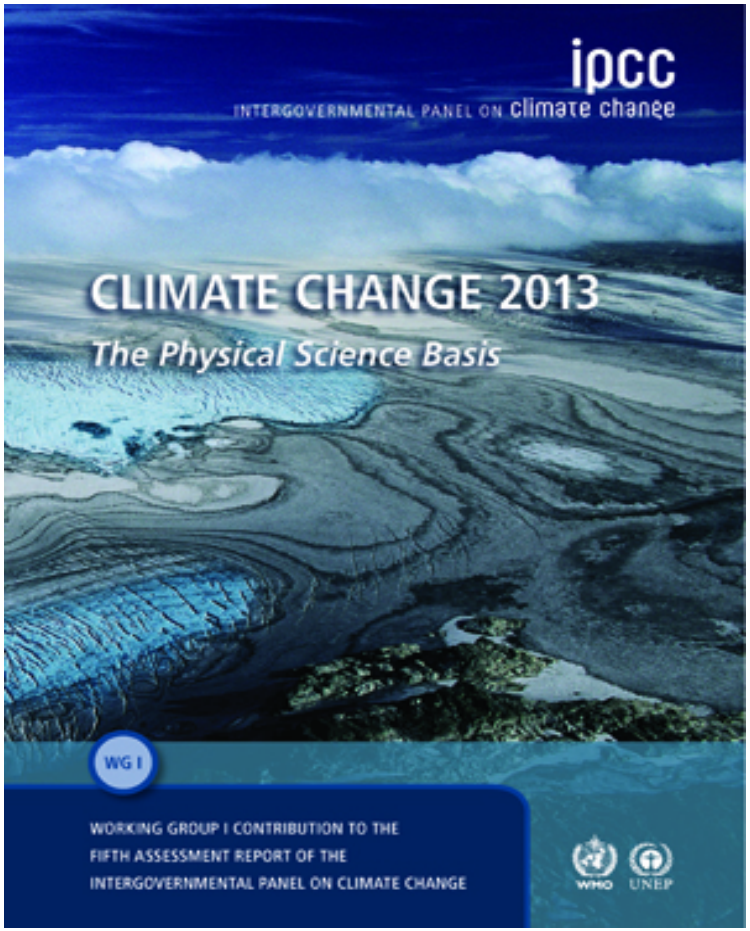
IPCC WG1 AR5 *Climate Change 2013: The Physical Science Basis*



- **The IPCC has released its *WG1 AR5 Climate Change 2013: The Physical Science Basis* on 27 Sept 2013 in Stockholm, Sweden**
- **The Summary for Policymakers (SPM) can be downloaded from the IPCC website http://www.ipcc.ch and www.climatechange2013.org**
- **This lecture highlights key findings of the report [SPM, TS, Underlying chapters]**

Cover Page: Folgefonna glacier on the high plateaus of Sørfjorden, Norway (60°14' N, 6°44' E).

Outline

- IPCC: Historical perspectives, roles & functions, assessment process
- Key findings based on observations
- Detection and attribution
- Future climate projections
- Relevance to Southeast Asia region
- Summary

Global Warming / Climate Change

These four questions were not easy to answer

What is the status of climate change?

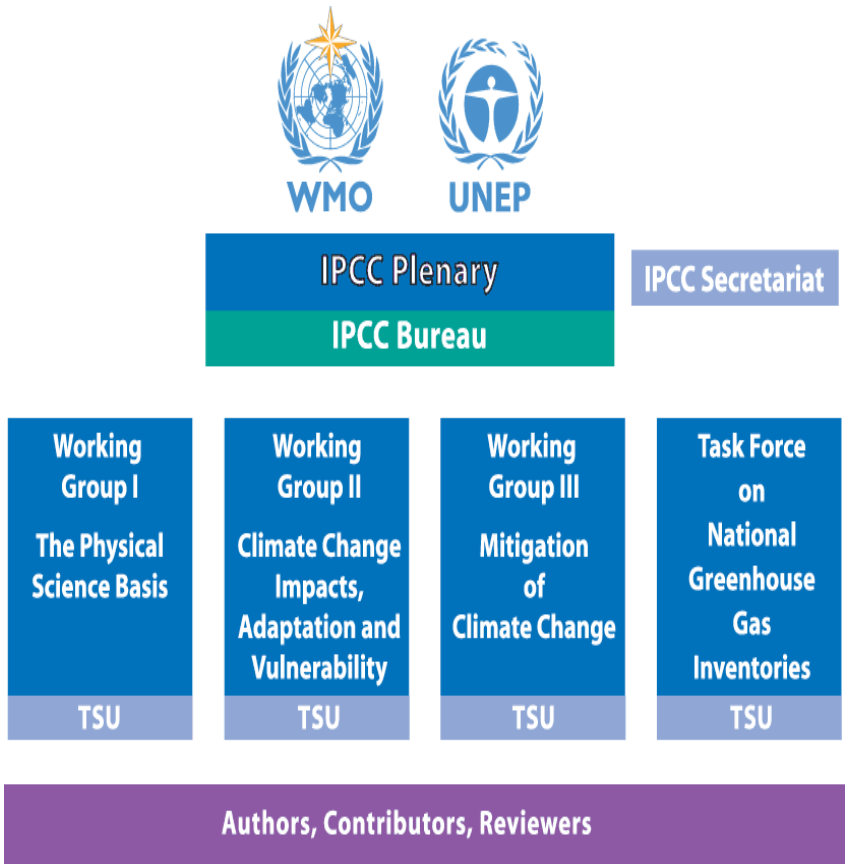
What are the causes?

How can we be affected?

How can we mitigate and adapt?

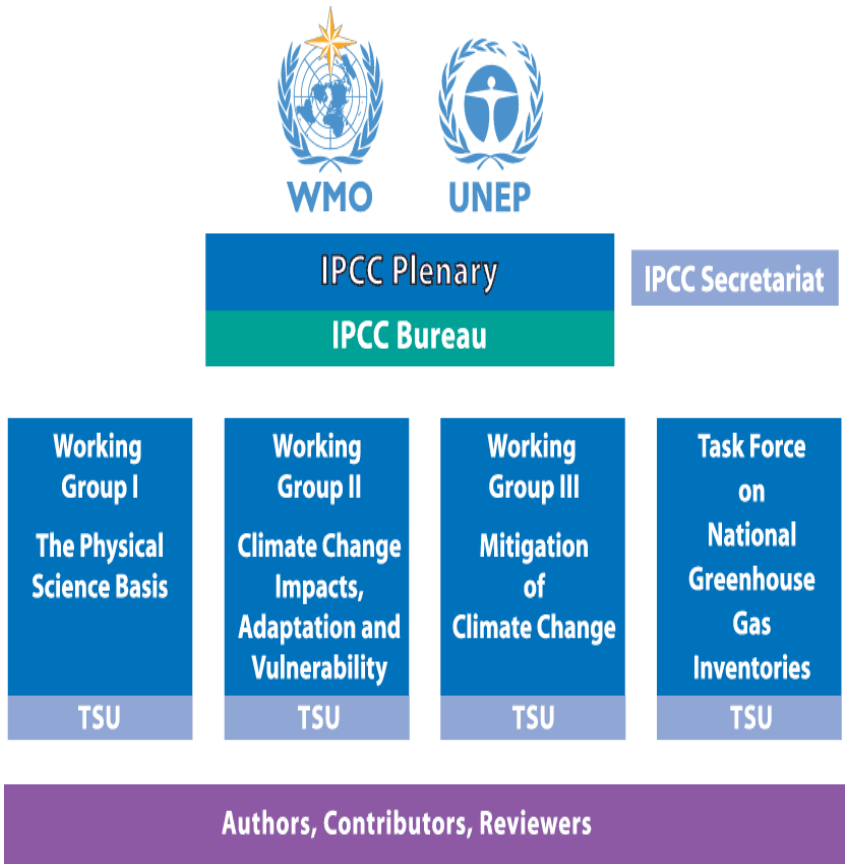
In fact IPCC was established by the United Nation 25 years ago to provide answers to these questions

Inter-governmental Panel on Climate Change (IPCC)



- IPCC plenary comprises of all countries in the world
- IPCC Bureau comprises of 30 elected members with variable numbers for each of the WMO region; IPCC elects its bureau members once in a 6-7 years cycle
- 3 working groups & a Task Force on NGGI
- Authors, Contributors, Reviewers, Review Editors

Inter-governmental Panel on Climate Change (IPCC)



THE IPCC BUREAU

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Why IPCC?

- **Prior to the establishment of IPCC, growing number of literatures indicate the Earth's climate system is warming due to increasing GHG concentration in atmosphere**

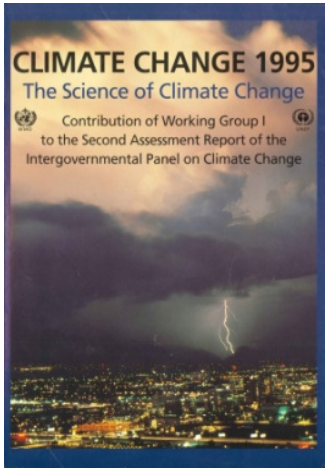
- **Independent, objective, fair and transparent assessment of the state of global climate system is required**

- **For this reason, United Nations General Assembly (UNGA) 42 proposed the establishment of IPCC and in 1988 IPCC was established under WMO and UNEP**

- **The IPCC provides such assessment and this becomes the source of information particularly to policy makers and UNFCCC on 1. Causes of climate change, 2. Potential impacts on built and natural systems and socio-economic, 3. Possible response options.**

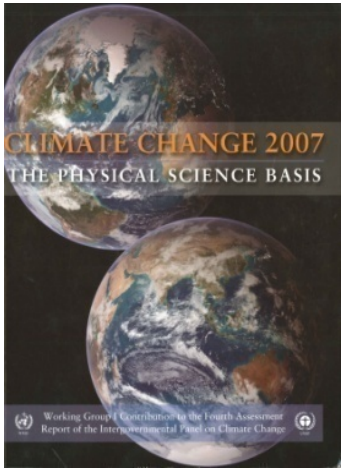
IPCC Reports

FAR 1990



SAR 1995

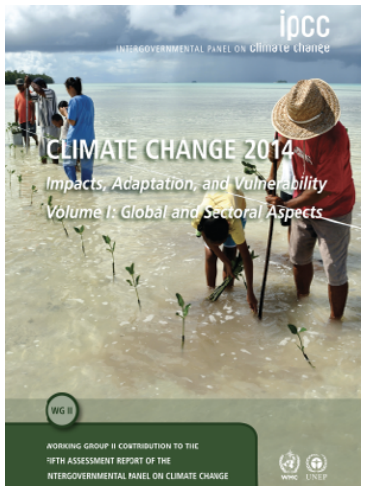
TAR 2001



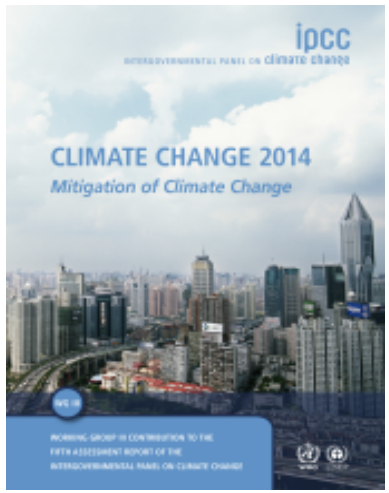
AR4 2007

Nobel Peace Prize 2007

AR5 WGI 2013



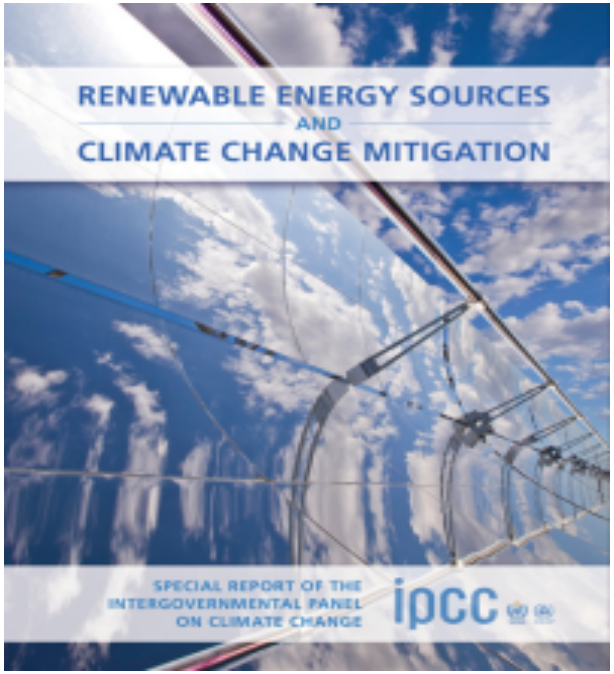
AR5 WGII 2014



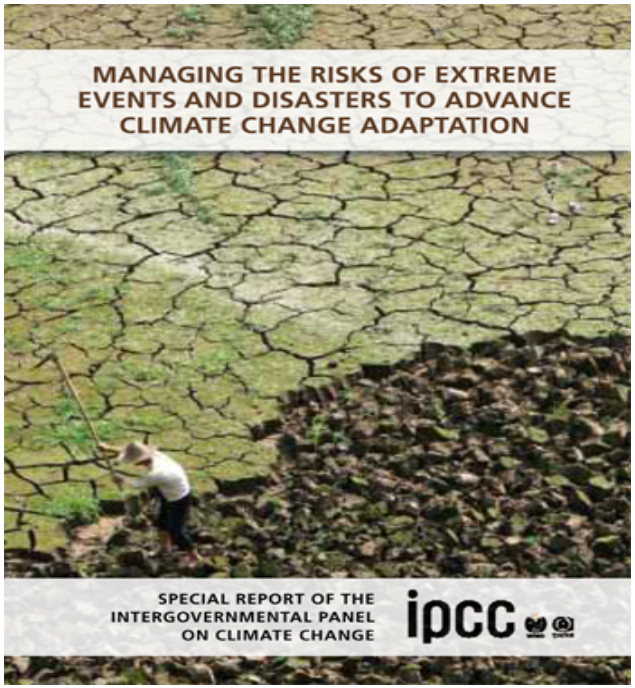
AR5 WGIII 2014

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

IPCC Special Reports

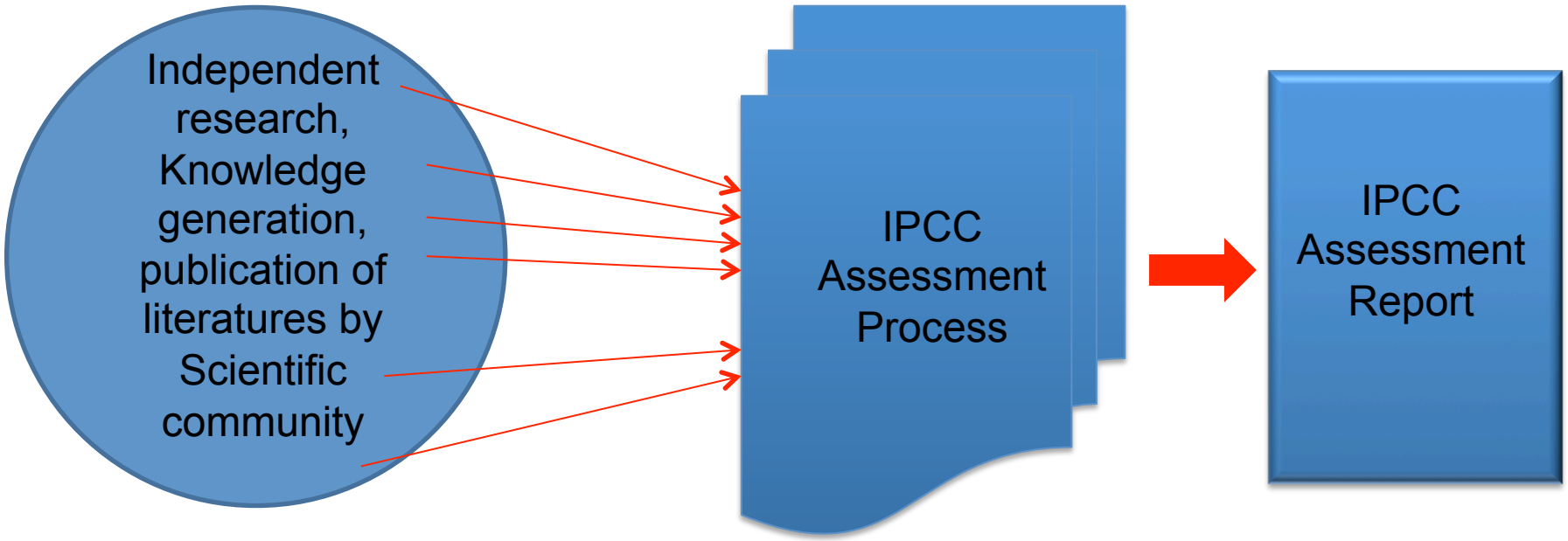


SRREN (2011)



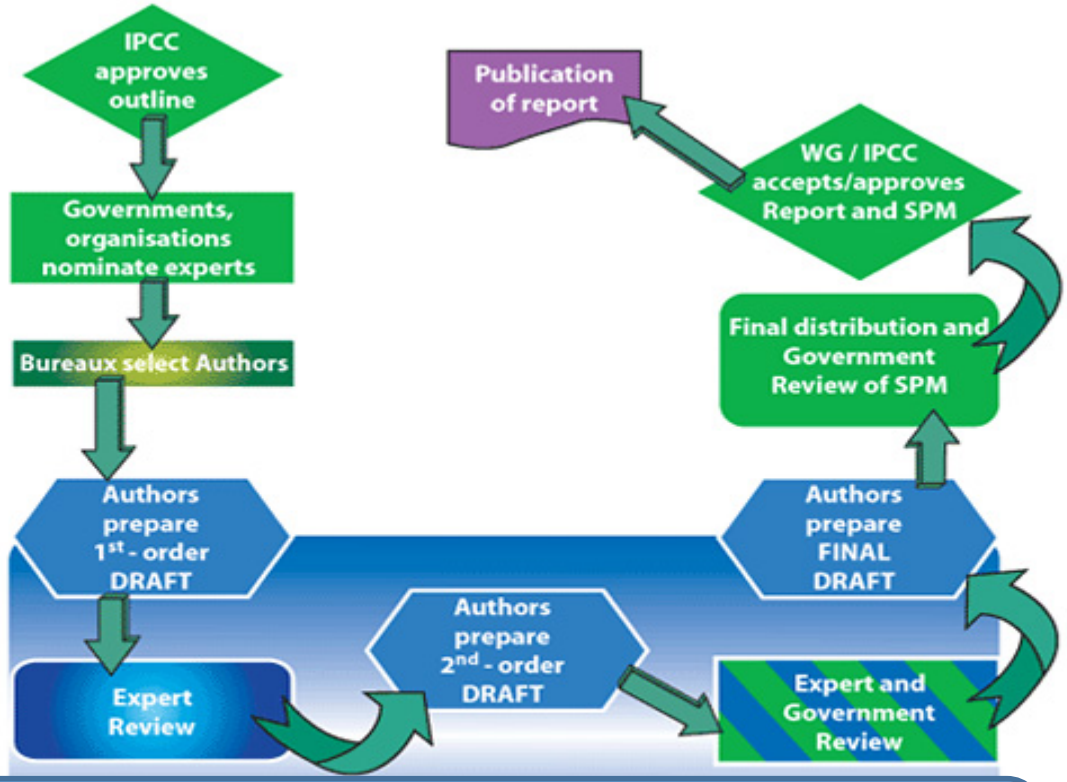
SREX (2012)

How IPCC produces these reports?



IPCC doesn't involve at this stage

IPCC Assessment Process



IPCC assessment is based on available peer-reviewed publications

Key « Rules » for IPCC Work

- COMPREHENSIVE – all the latest relevant scientific, technical and socio-economic literature published wordwide is assessed
- BALANCED – differring views are reflected in the reports
- OPEN – selection of authors from all countries and relevant discipline, wide review process by experts and governments
- TRANSPARENT – strict clear procedures

Key SPM Messages

19 Headlines

on less than 2 Pages

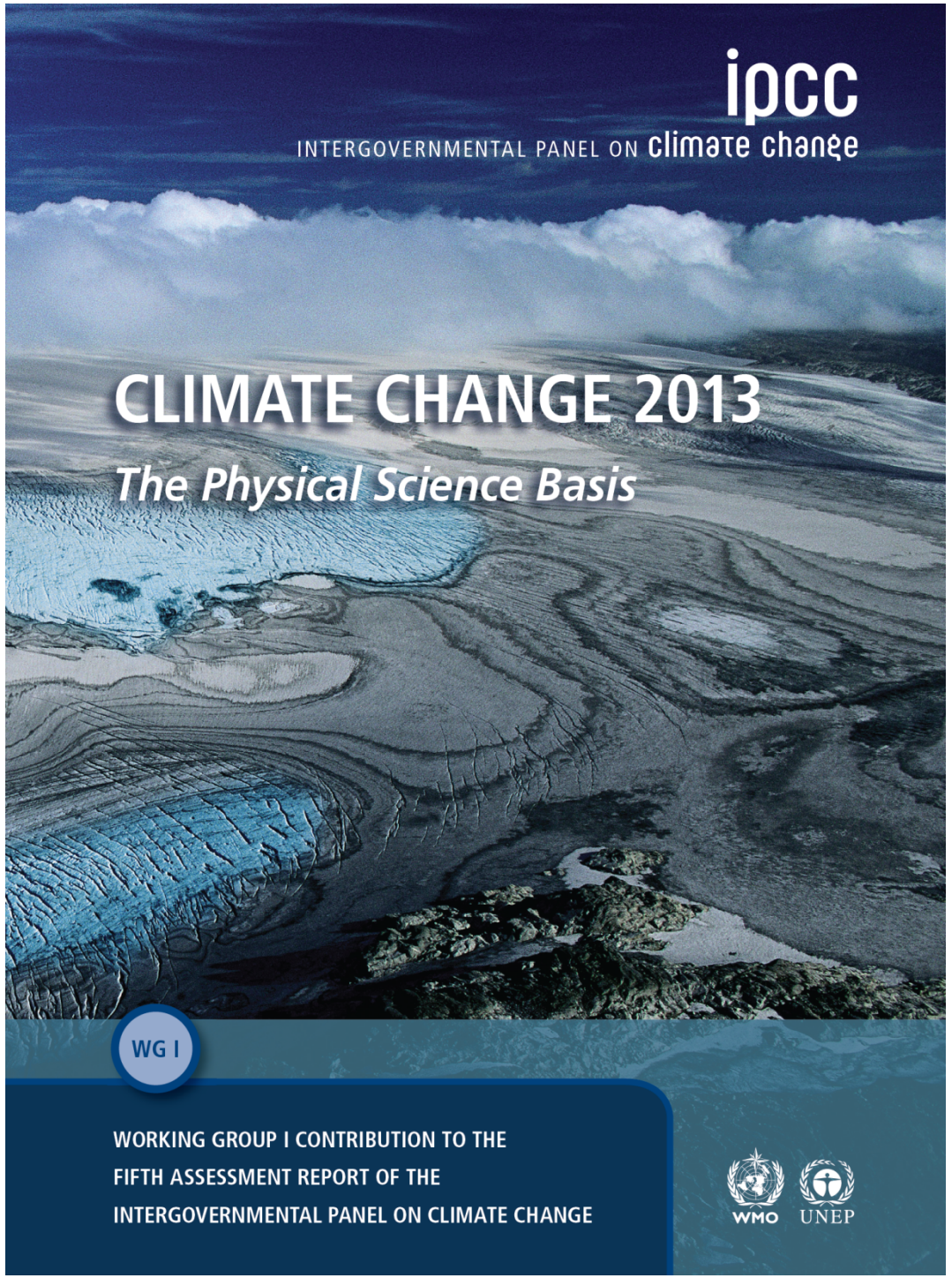
Summary for Policymakers
~14,000 Words

14 Chapters
Atlas of Regional Projections

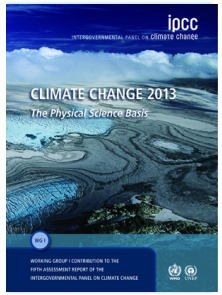
54,677 Review Comments
by 1089 Experts

2010: 259 Authors Selected

2009: WGI Outline Approved



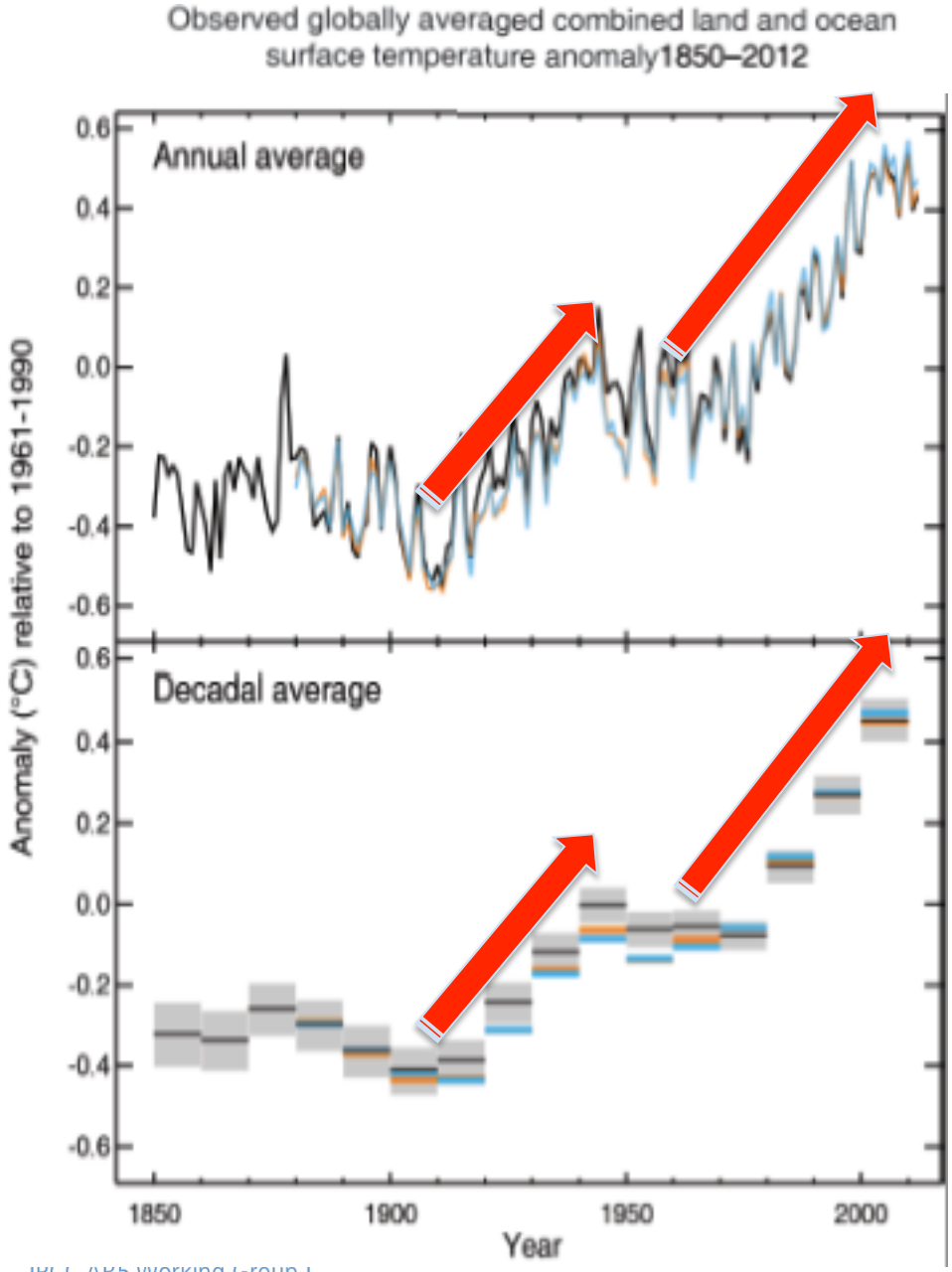
The Relative Comprehensiveness of IPCC WG1 AR5



	FAR 1990 11 Chapters	SAR 1995 11 Chapters	TAR 2001 14 Chapters	AR4 2007 11 Chapters	AR5 2013 14 Chapters
observations	✓	✓	✓	✓✓✓	✓✓✓
paleoclimate				✓	✓
sea level	✓	✓	✓		✓
clouds					✓
carbon cycle			✓		✓
regional change			✓	✓	✓✓✓

Key Statement / Headline of IPCC WG1 AR5 SPM

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased

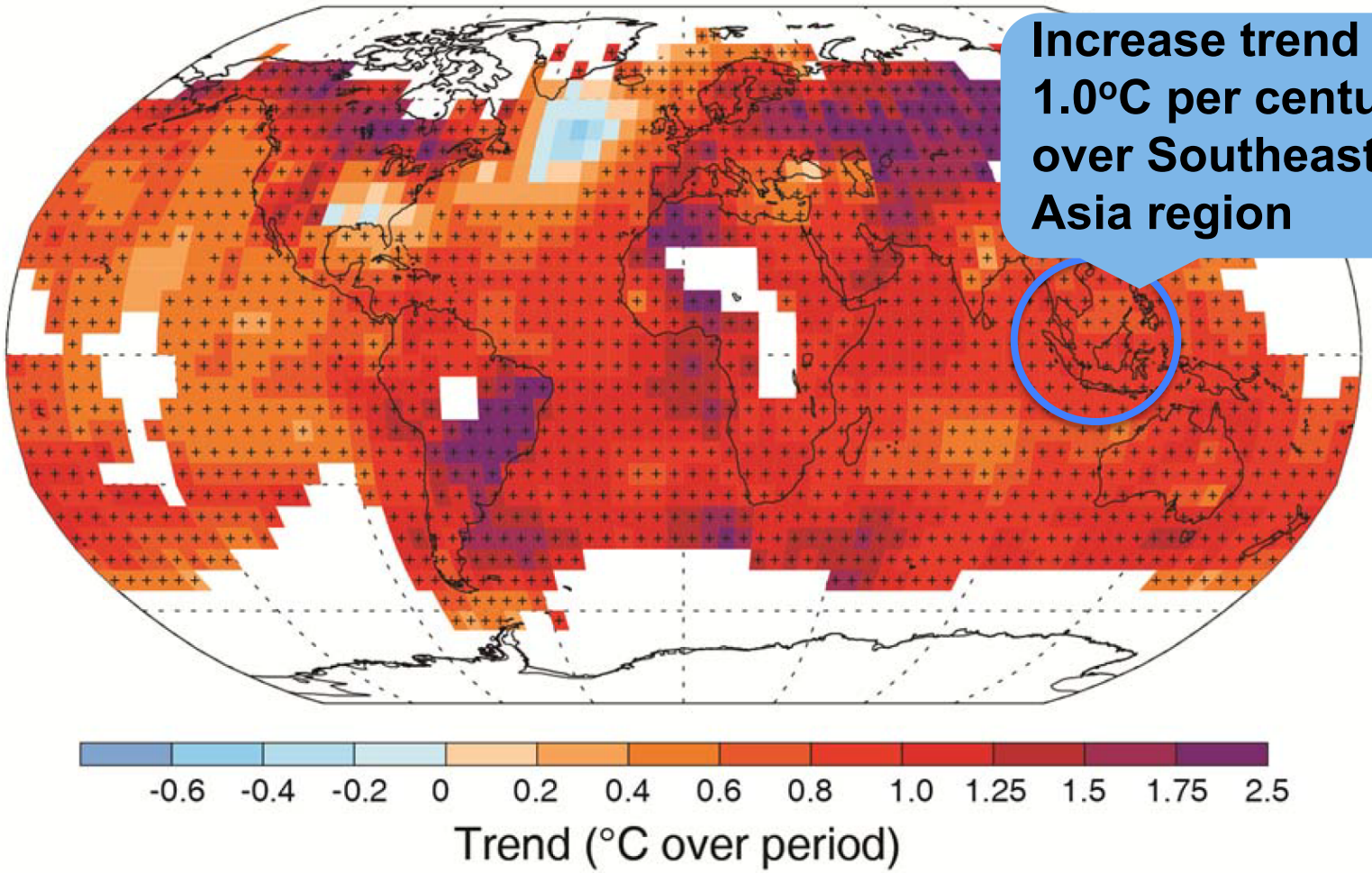


The globally averaged surface temperature data as calculated by a linear trend, show a warming of 0.85 [0.65 to 1.06] °C over 1880 - 2012

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

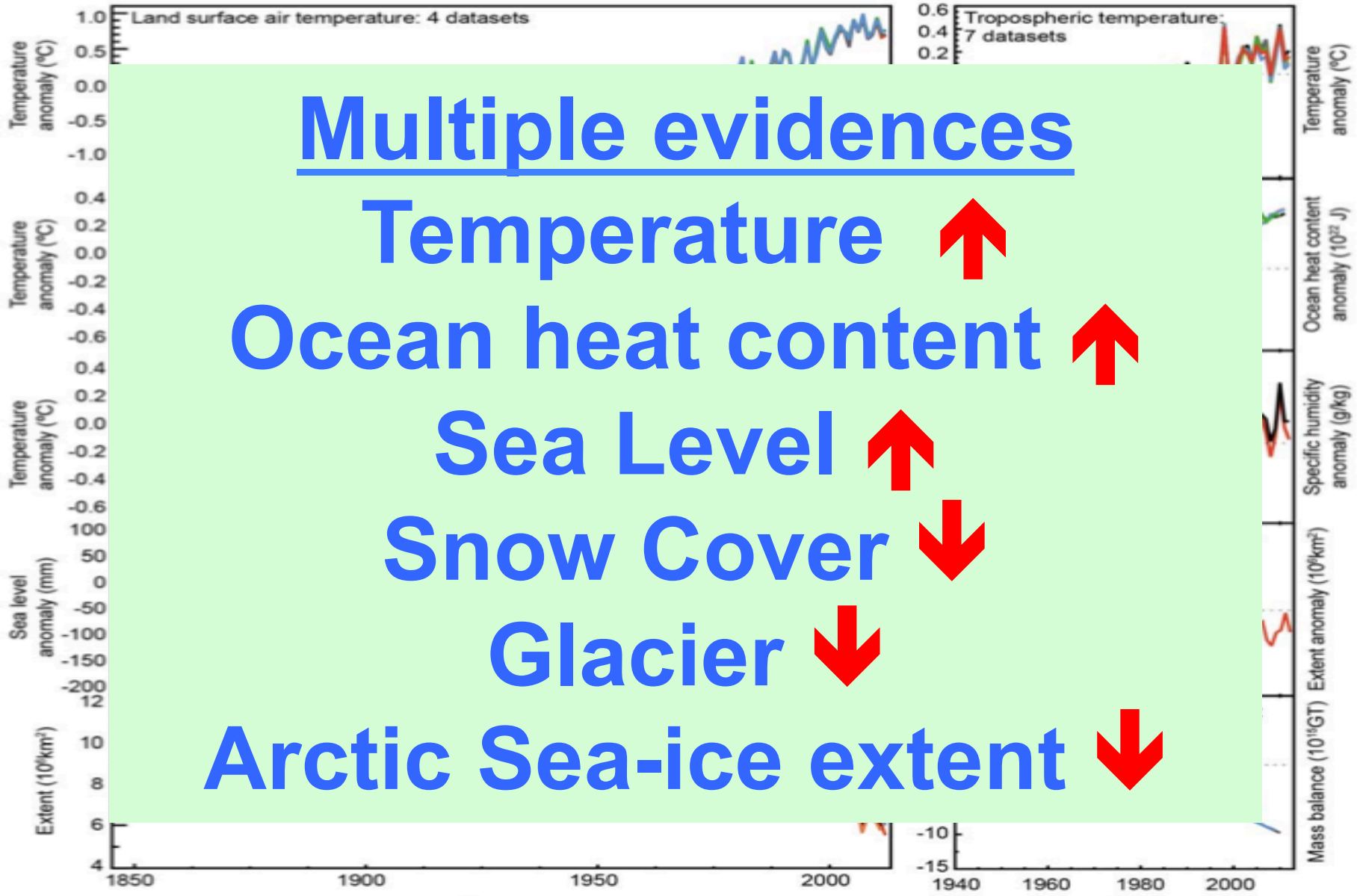
In the Northern Hemisphere, 1983–2012 was *likely* the warmest 30-year period of the last 1400 years (*medium confidence*)

(IPCC 2013, Fig. SPM.1a)



(IPCC 2013, Fig. SPM.1b)

Warming in the climate system is unequivocal



Multiple evidences

Temperature ↑

Ocean heat content ↑

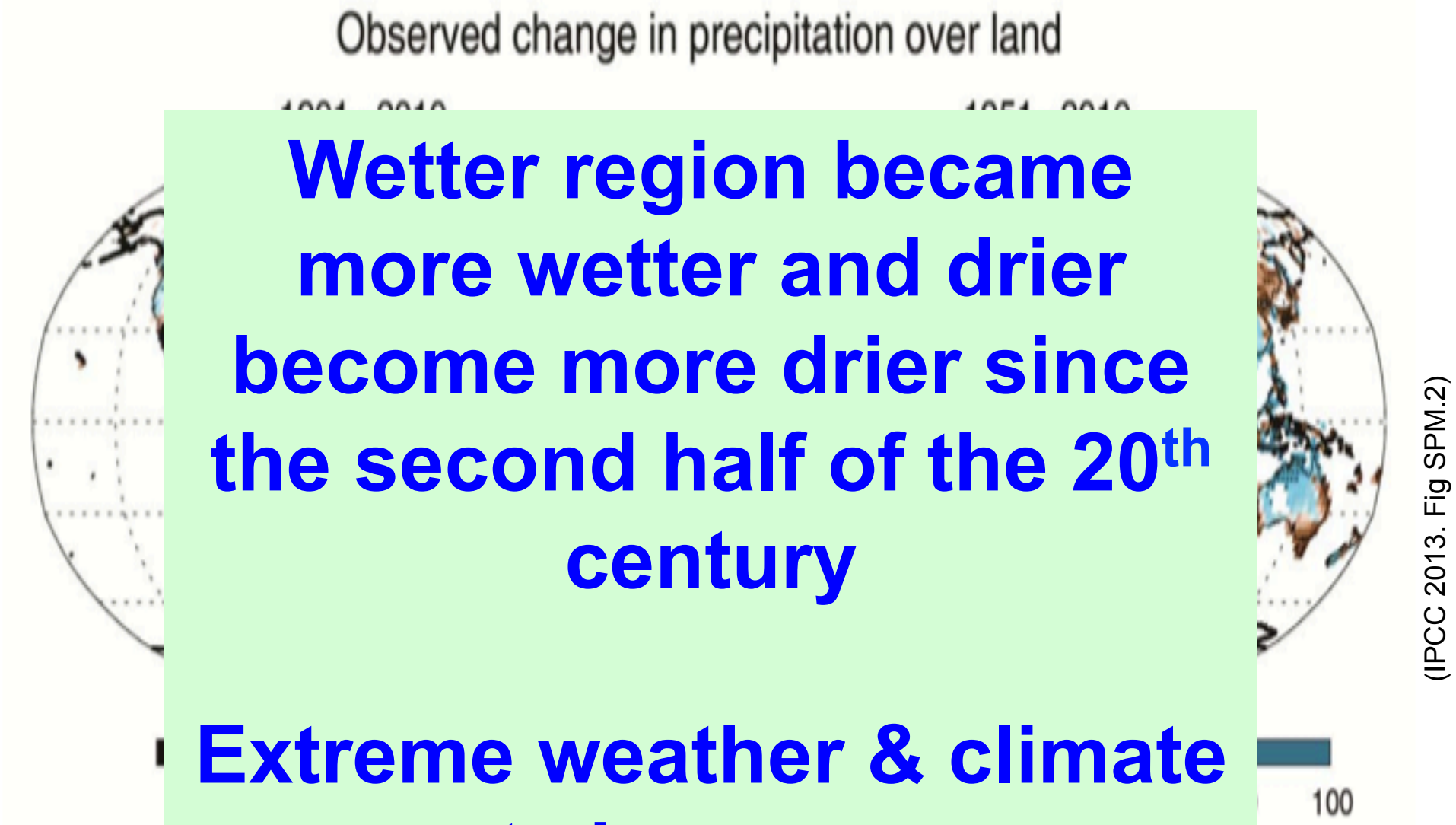
Sea Level ↑

Snow Cover ↓

Glacier ↓

Arctic Sea-ice extent ↓

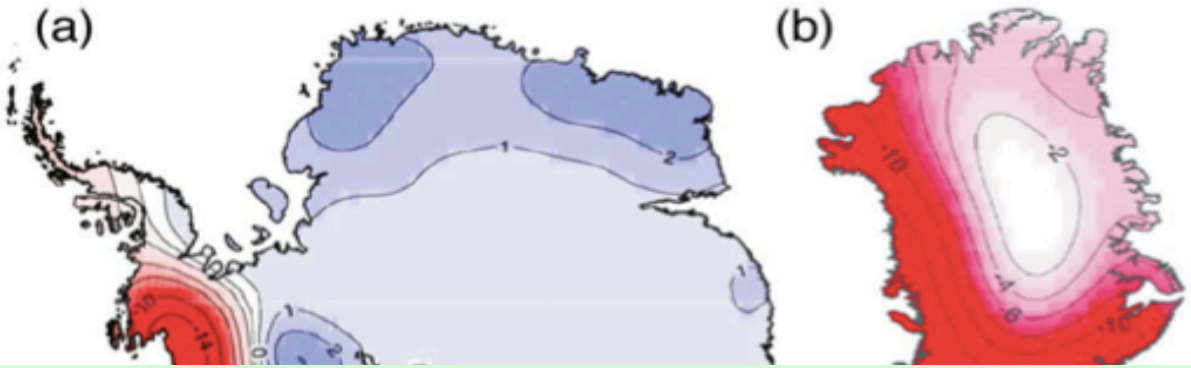
(IPCC 2013. Fig TS.1)



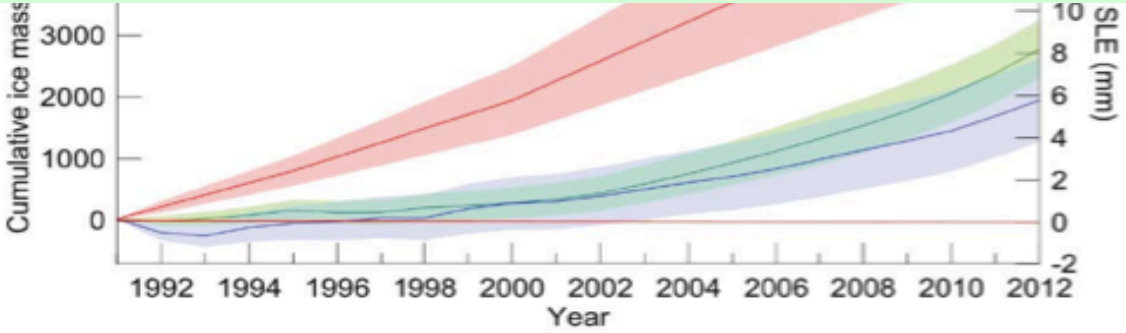
Wetter region became more wetter and drier become more drier since the second half of the 20th century

Extreme weather & climate events became more frequent

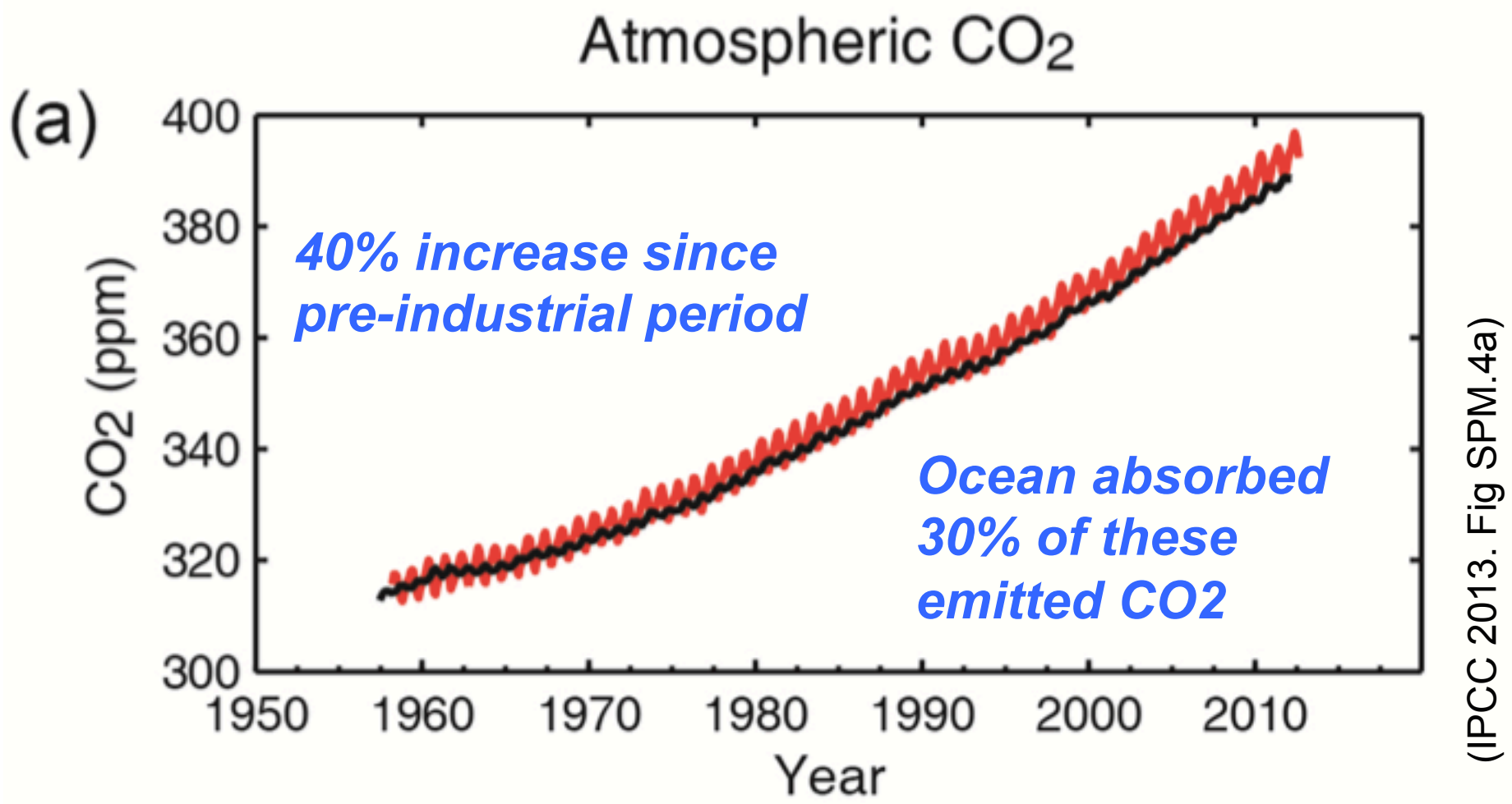
(IPCC 2013. Fig SPM.2)



Glaciers and ice melting has accelerated in unprecedented speed in the last decade

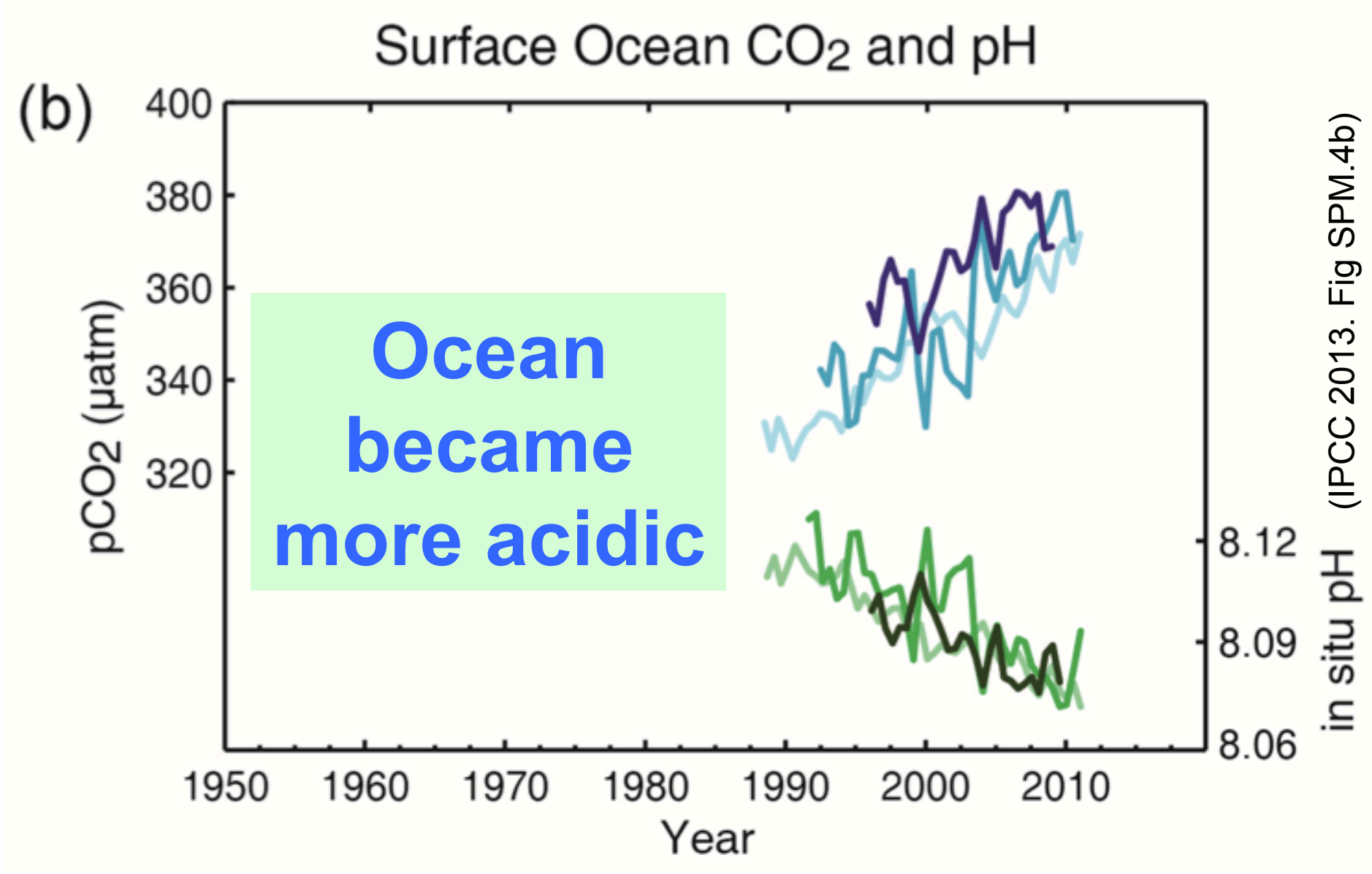


(IPCC 2013. Fig TS.3)

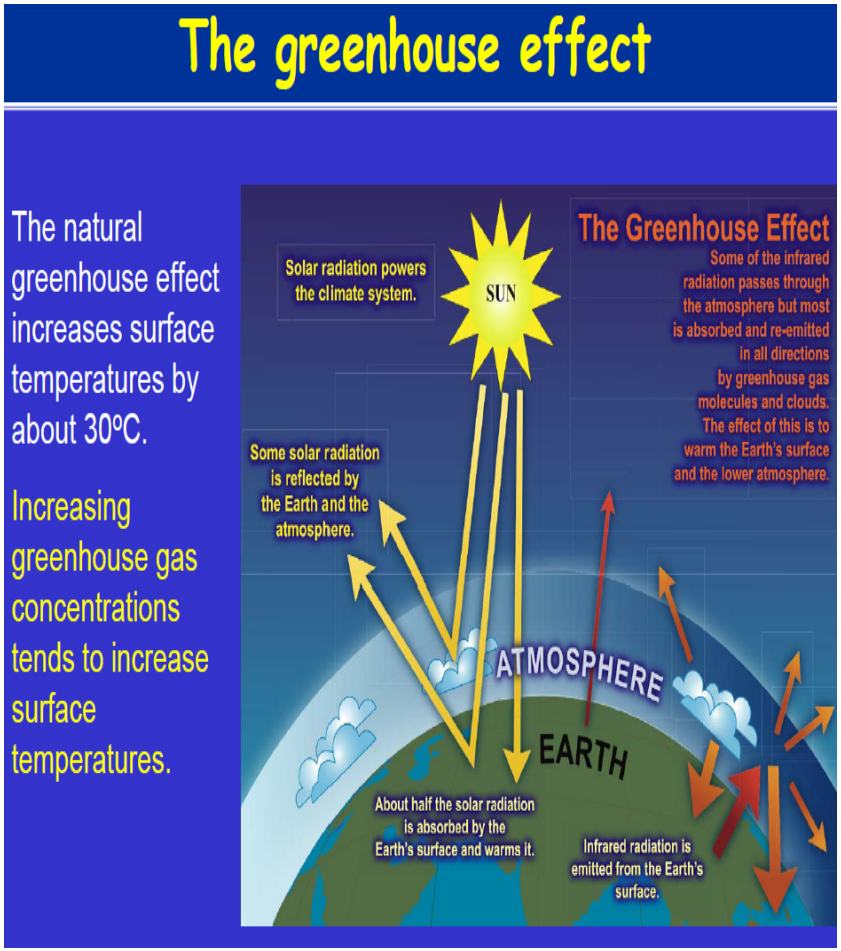


(IPCC 2013. Fig SPM.4a)

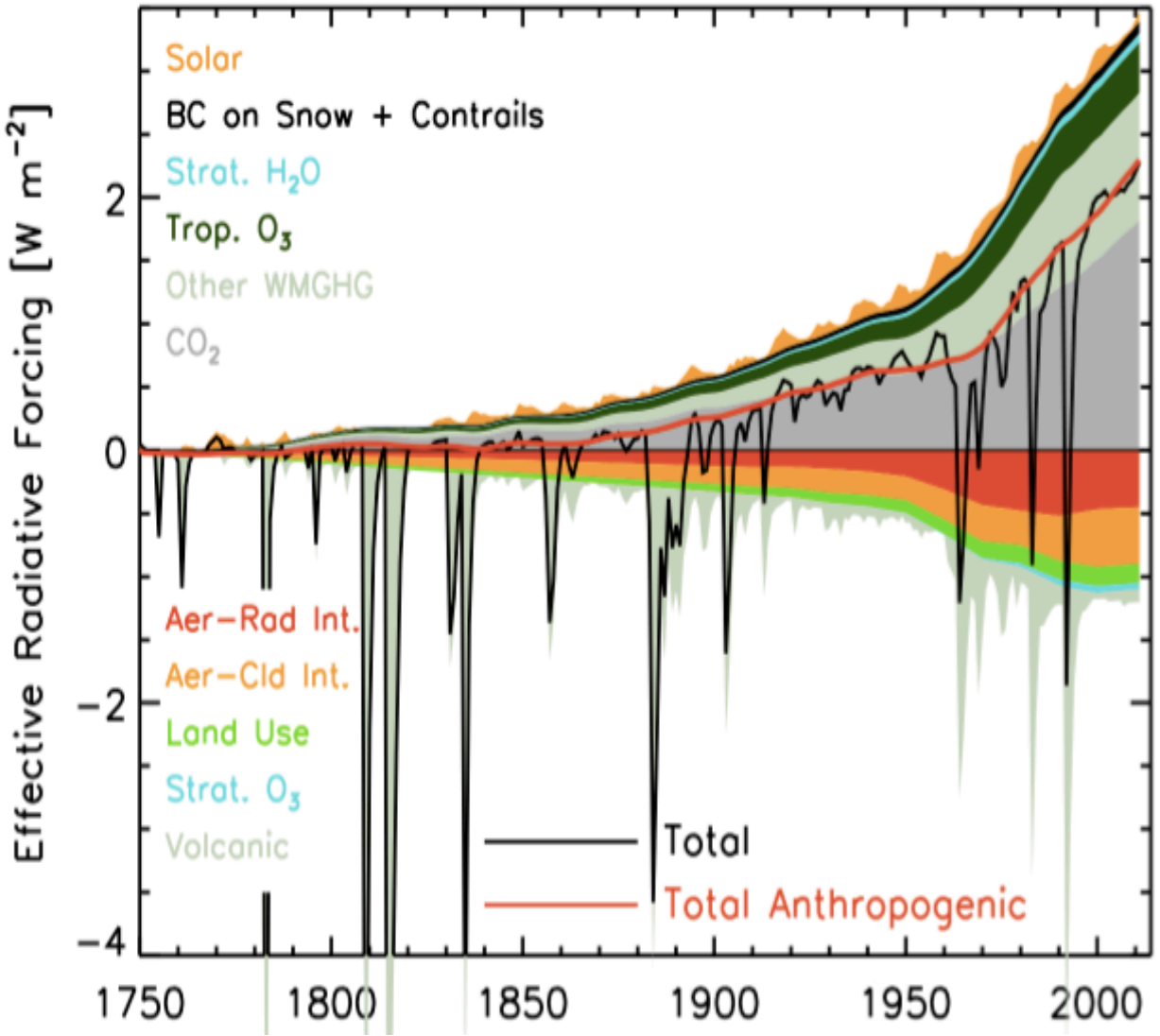
The atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have increased to levels unprecedented in at least the last 800,000 years.


Surface Ocean CO_2 and pH
(b)
400
380
360
340
320
pCO_2 (µatm)
Ocean became more acidic
8.12
8.09
8.06
in situ pH
(IPCC 2013. Fig SPM.4b)
1950
1960
1970
1980
1990
2000
2010
Year

What is Radiative Forcing?

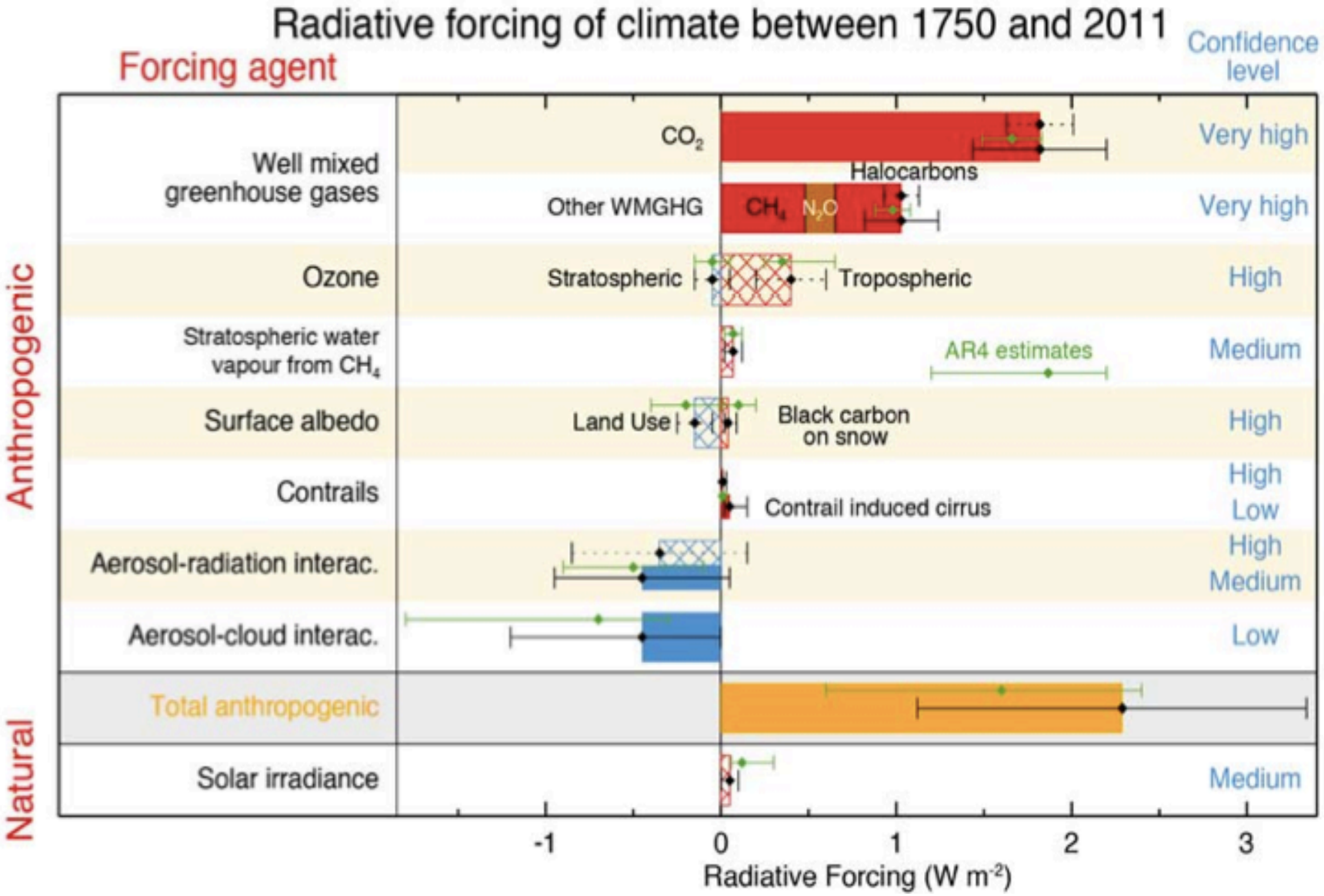


- Change in energy flux caused by natural or anthropogenic drivers of climate change (in Wm^{-2})
- Positive → near-surface warming; Negative → cooling
- Puts various drivers on common scale, indicates magnitude of impact

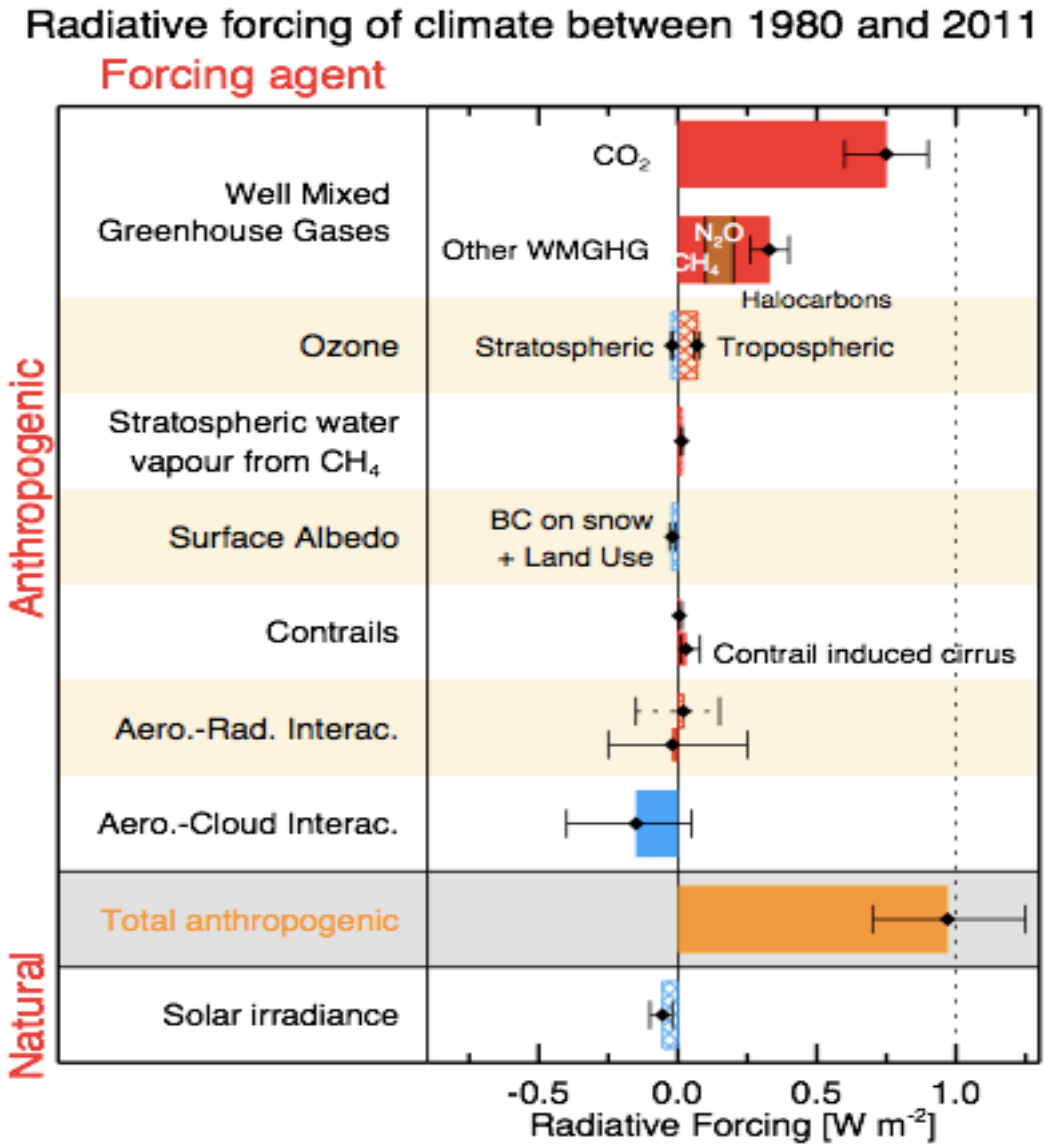


- Except volcanic, changes gradual
- Anthro. faster since ~1970, CO2 largest every decade since 1960s
- Time-averaged natural forcing small

(IPCC 2013. Fig 8.18)



(IPCC 2013. Fig TS.6)

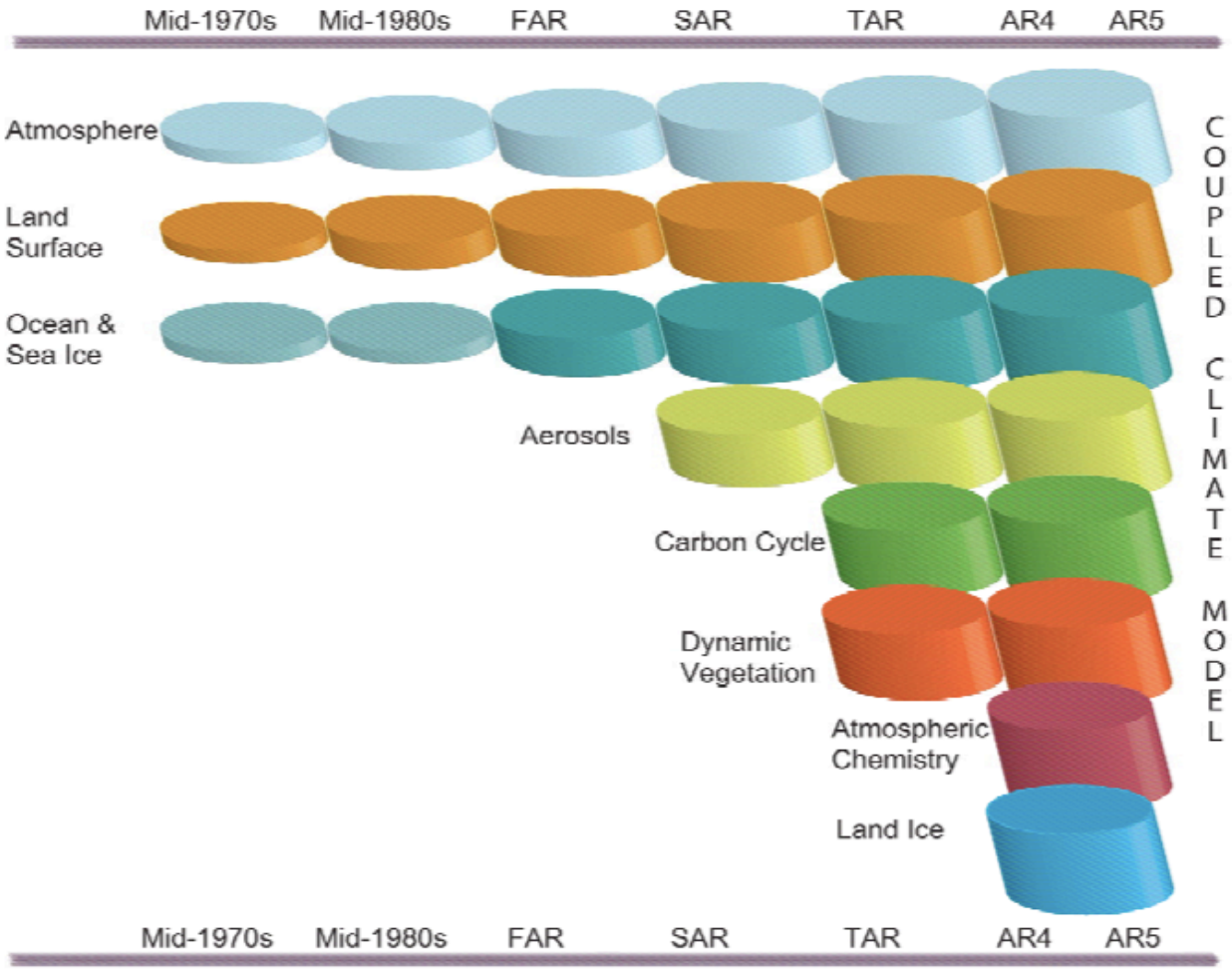


(IPCC 2013. Fig 8.20)

Earth has been in radiative imbalance, with more energy from the sun entering than exiting the top of the atmosphere, since at least circa 1970. It is *virtually certain* that Earth has gained substantial energy from 1971–2010. More than 90% of this extra heat is absorbed by the ocean (*high confidence*)

Detection and Attribution

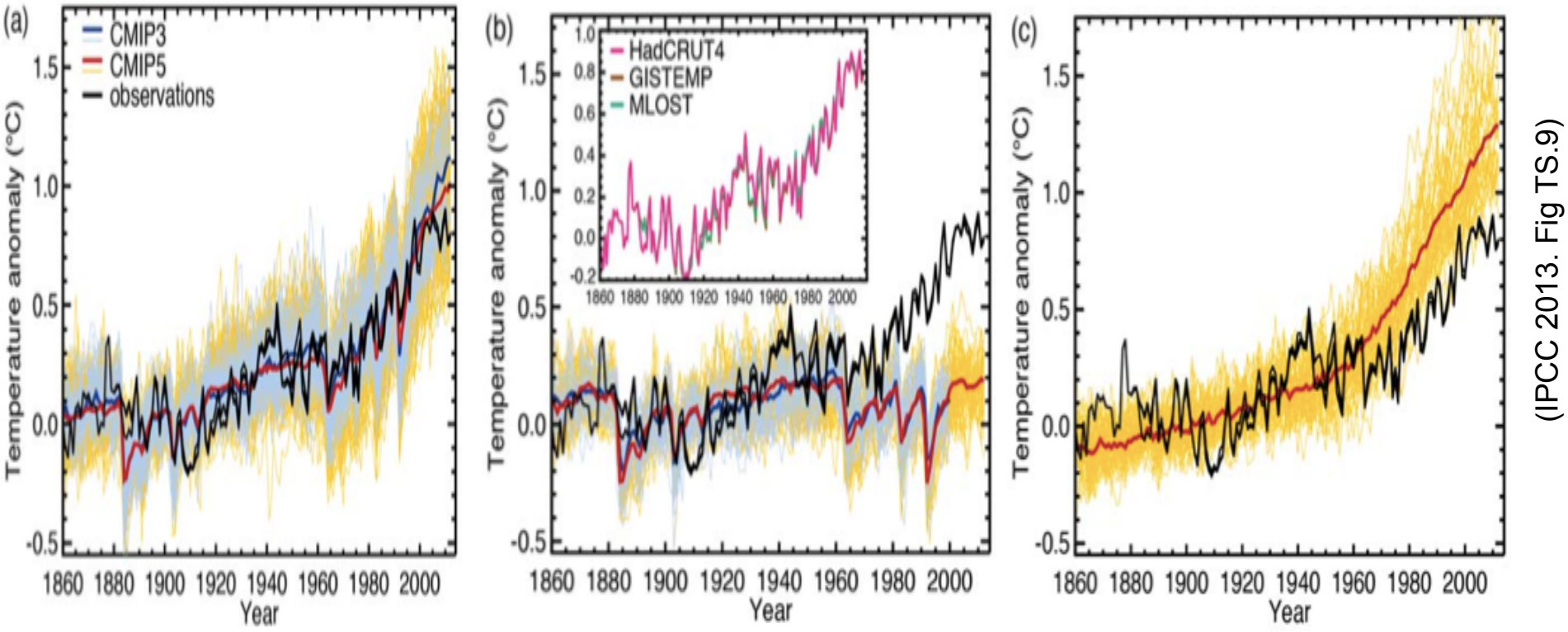
The complexity of climate model over time



(IPCC 2013. Fig 1.13)

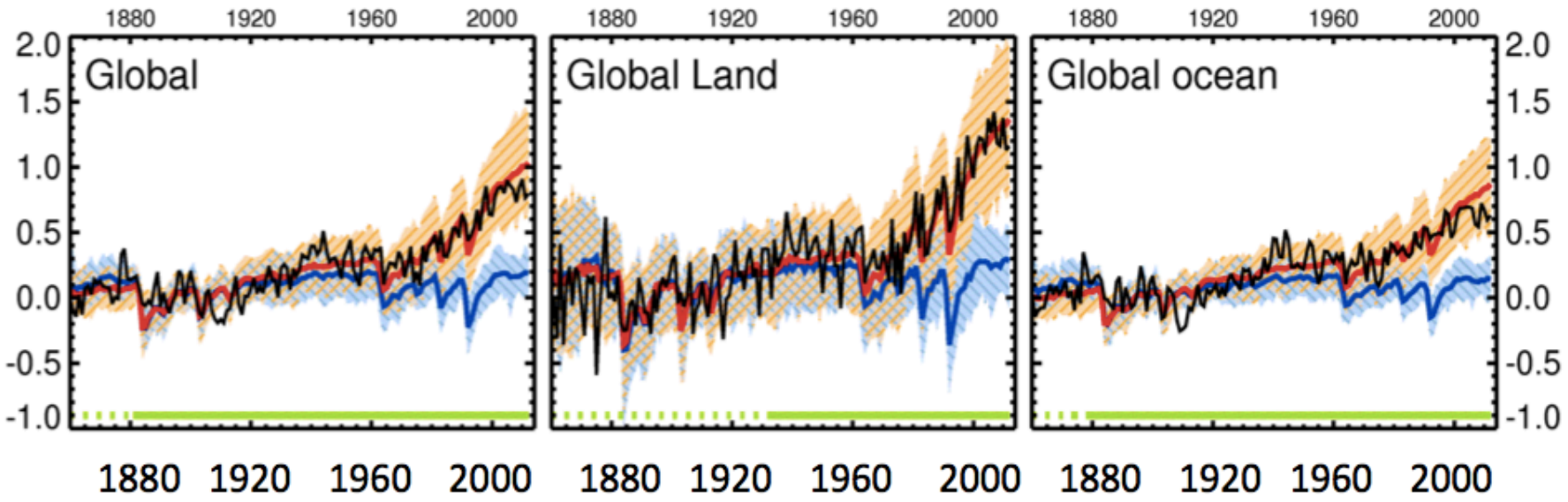
Climate Models Responses to Various Forcings

Natural + Anthropogenic | **Natural** | **CO2 forcing only**

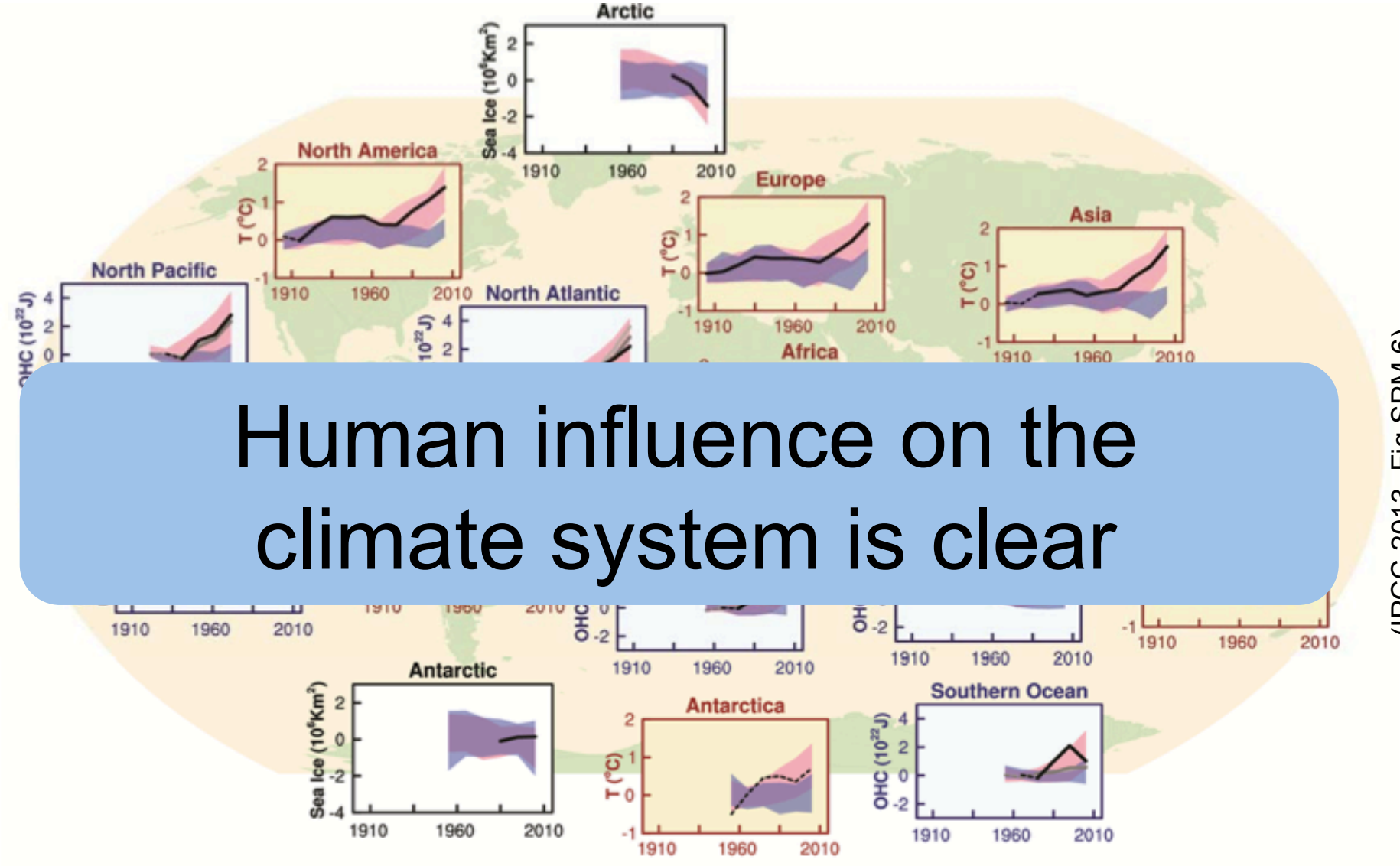


(IPCC 2013. Fig TS.9)

Observed warming consistent with that expected from anthropogenic factors and inconsistent with that expected from natural factors

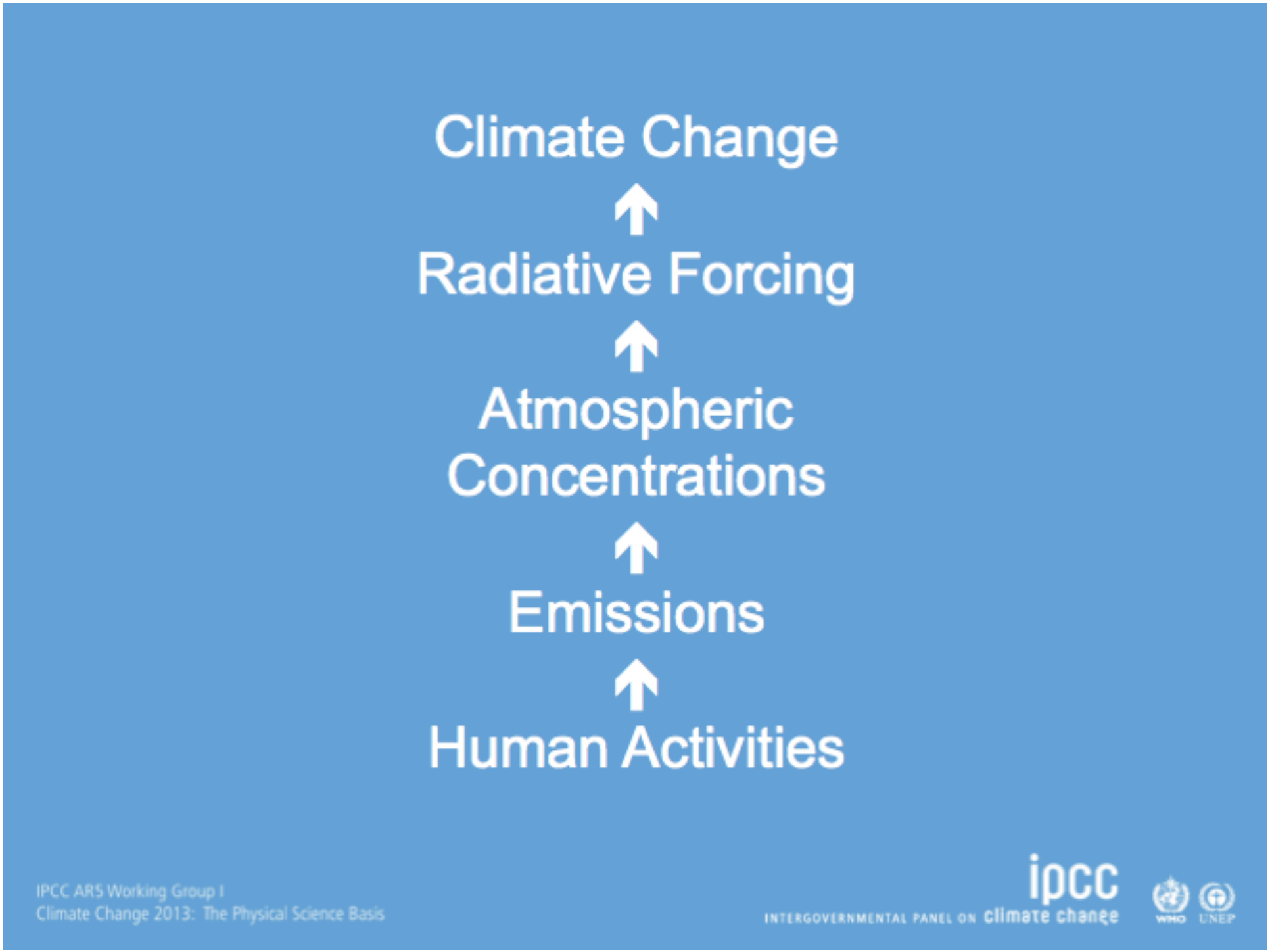


(IPCC 2013. Fig 10.7)



Human influence on the climate system is clear

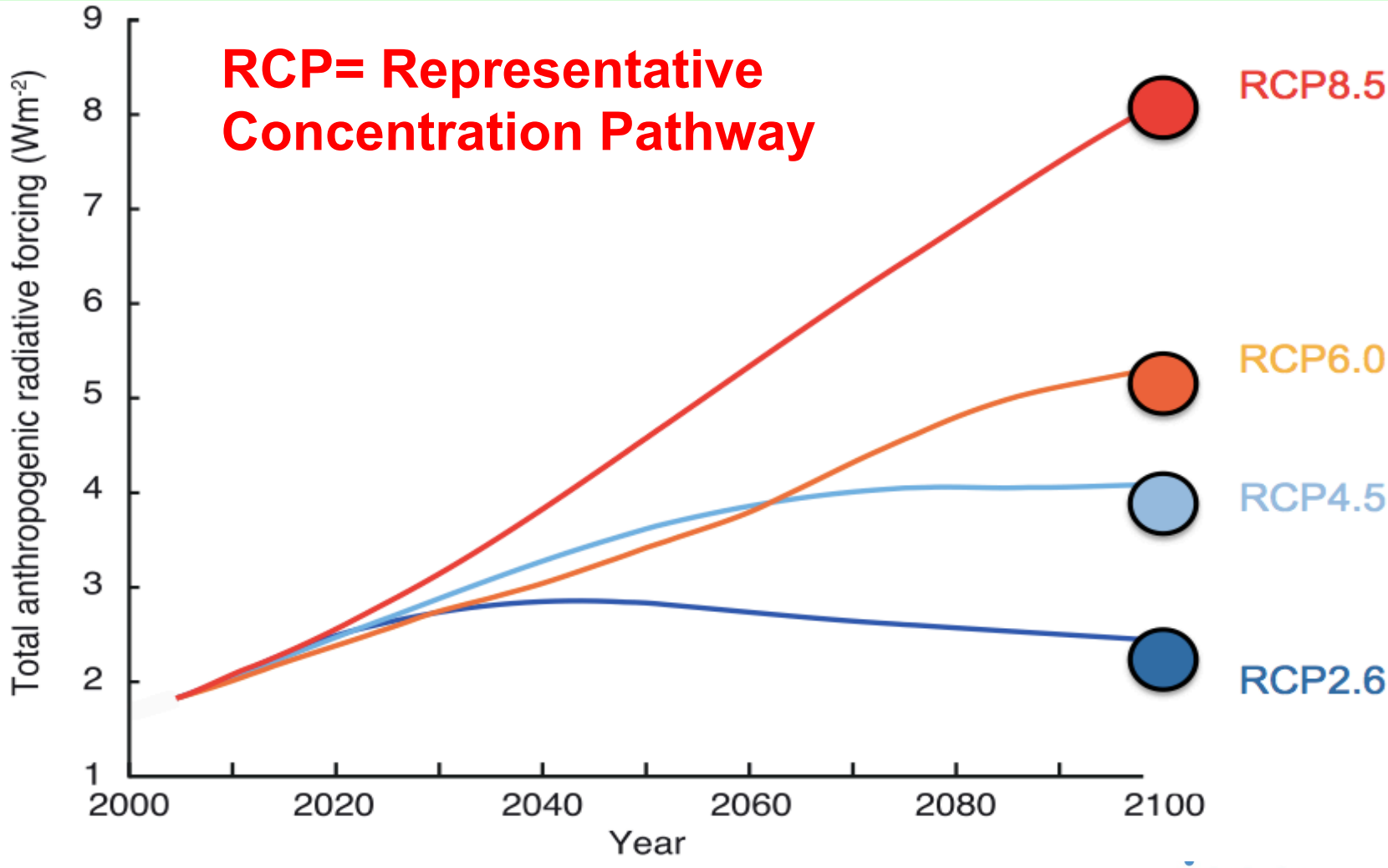
(IPCC 2013. Fig SPM.6)


Climate Change
Radiative Forcing
Atmospheric Concentrations
Emissions
Human Activities
IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Future Climate Projections

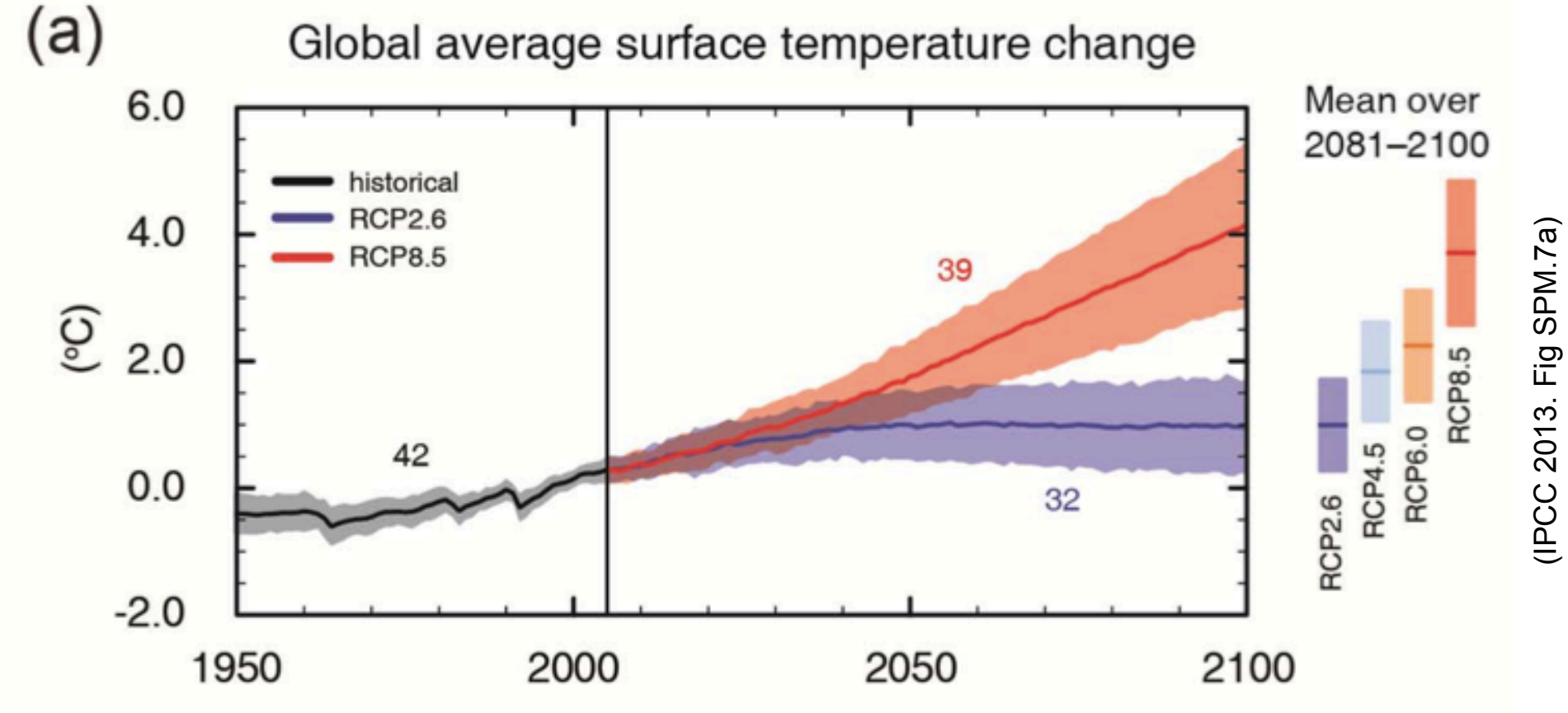
For future climate projections, climate models require Emission Scenarios. Models in AR5 use Representative Concentration Pathway (RCP)

Indicative Anthropogenic Radiative Forcing (RF) for RCPs



(IPCC 2013. Box TS.6)

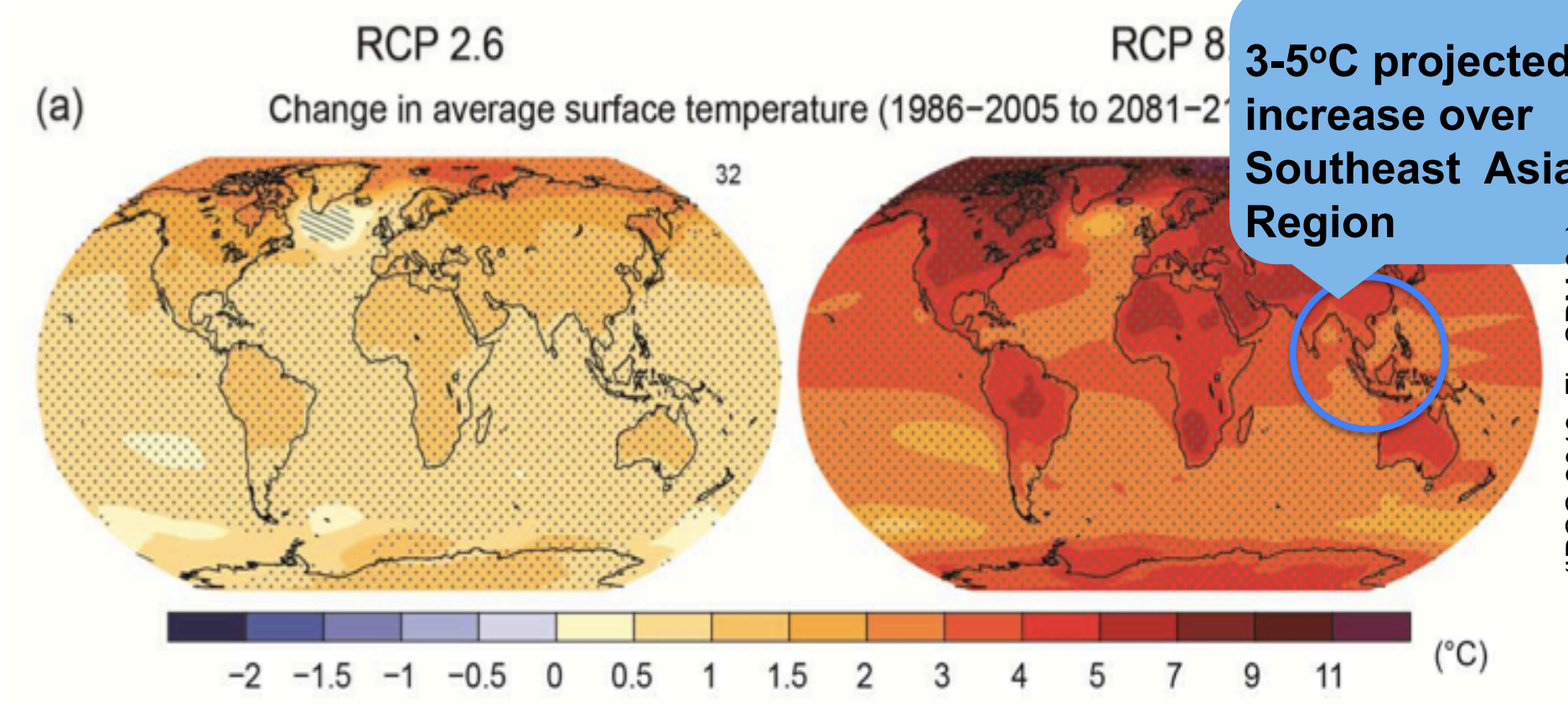
Projected Global Average Temperature Change by end of 21st Century



(IPCC 2013. Fig SPM.7a)

The temperature increase during the last 100 years was only about 0.8°C.

Projected Global Average Temperature Change by end of 21st Century



3-5°C projected increase over Southeast Asia Region

(IPCC 2013. Fig SPM.8a)

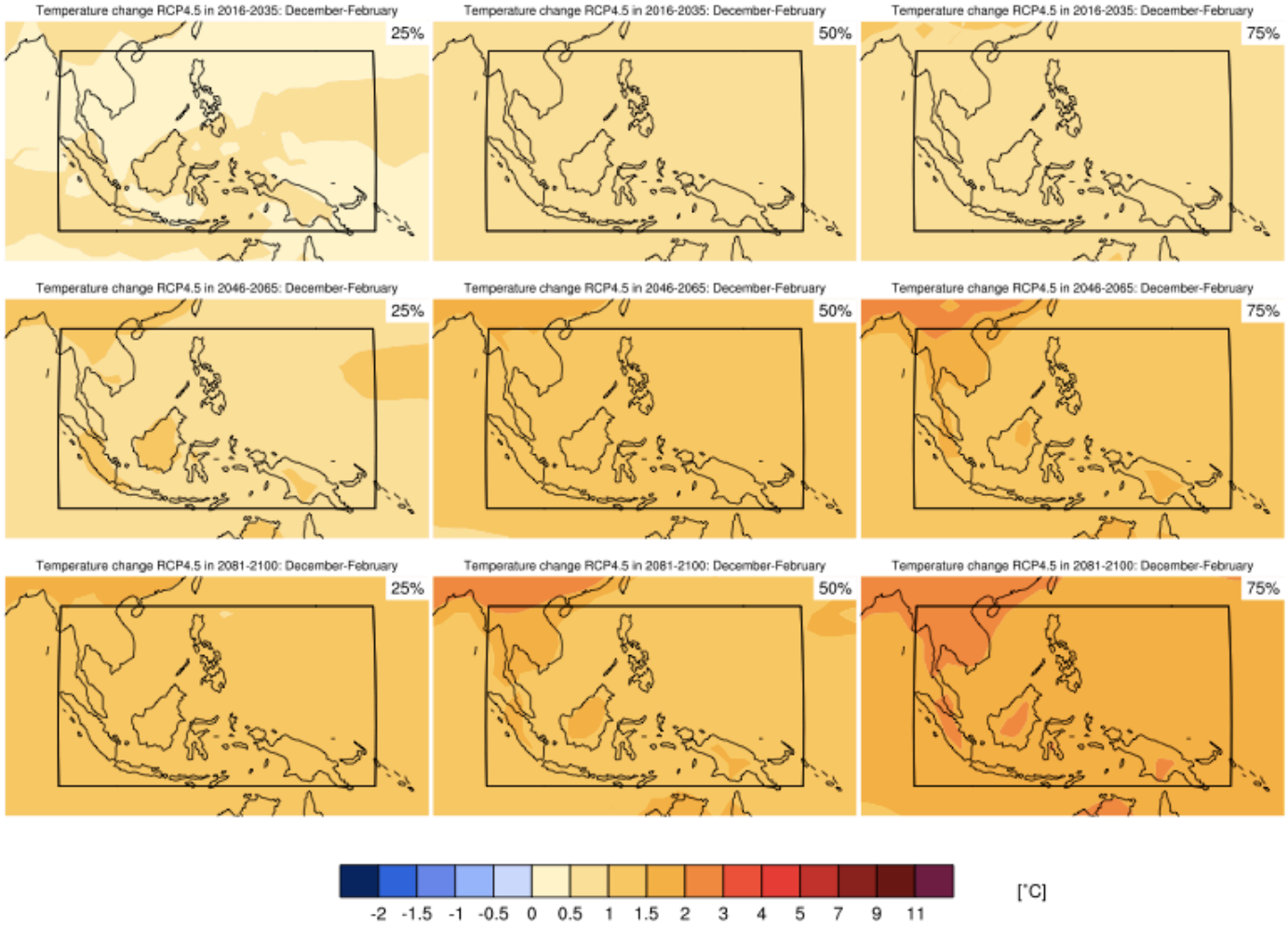
The temperature increase during the last 100 years is only about 0.8°C.

Projected Air Temperature (DJF) (RCP4.5)

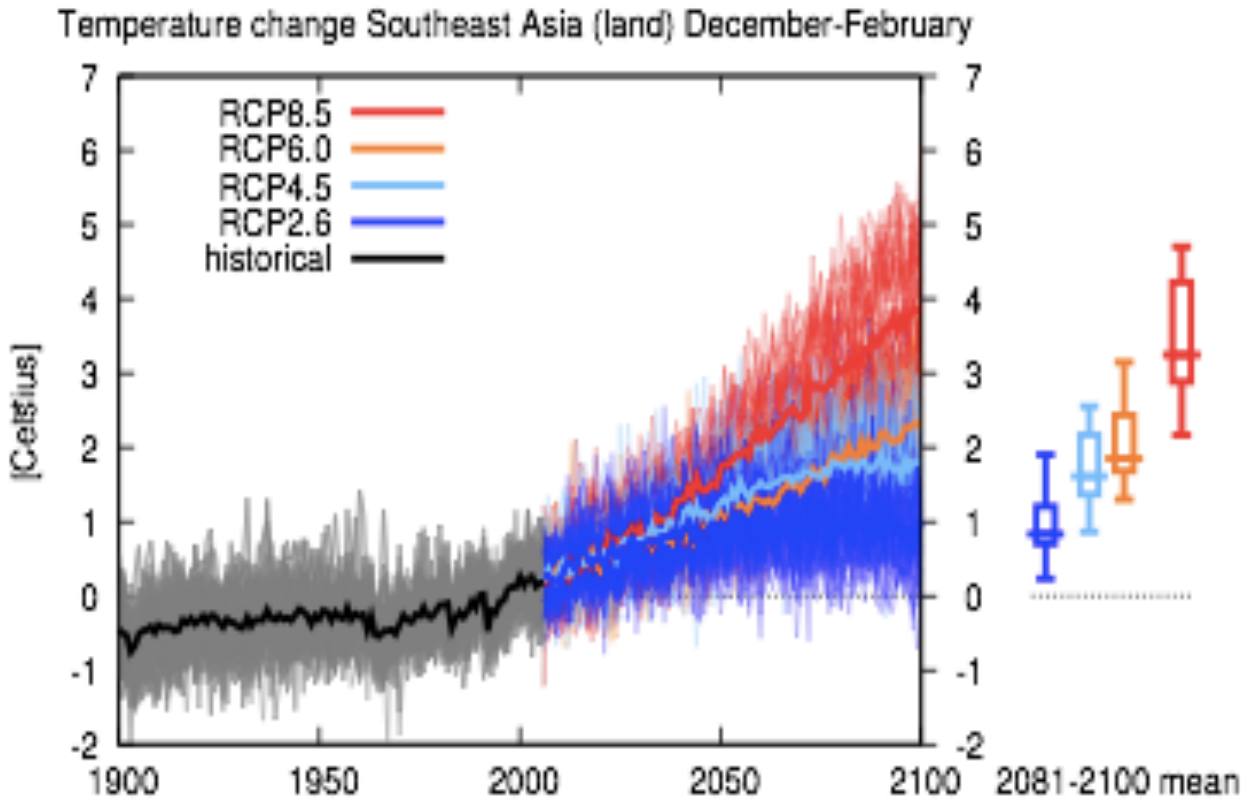
2016-2035

2046-2065

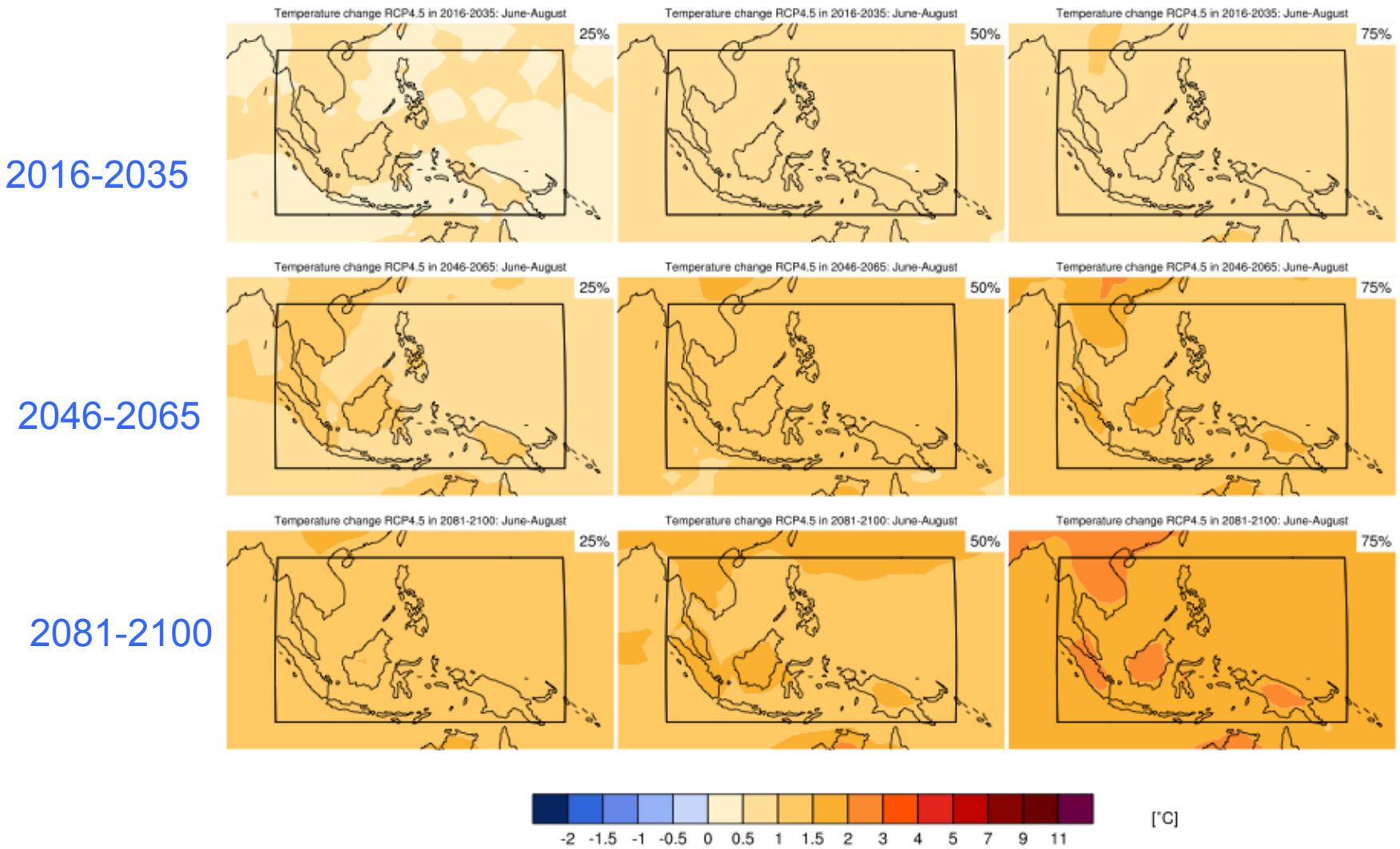
2081-2100



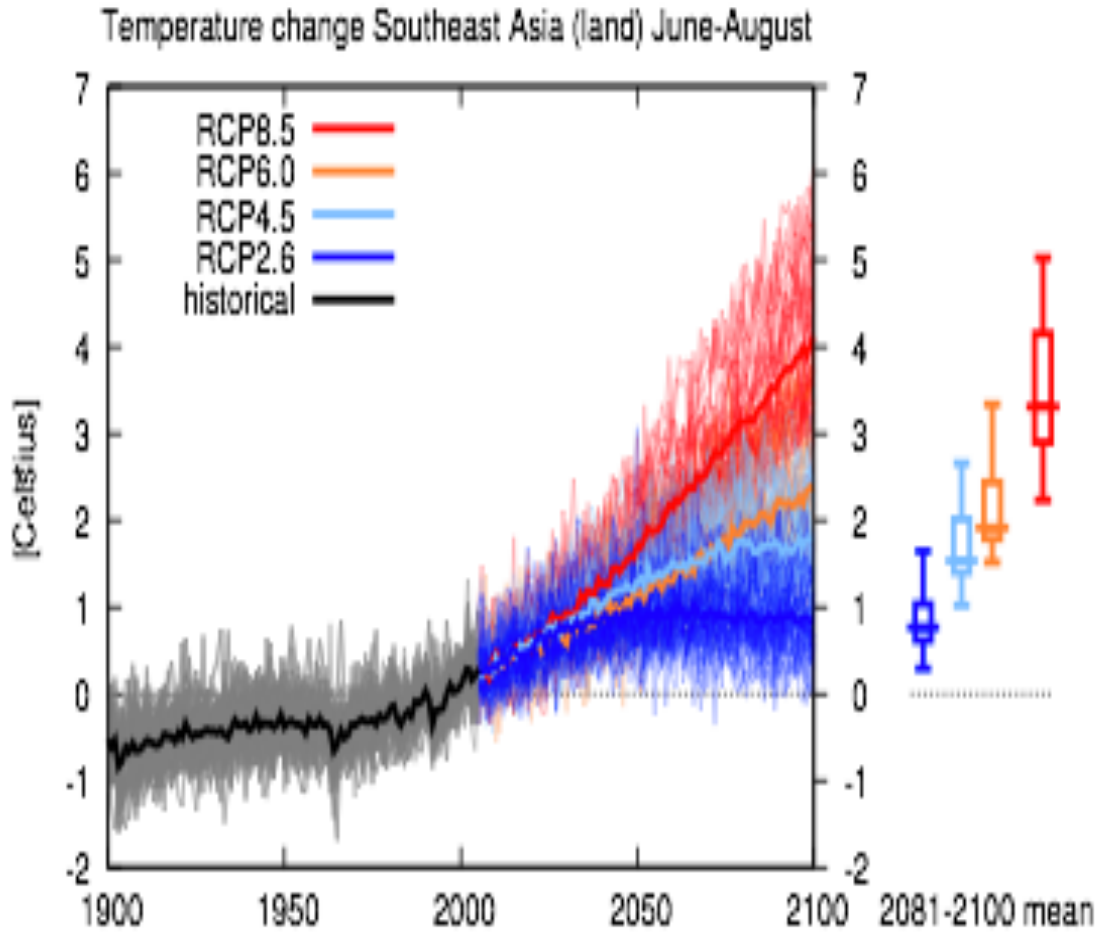
Projected Average DJF Temperature Change Over Southeast Asia Region (Land)



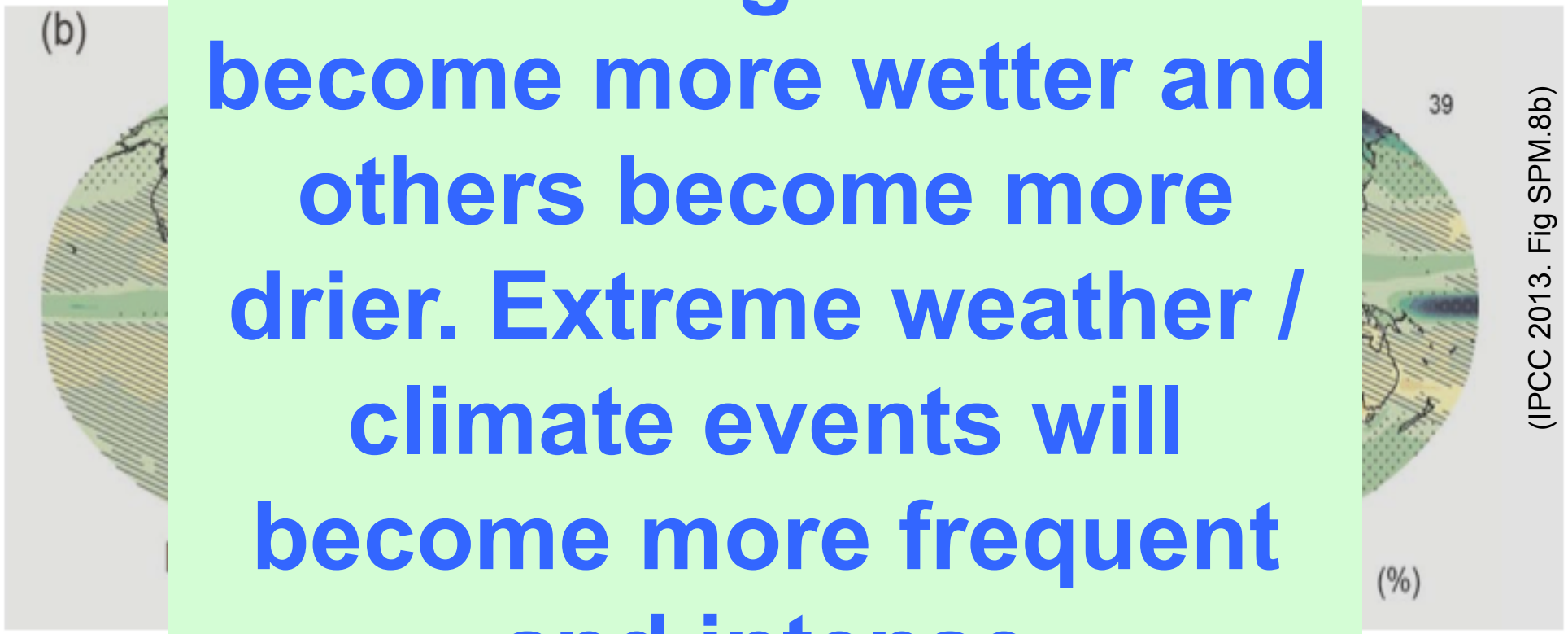
Projected Air Temperature (JJA) (RCP4.5)



Projected Average JJA Temperature Change Over Southeast Asia Region (Land)



Projected Precipitation Change by end of 21st Century

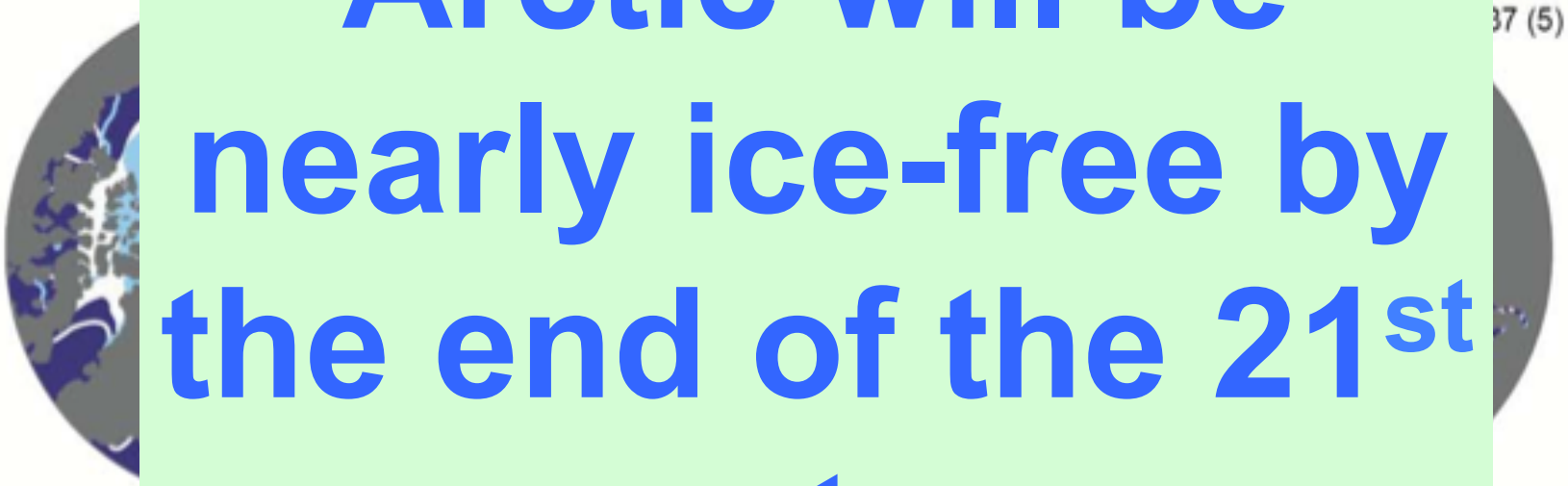


(IPCC 2013. Fig SPM.8b)

Some regions will become more wetter and others become more drier. Extreme weather / climate events will become more frequent and intense

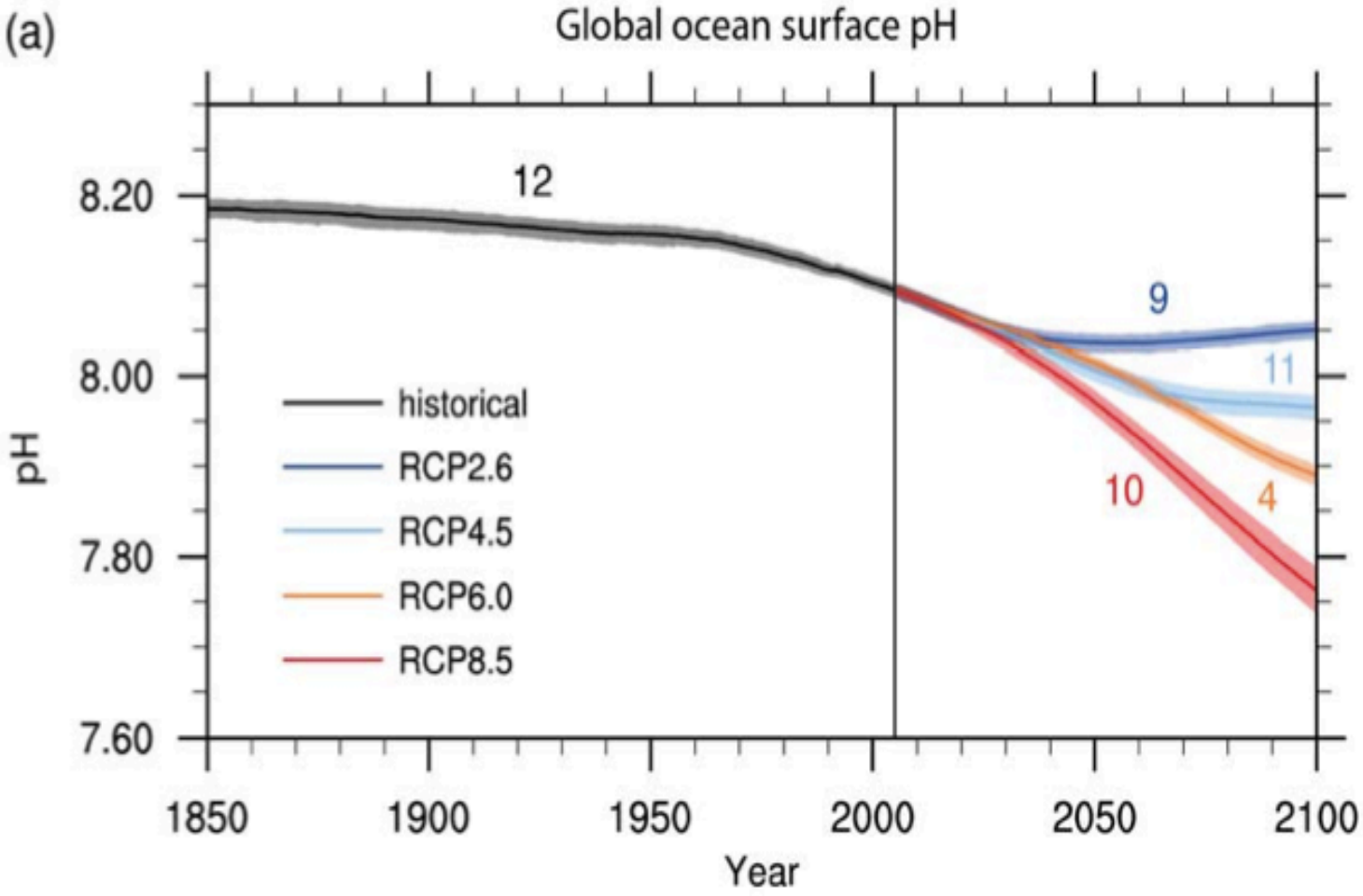
RCP 2.6

RCP 8.5

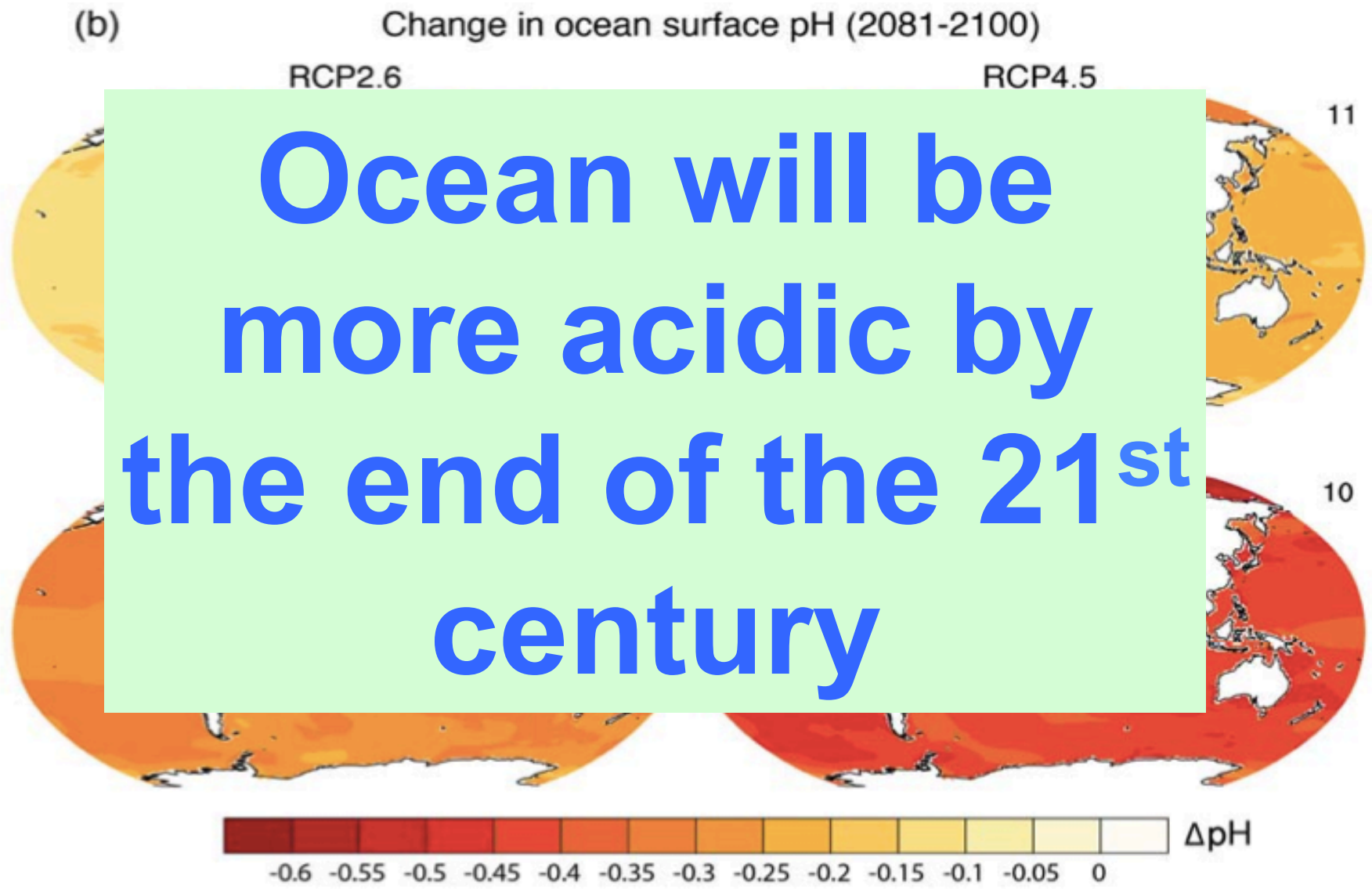


Arctic will be nearly ice-free by the end of the 21st century

(IPCC 2013. Fig SPM.8c)

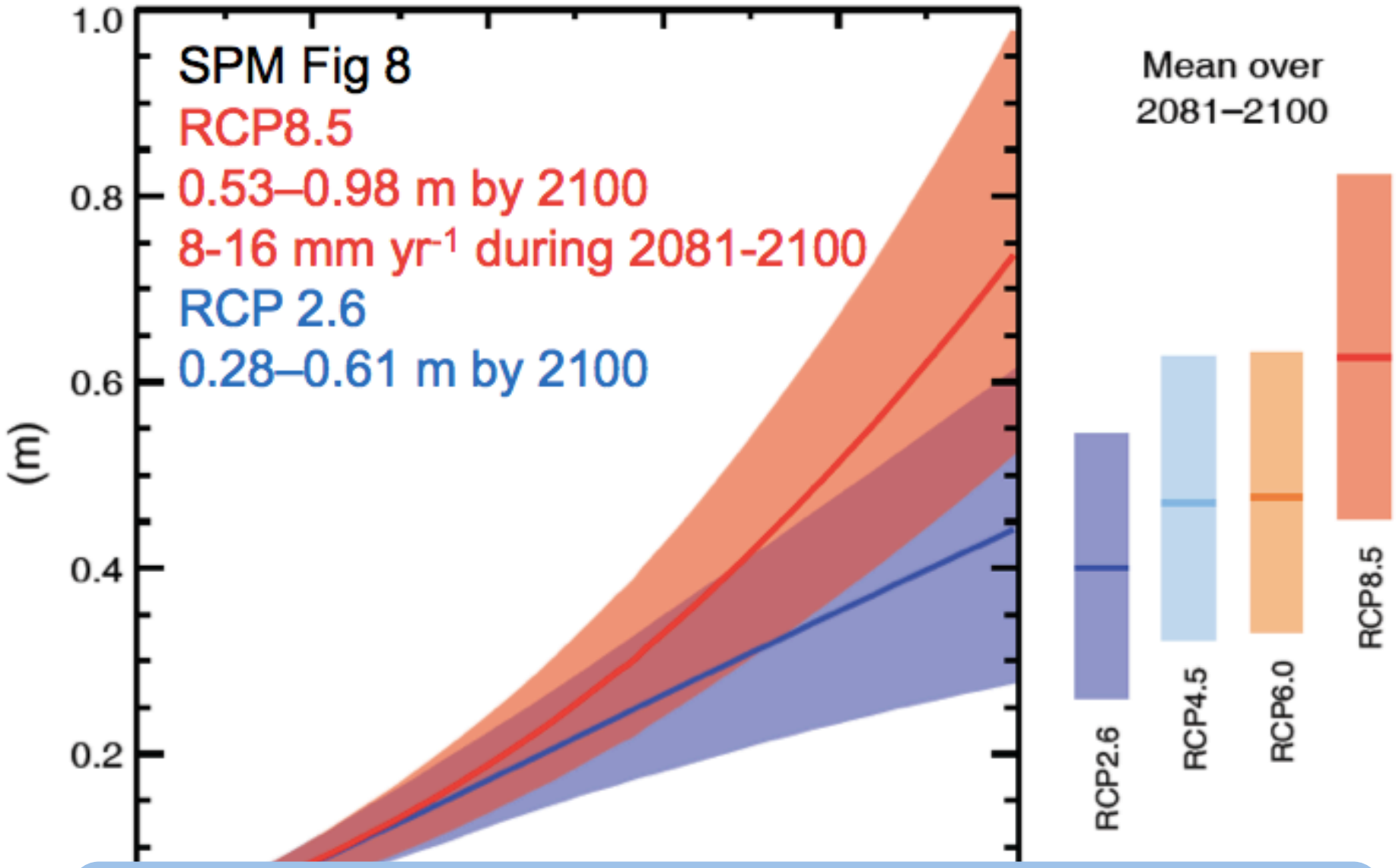


(IPCC 2013. Fig TS.20a)



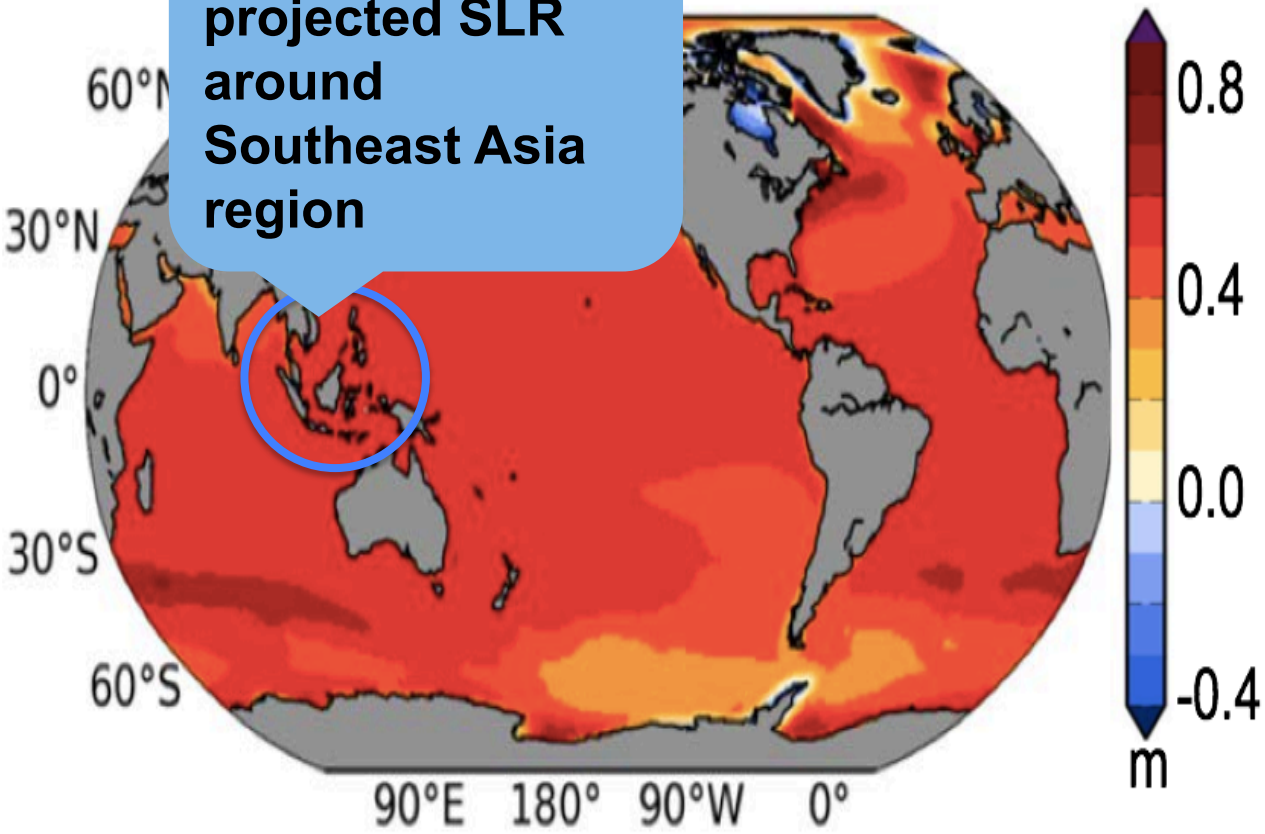
Ocean will be more acidic by the end of the 21st century

(IPCC 2013. Fig TS.20b)



Global mean sea level will continue to rise during the 21st century

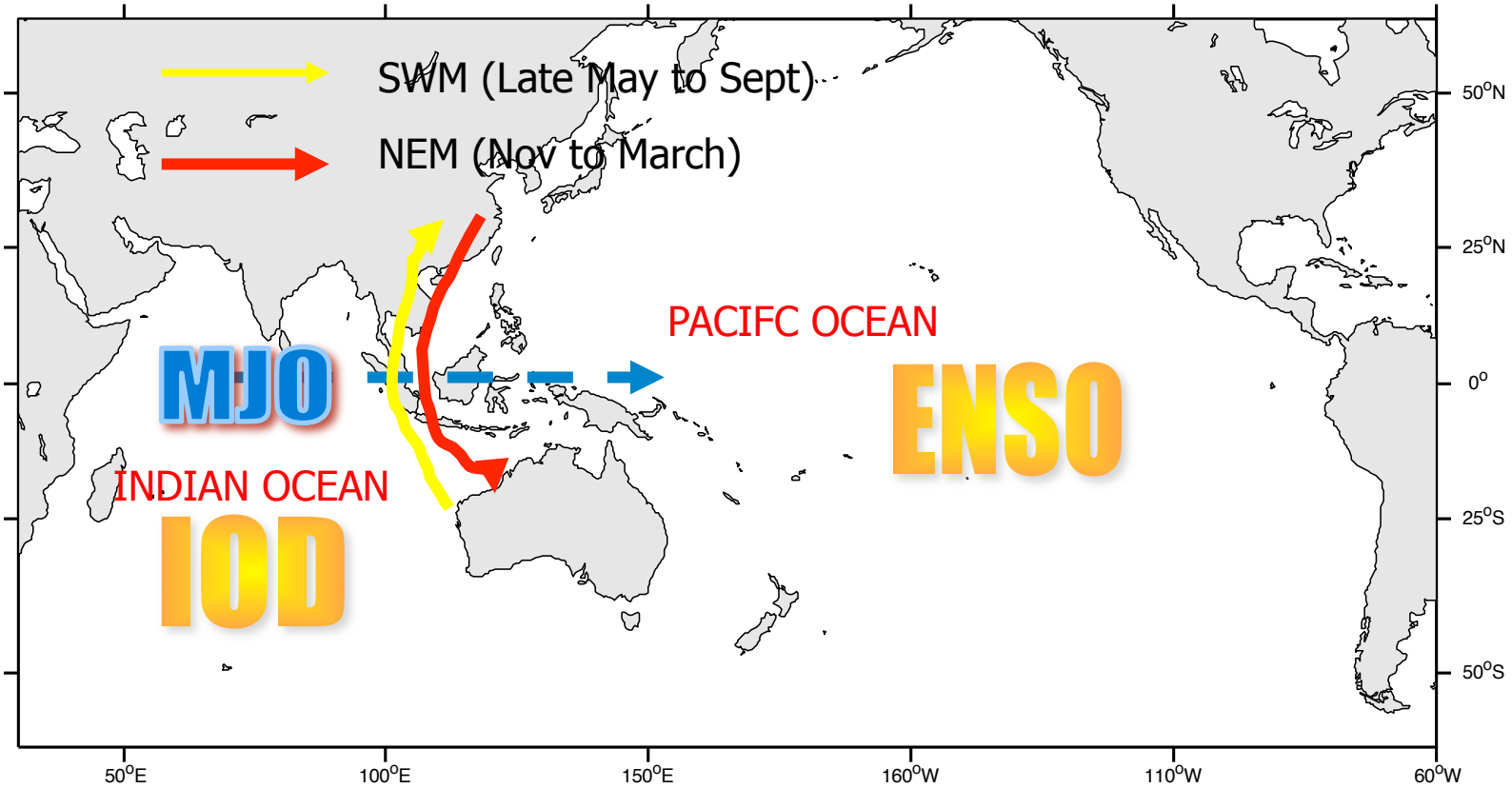
Regional sea level rise by the end of the 21st century



It is *very likely* that sea level will rise in more than about 95% of the ocean area.

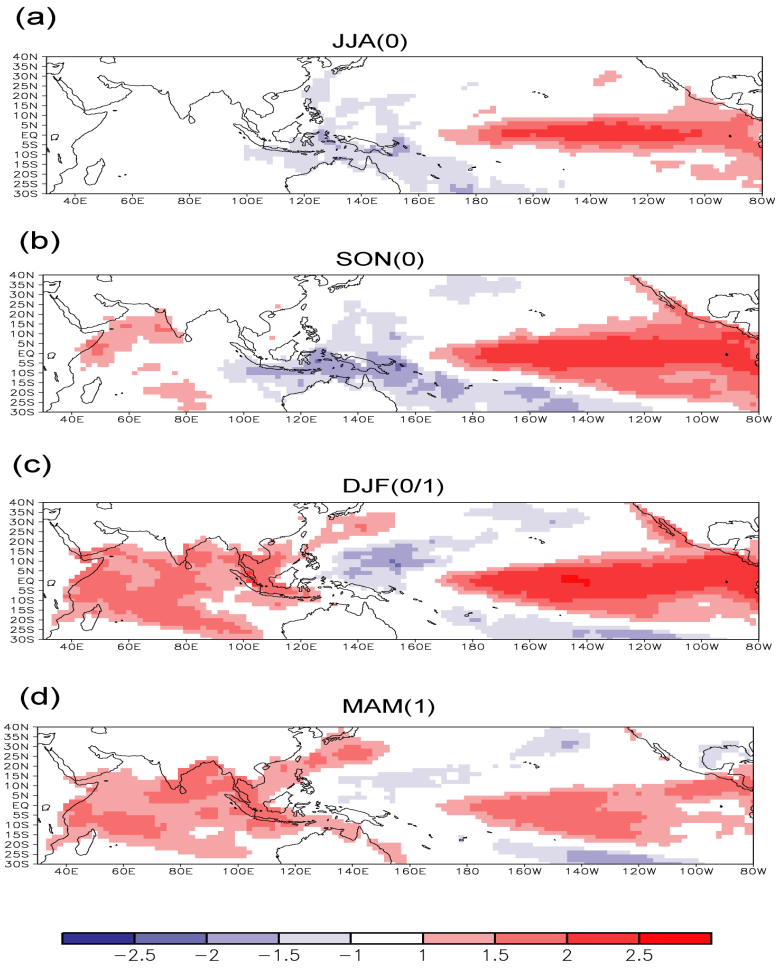
IPCC 2013 Fig 13.20b

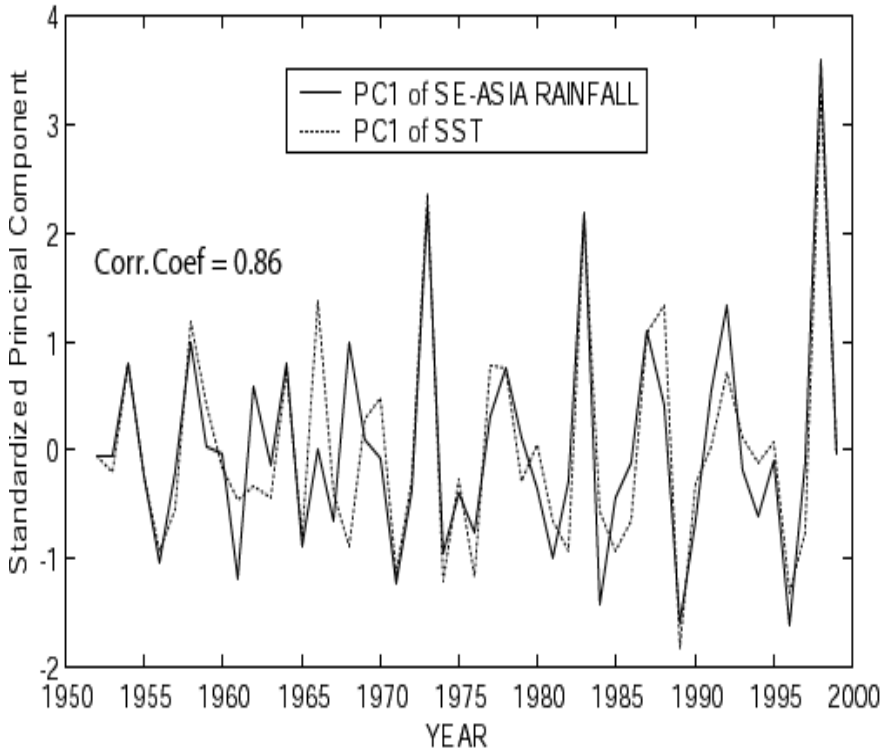
Monsoon & Dominant Modes of Climate Variability



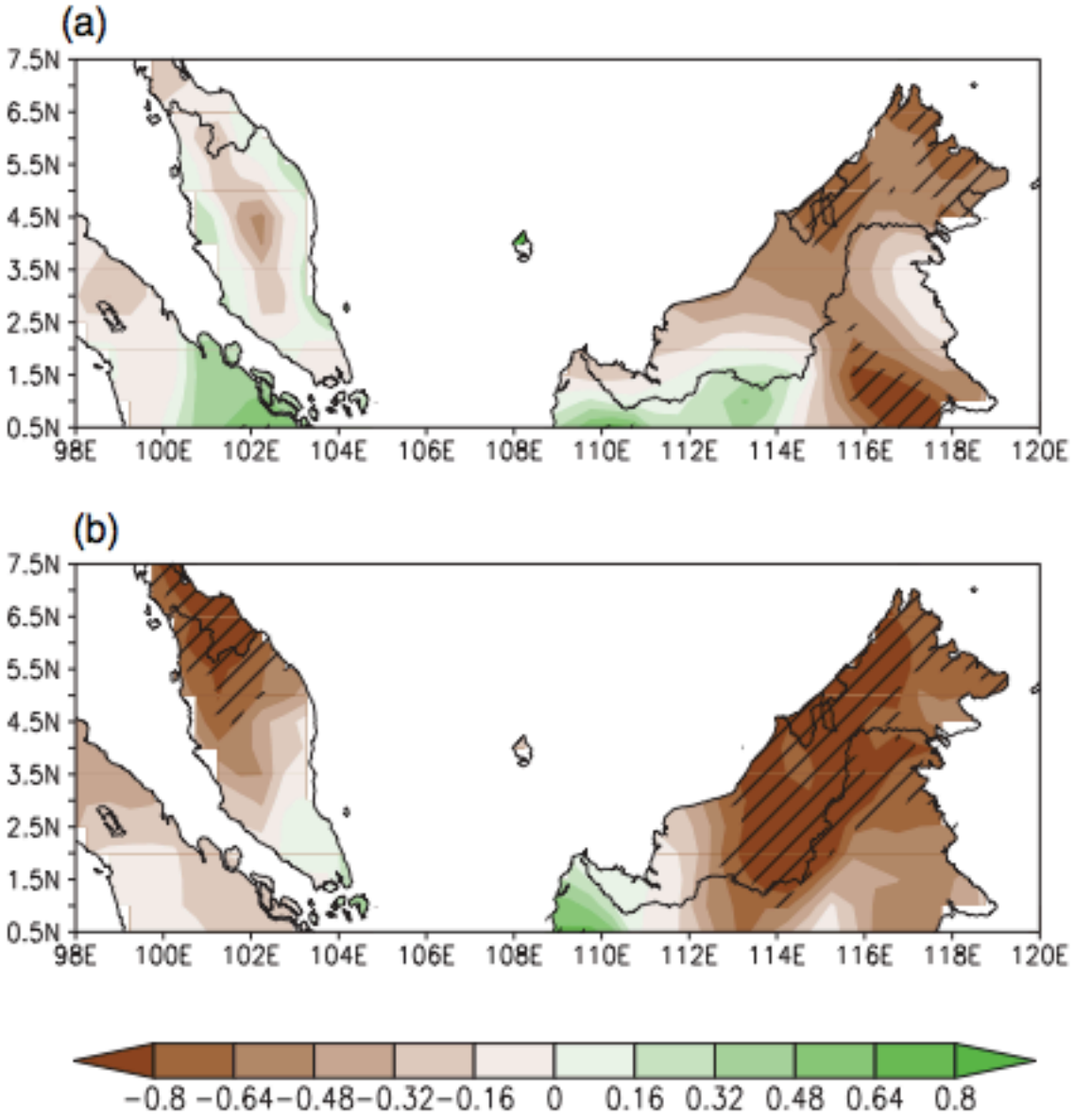
Indian Ocean Dipole (IOD), El Nino-Southern Oscillation (ENSO) ---- Interannual oscillation (2-7 years)

Madden-Julian Oscillation (MJO) – intra-seasonal oscillation (20-60 days)





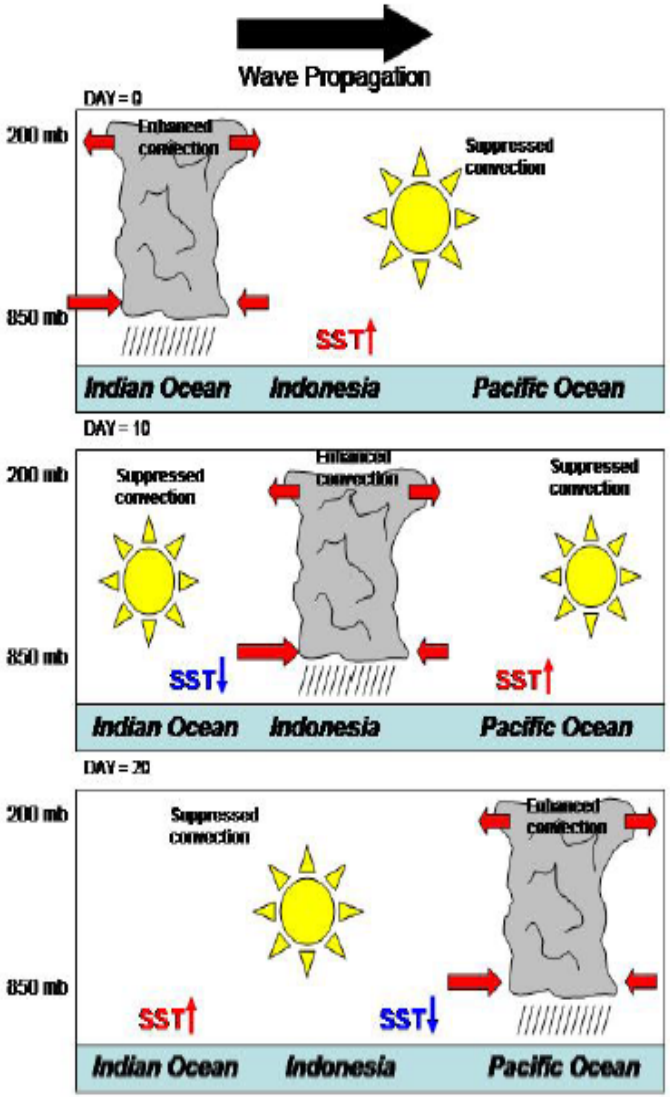
Juneng and Tangang
(*Clim Dyn* . 2005)

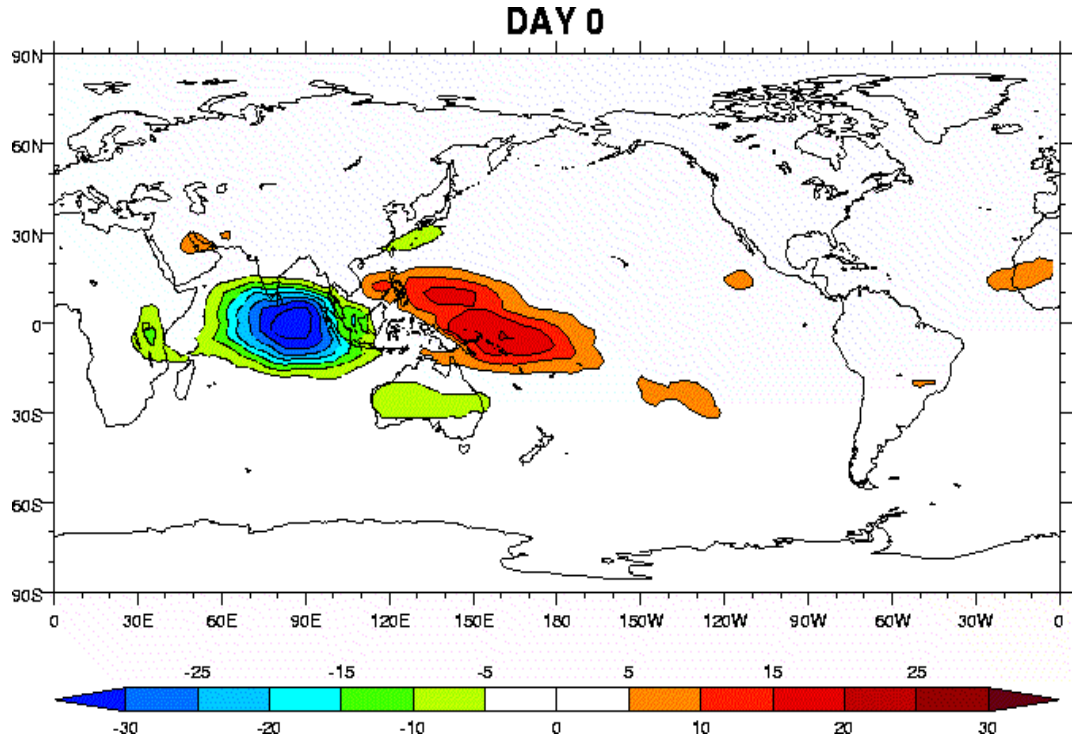


Composites of Rainfall Anomaly during Conventional El Nino (a) & El Nino Modoki (b)

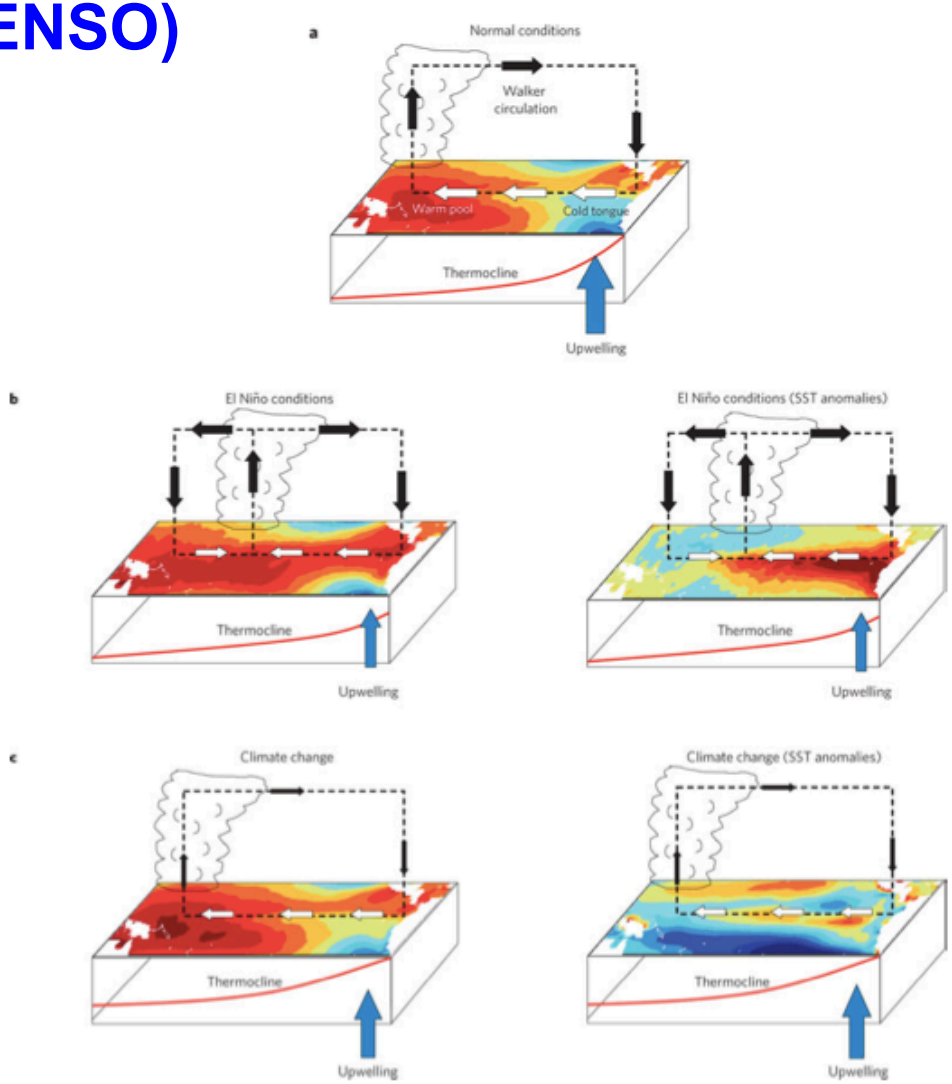
Salimun, Tangang & others (2013, Int. J. Climatol.)

Schematic Representation of MJO eastward propagation from Indian Ocean to western Pacific Ocean





El Niño-Southern Oscillation (ENSO)



IPCC AR5 Chapter 14

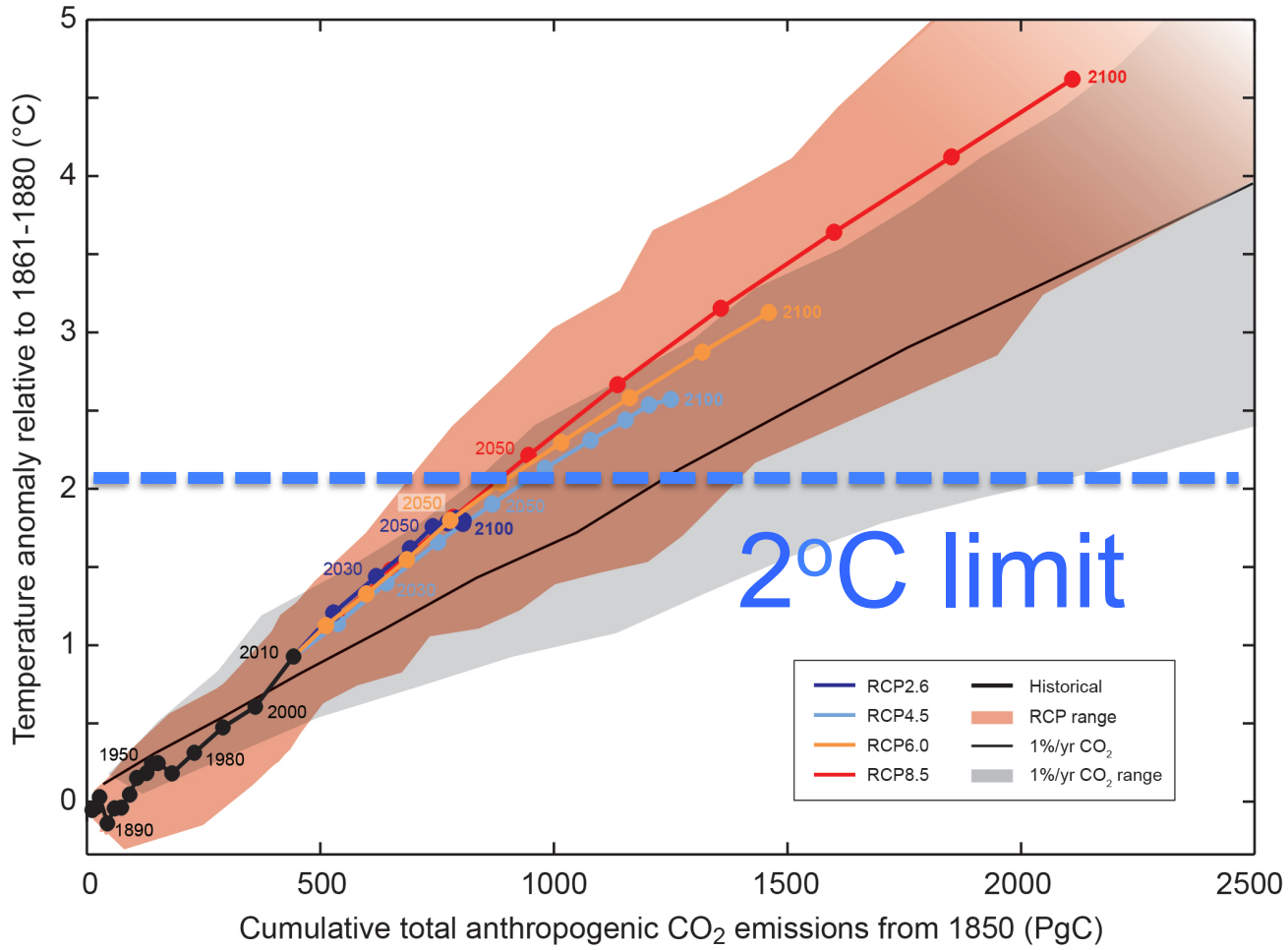
- There is *high confidence* that ENSO will remain the dominant mode of interannual variability in the tropical Pacific, with global effects in the 21st century.
- Due to the increase in moisture availability, ENSO-related precipitation variability on regional scales will *likely* intensify.

How

Southeast Asia region

could be affected in the future?

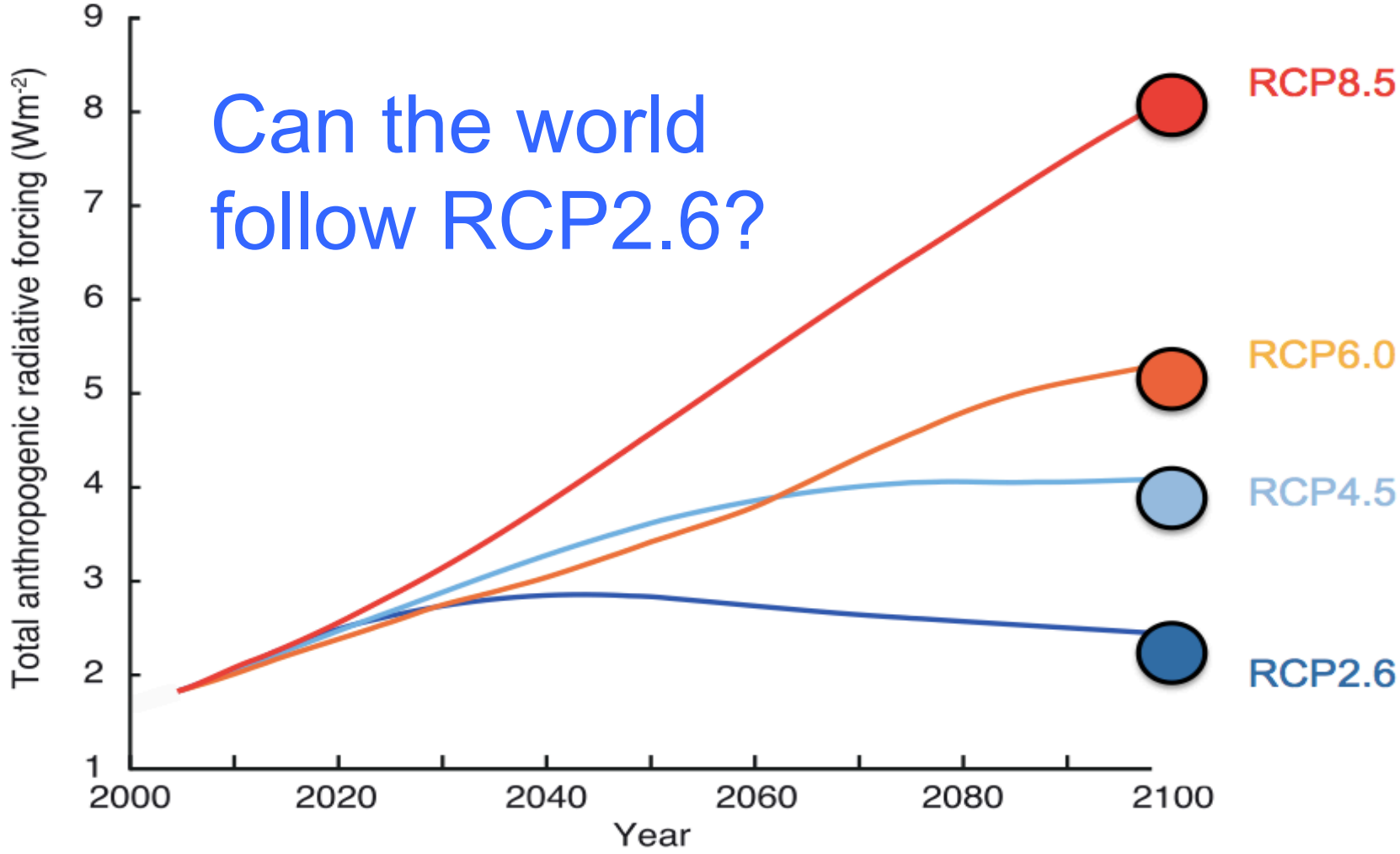
- **Warmer temperature** ✓
- **More intense precipitation events** ✓
- **Large variations of rainfall and temperature associated with ENSO** ✓
- **Changes in monsoon** ✓
- **Sea level rise** ✓
- **Warmer ocean & acidification** ✓

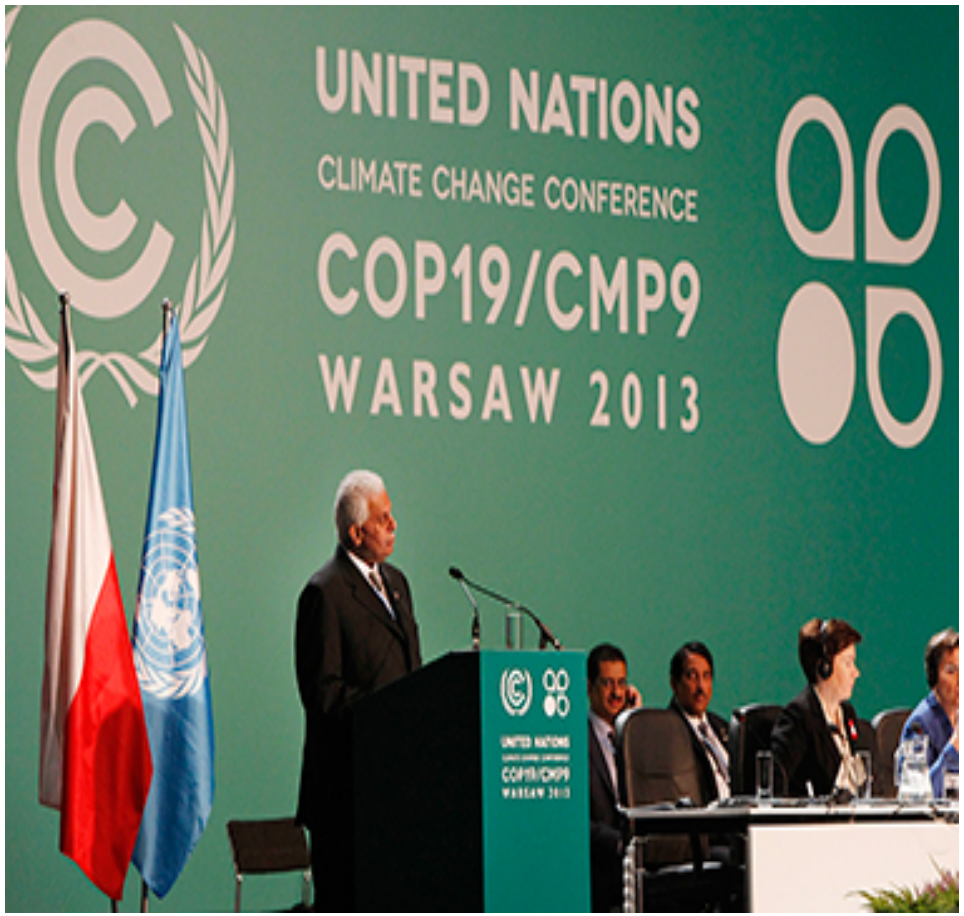


(IPCC 2013, Fig. SPM.10)

Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions

RCP2.6 would be the Emission Scenario to follow if we were to cap warming at 2°C





November 11-22, 2013,
Warsaw, Poland

"Urging all Parties to the Kyoto Protocol to ratify and implement the Doha Amendment to the Kyoto Protocol as a matter of urgency"

SUMMARY

- **Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.**
- **The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased**
- **Human influence on the climate system is clear**
- **Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system.**
- **Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6.**
- **Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions**

Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP