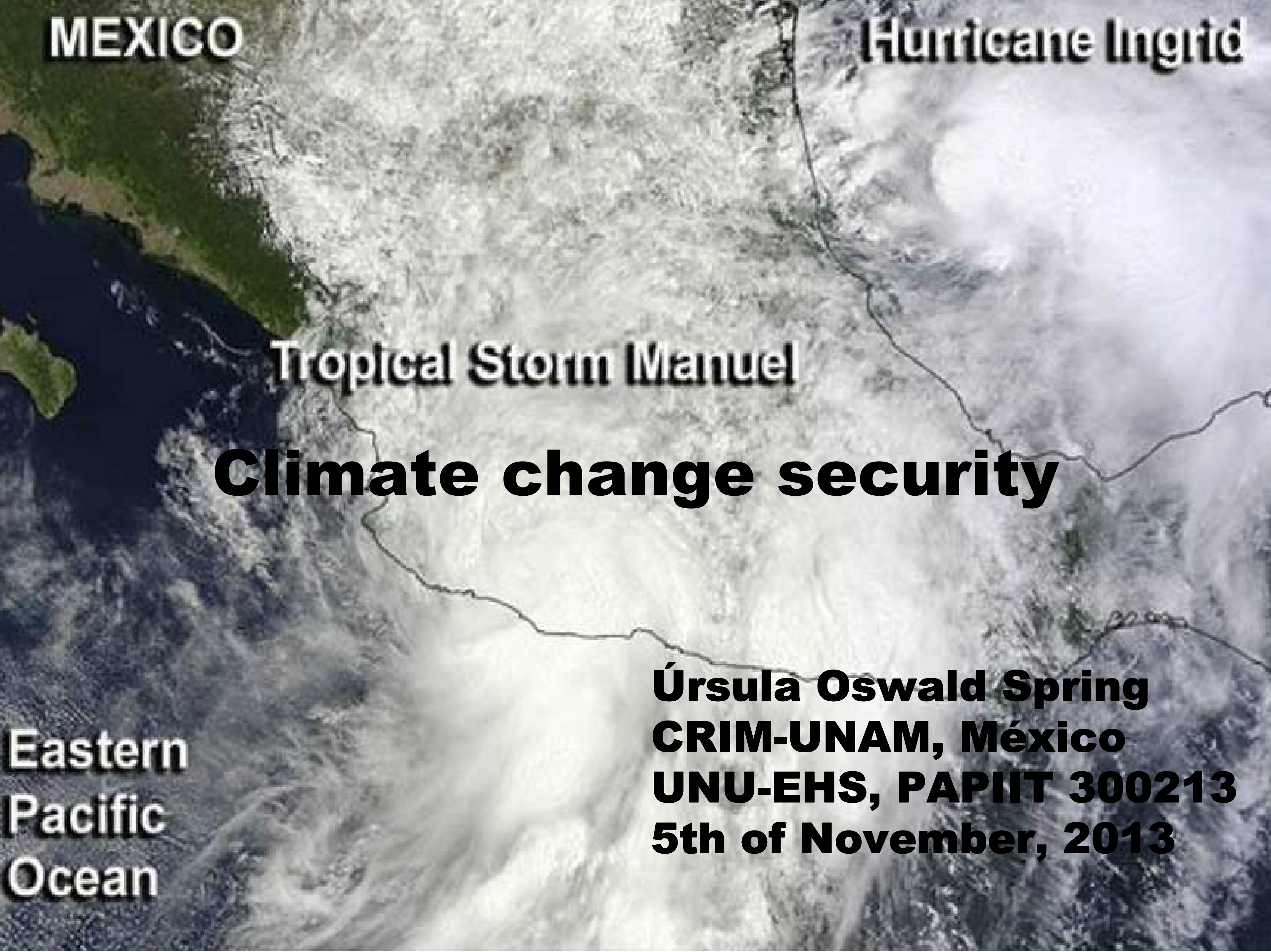


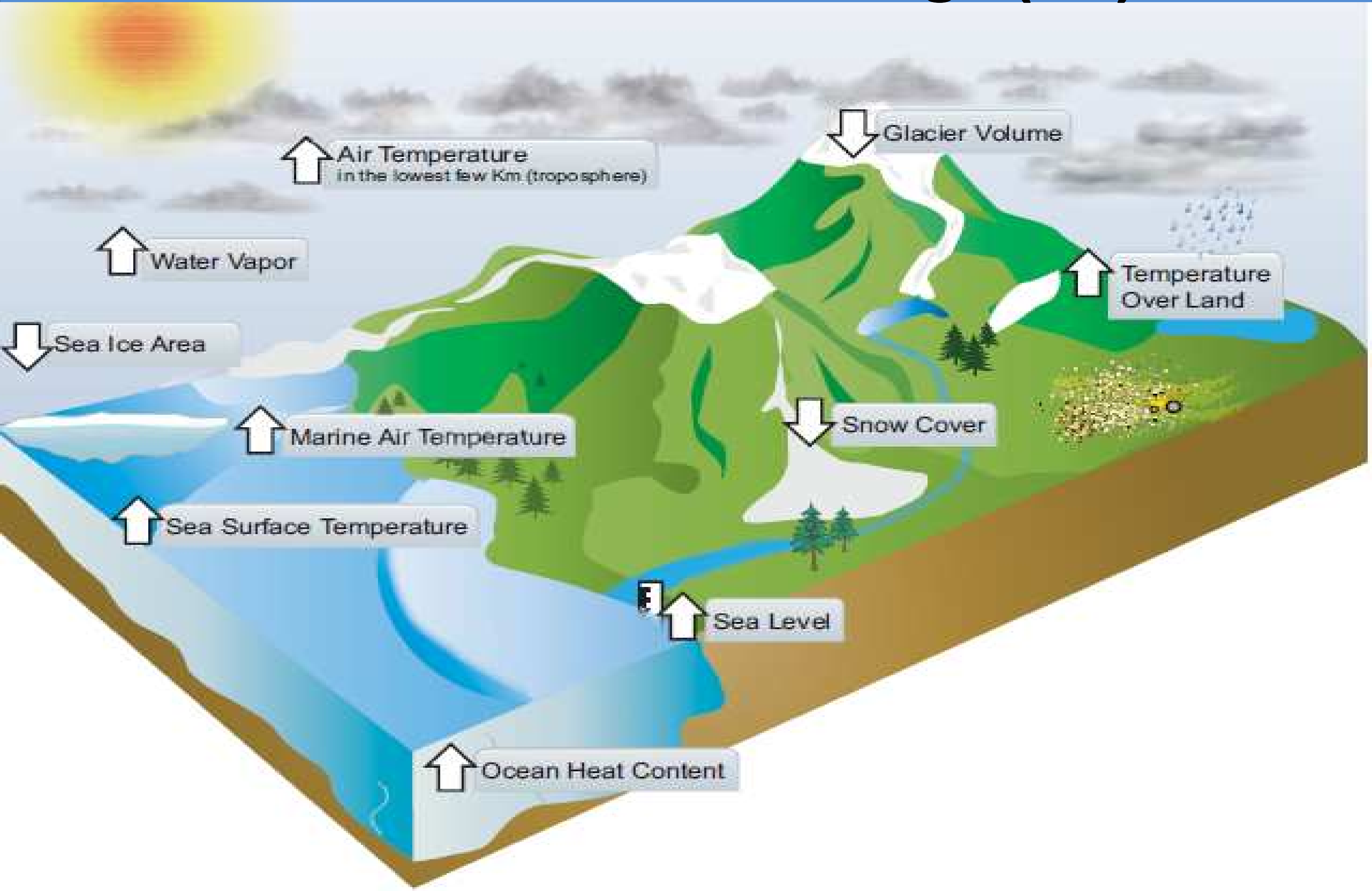
Climate change security

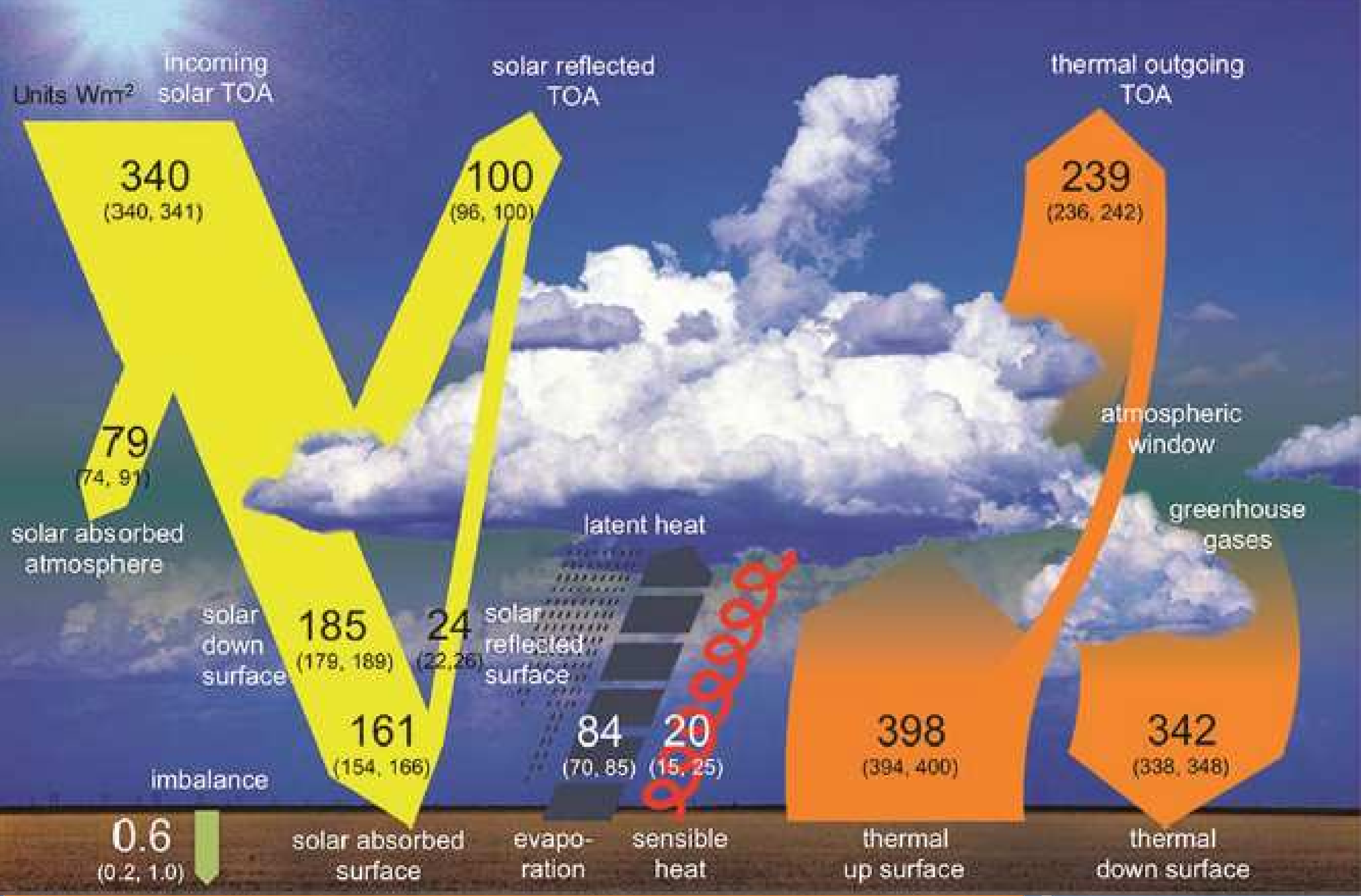
Úrsula Oswald Spring
CRIM-UNAM, México
UNU-EHS, PAPIIT 300213
5th of November, 2013

Content

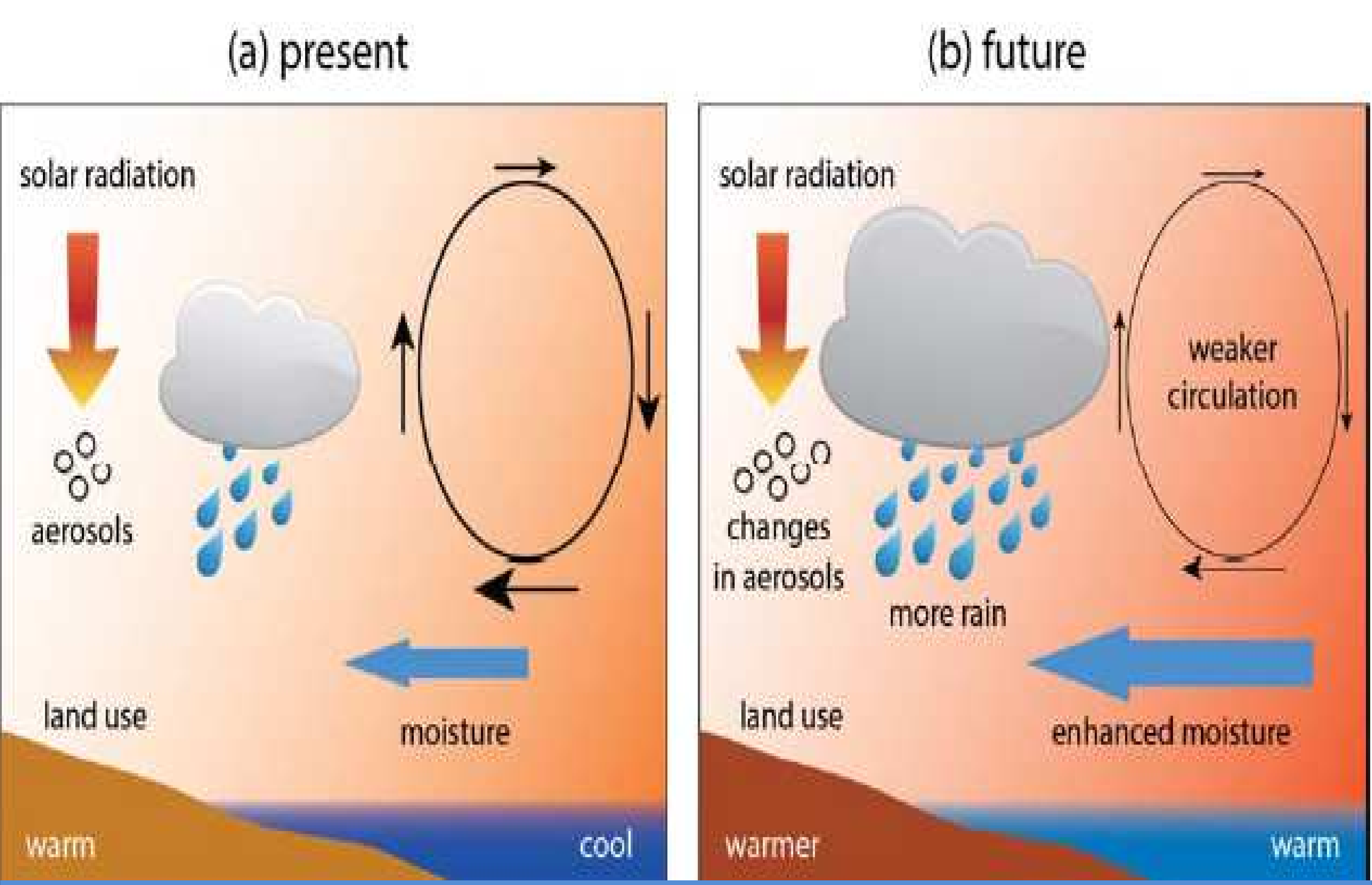
1. What is climate change (CC)?
2. What are the recent data of IPCC?
3. How is CC related to global environmental change (GEC)?
4. Which are the dangers fro humankind and nature?

1. What is climate change (CC)

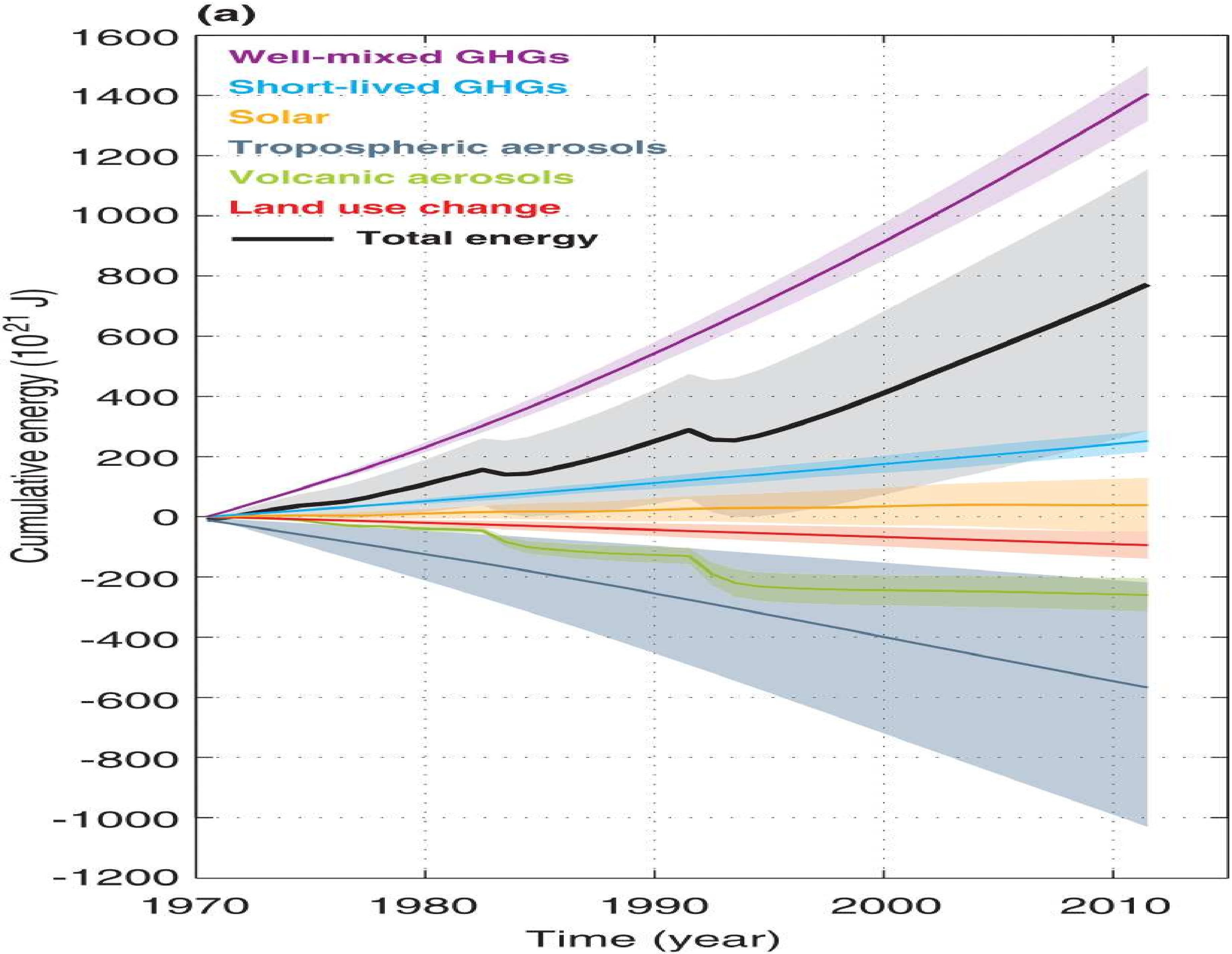




Global energy budget



What is changing?


(a)
Well-mixed GHGs
Short-lived GHGs
Solar
Tropospheric aerosols
Volcanic aerosols
Land use change
Total energy
Cumulative energy (10^{21} J)
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
1970
1980
1990
2000
2010
Time (year)

CO2 emissions from fossil fuel

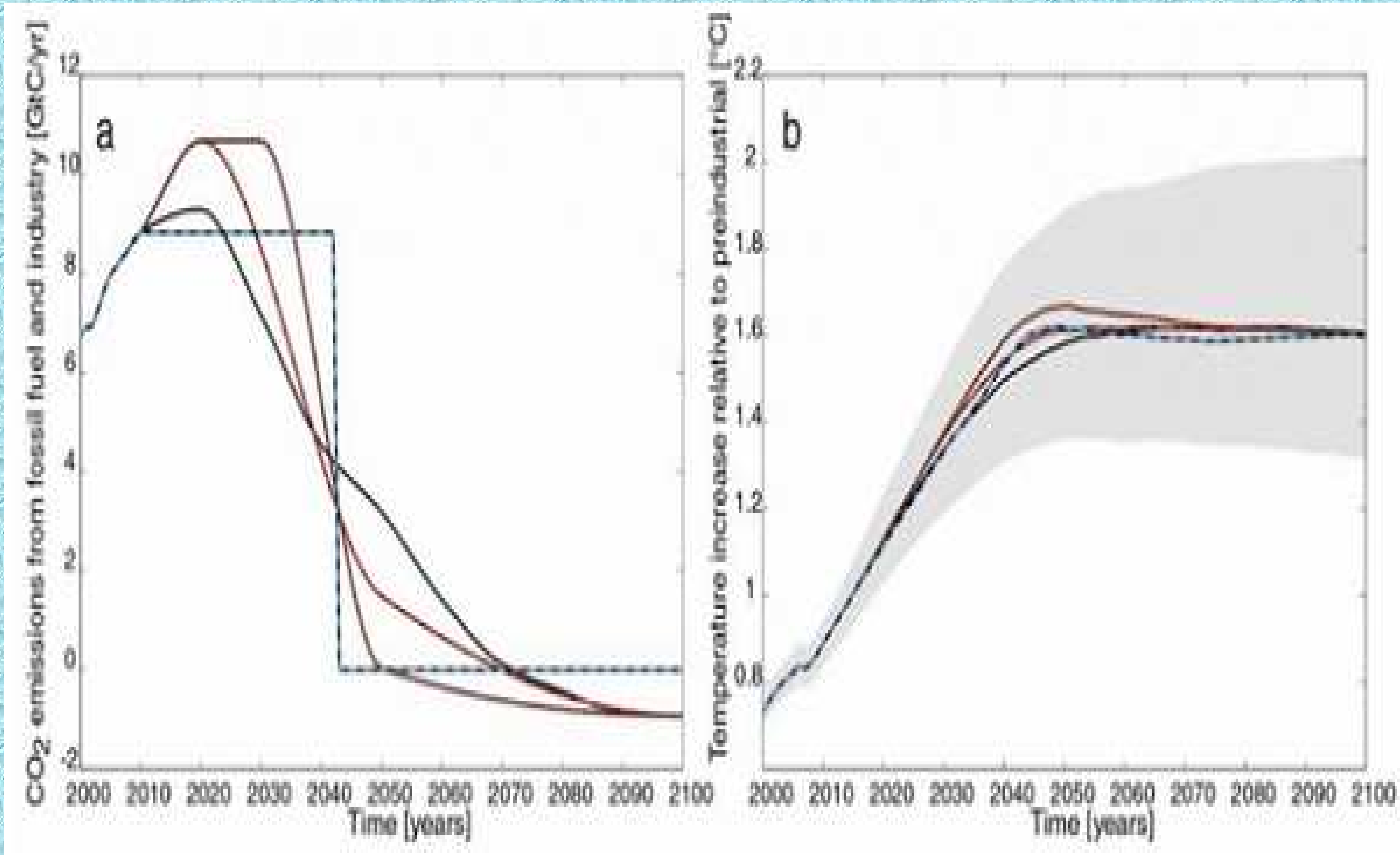


Figure 3. World petroleum and other liquids production, 2010-2040

million barrels per day

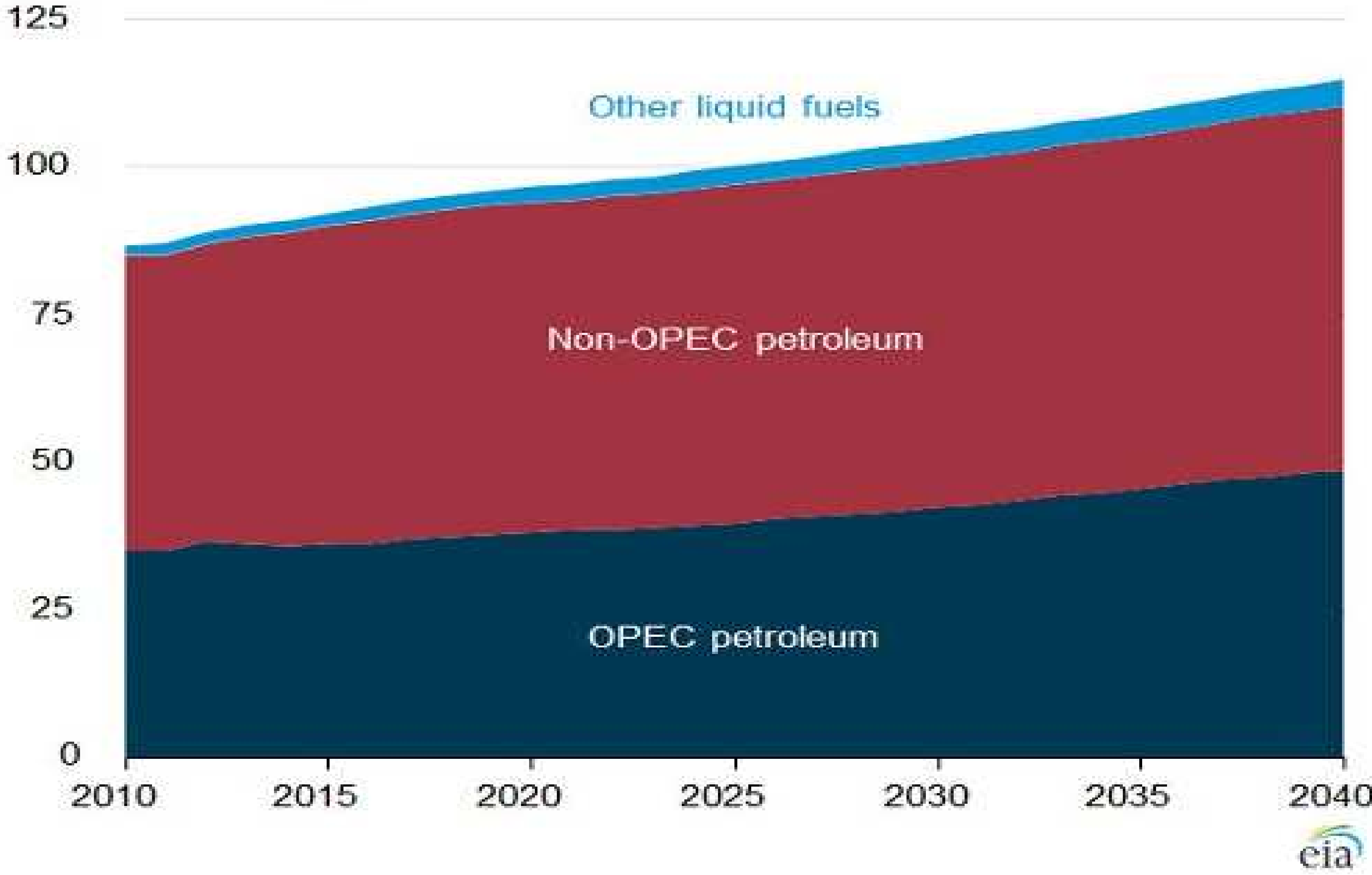
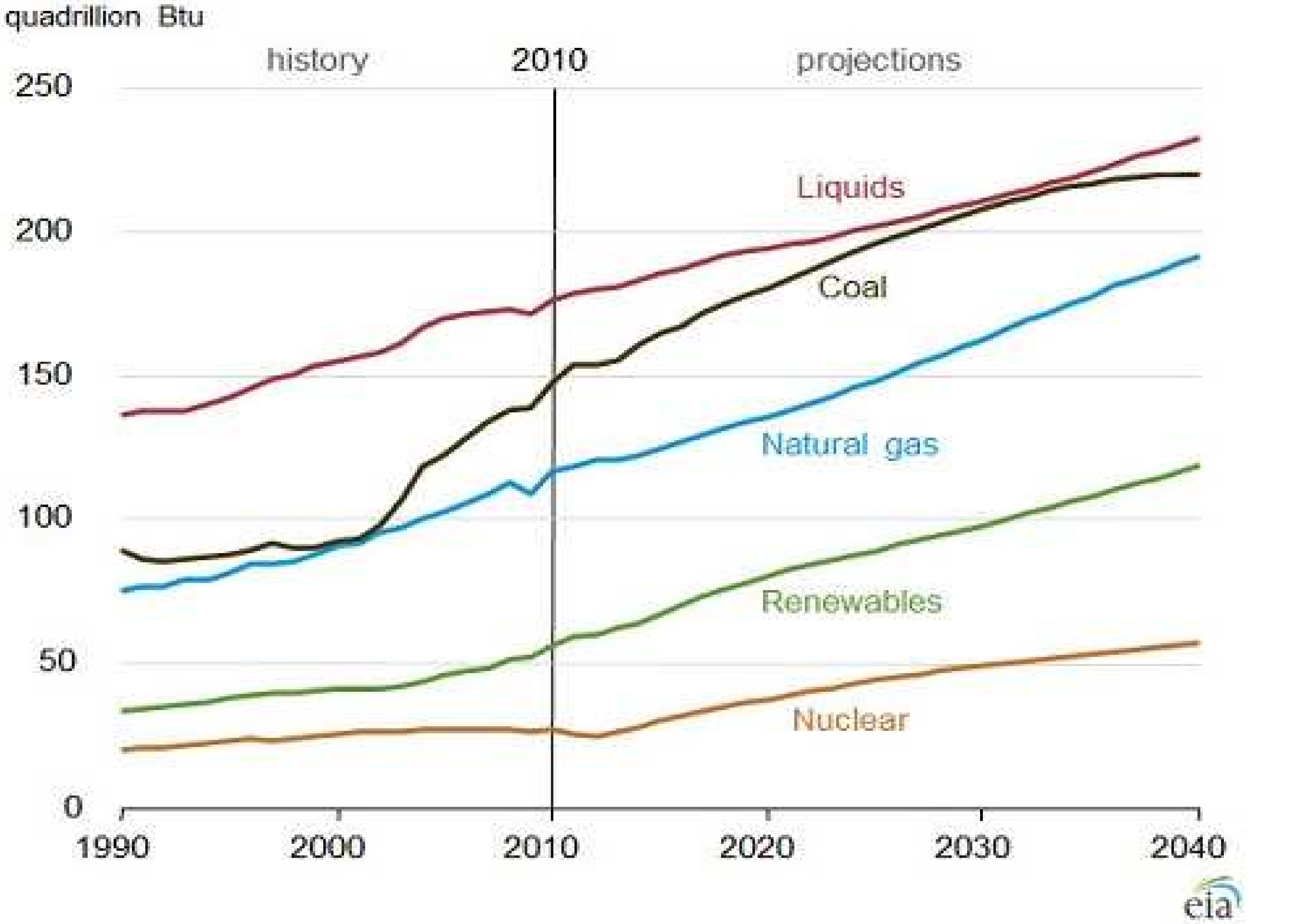
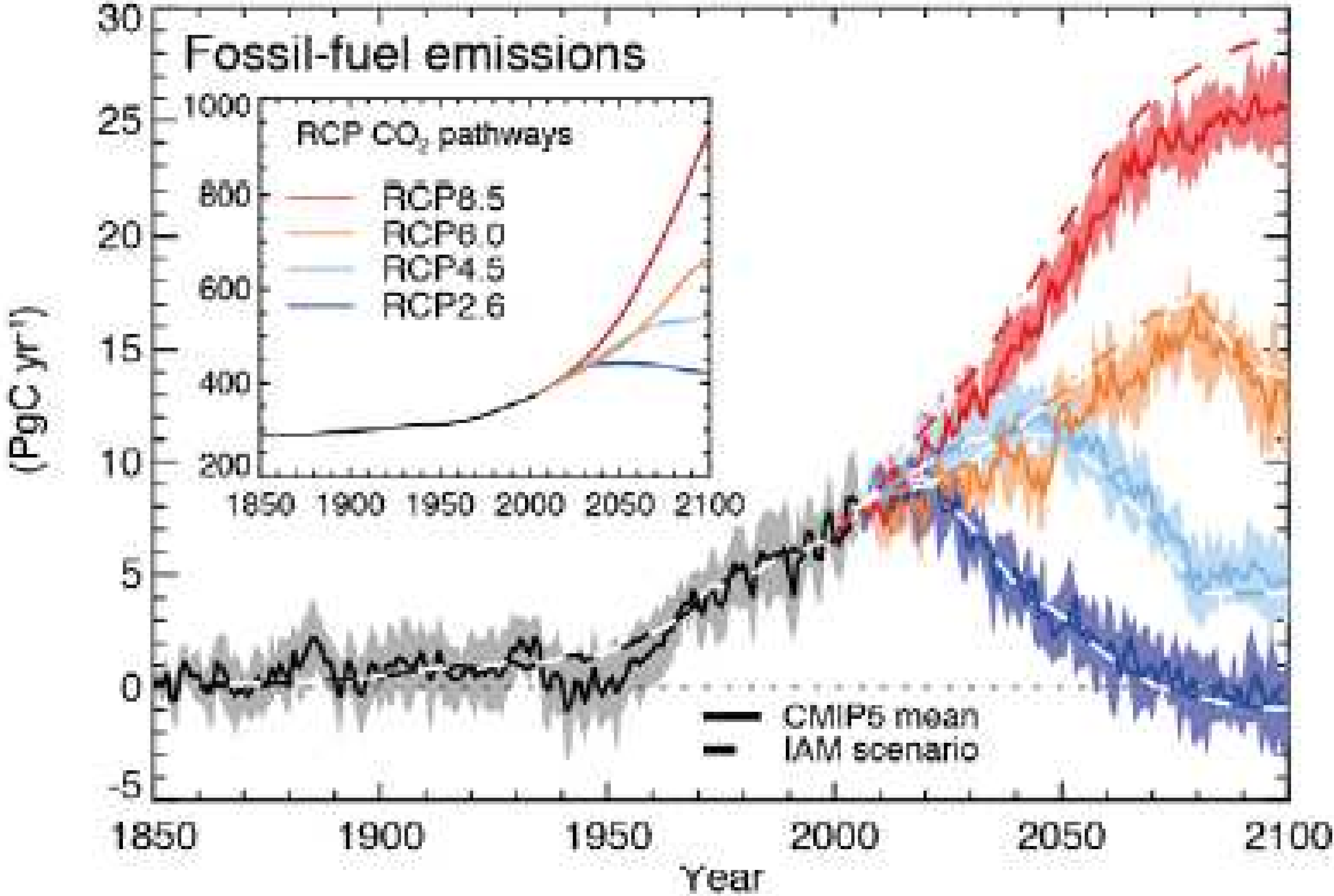


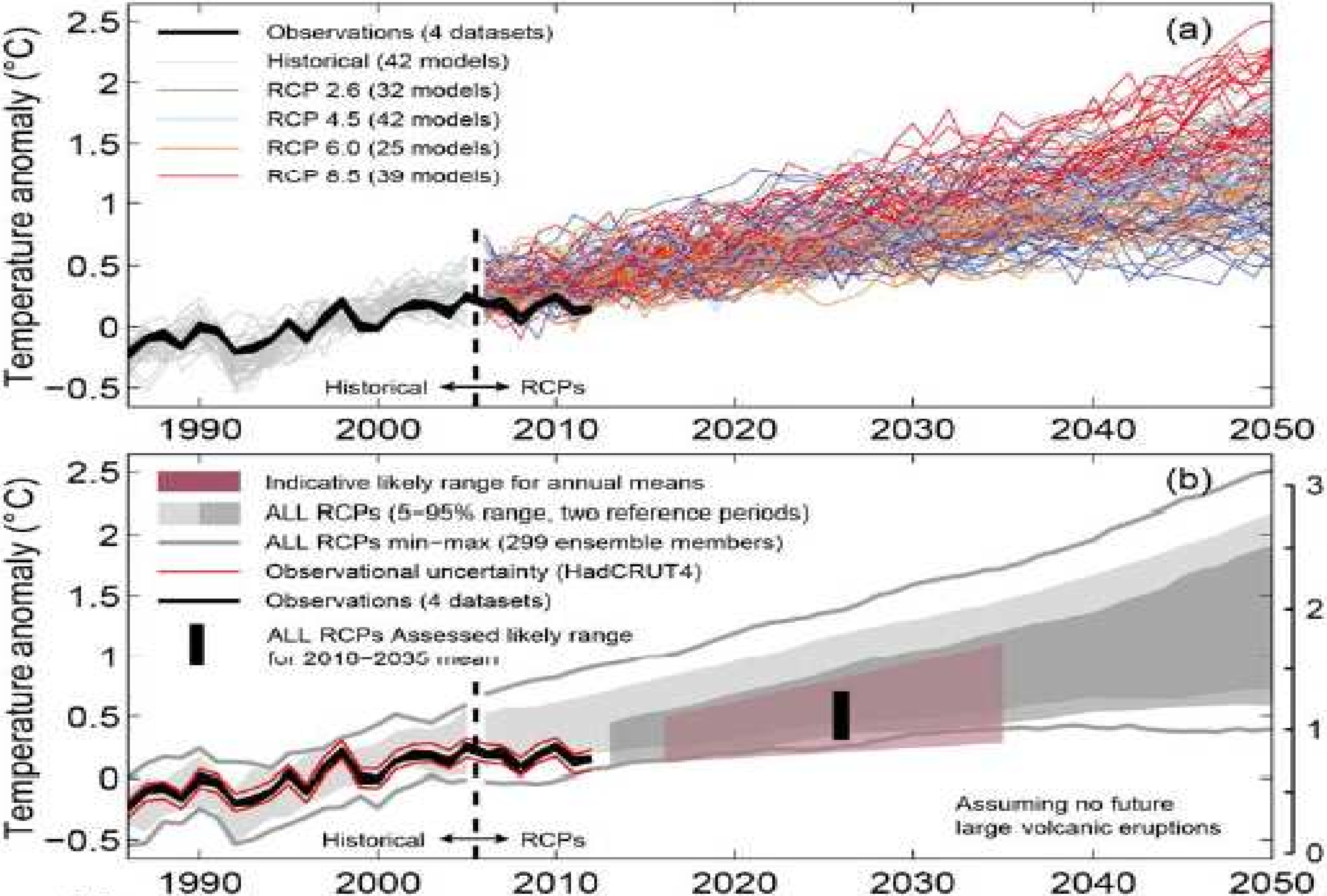
Figure 2. World energy consumption by fuel type, 1990-2040

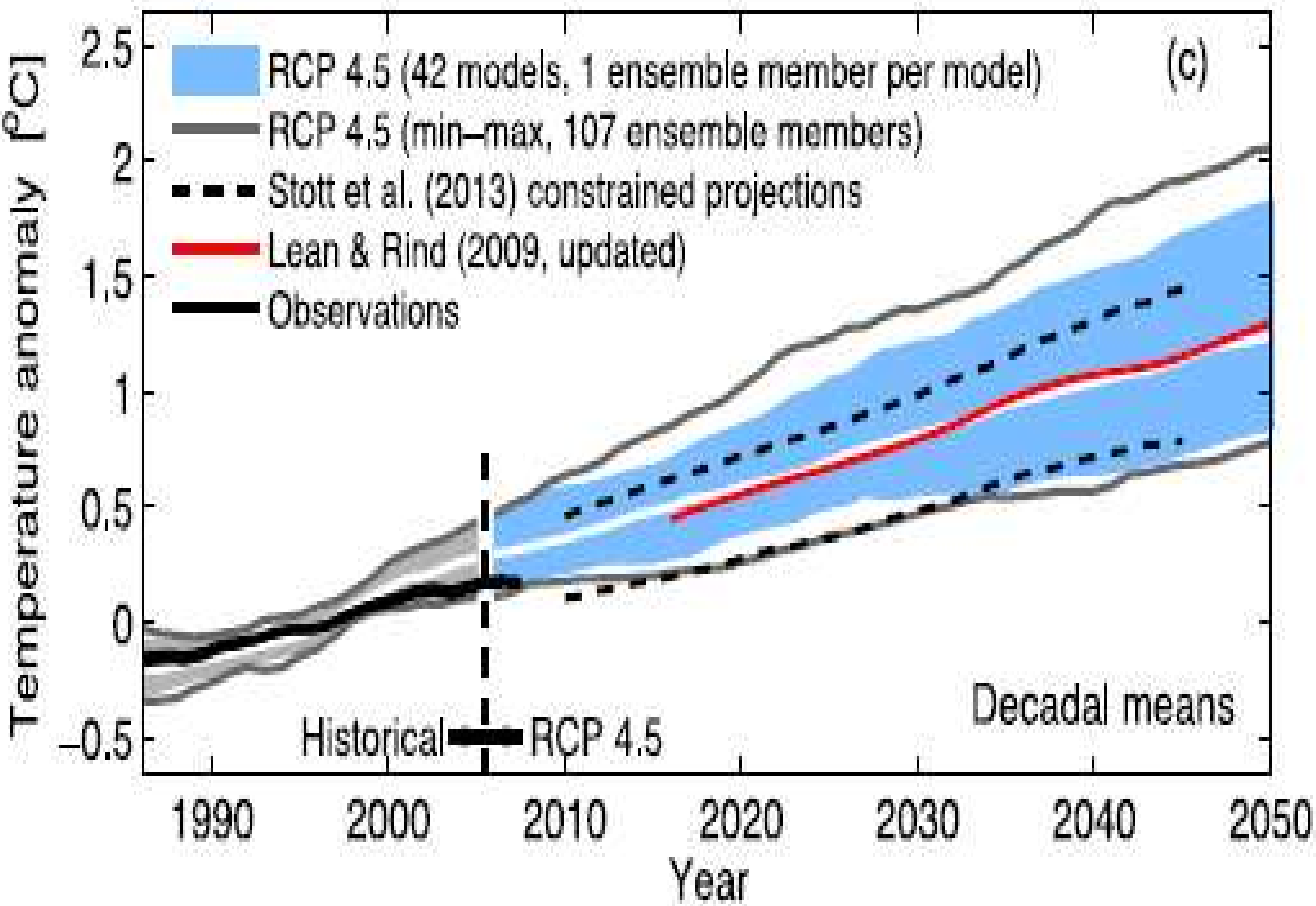


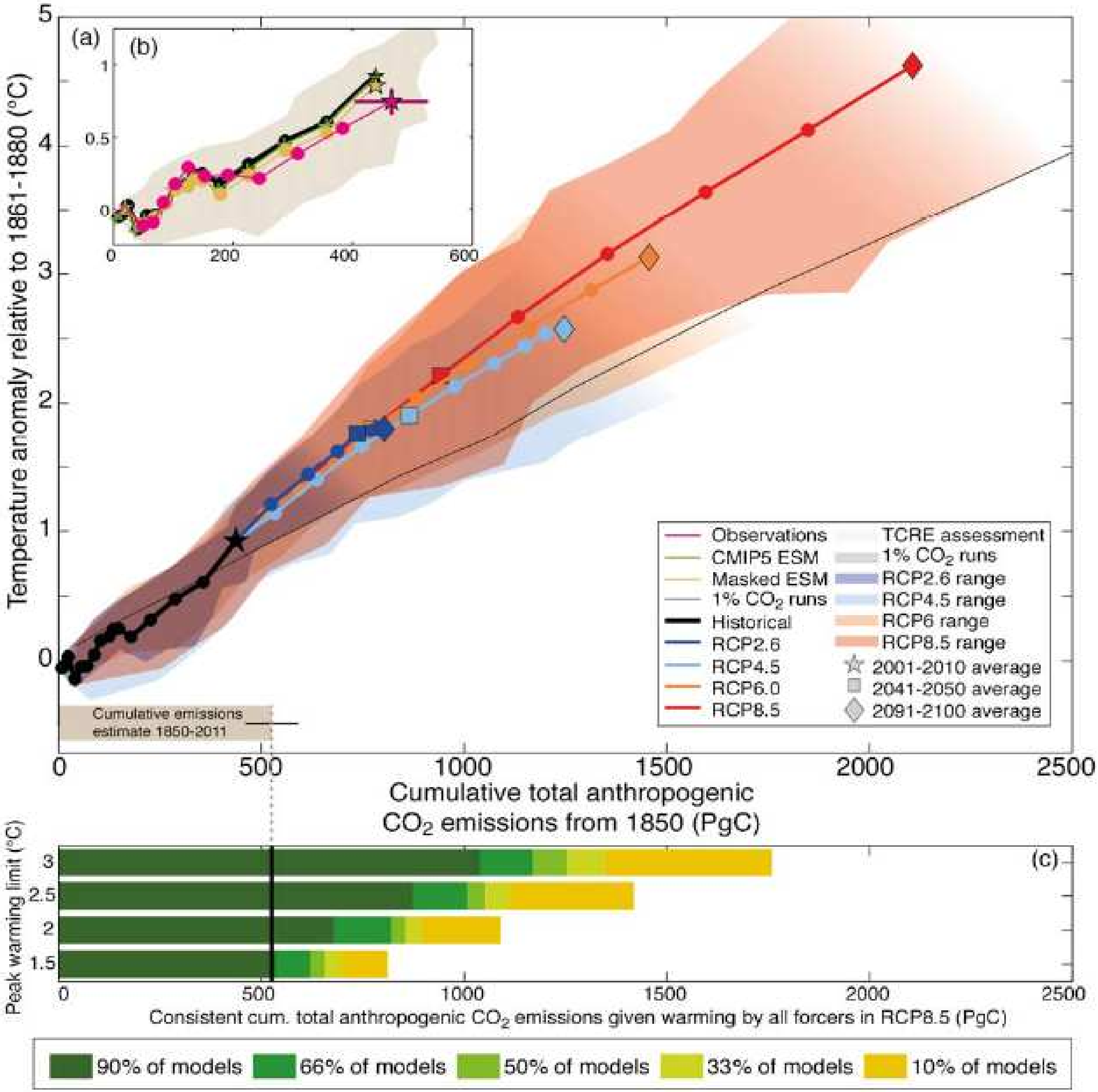

2. What are the recent data of IPCC 2013?
REUTERS


Fossil-fuel emissions
(PgC yr⁻¹)
30
25
20
15
10
5
0
-5
1850
1900
1950
2000
2050
2100
Year
RCP CO₂ pathways
1000
800
600
400
200
1850 1900 1950 2000 2050 2100
RCP8.5
RCP6.0
RCP4.5
RCP2.6
CMIP5 mean
IAM scenario

Models of temperature anomaly

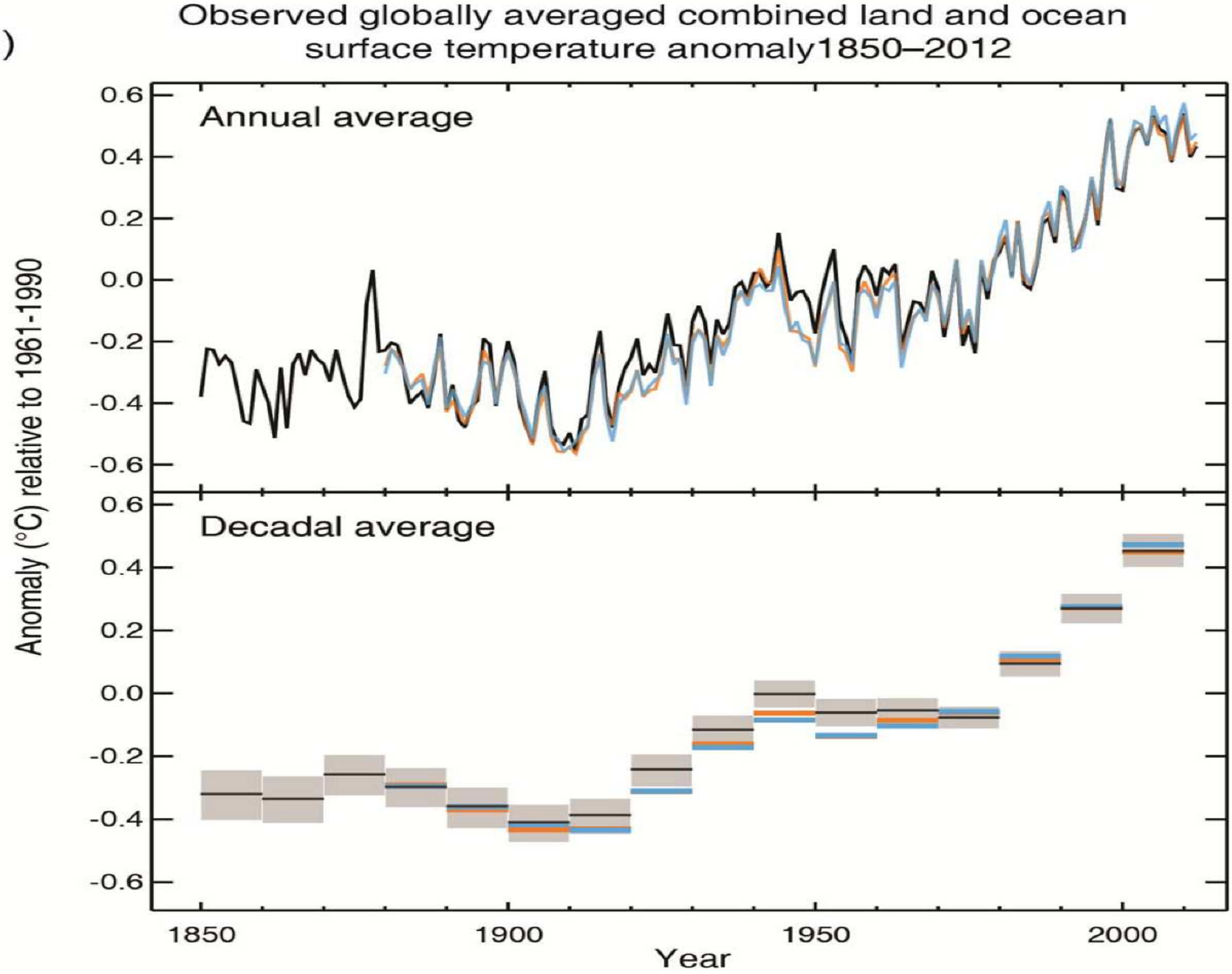



RCP 4.5 (42 models, 1 ensemble member per model)
RCP 4.5 (min–max, 107 ensemble members)
Stott et al. (2013) constrained projections
Lean & Rind (2009, updated)
Observations
(c)
Temperature anomaly [°C]
2.5
2
1.5
1
0.5
0
−0.5
Historical
RCP 4.5
Decadal means
1990
2000
2010
2020
2030
2040
2050
Year



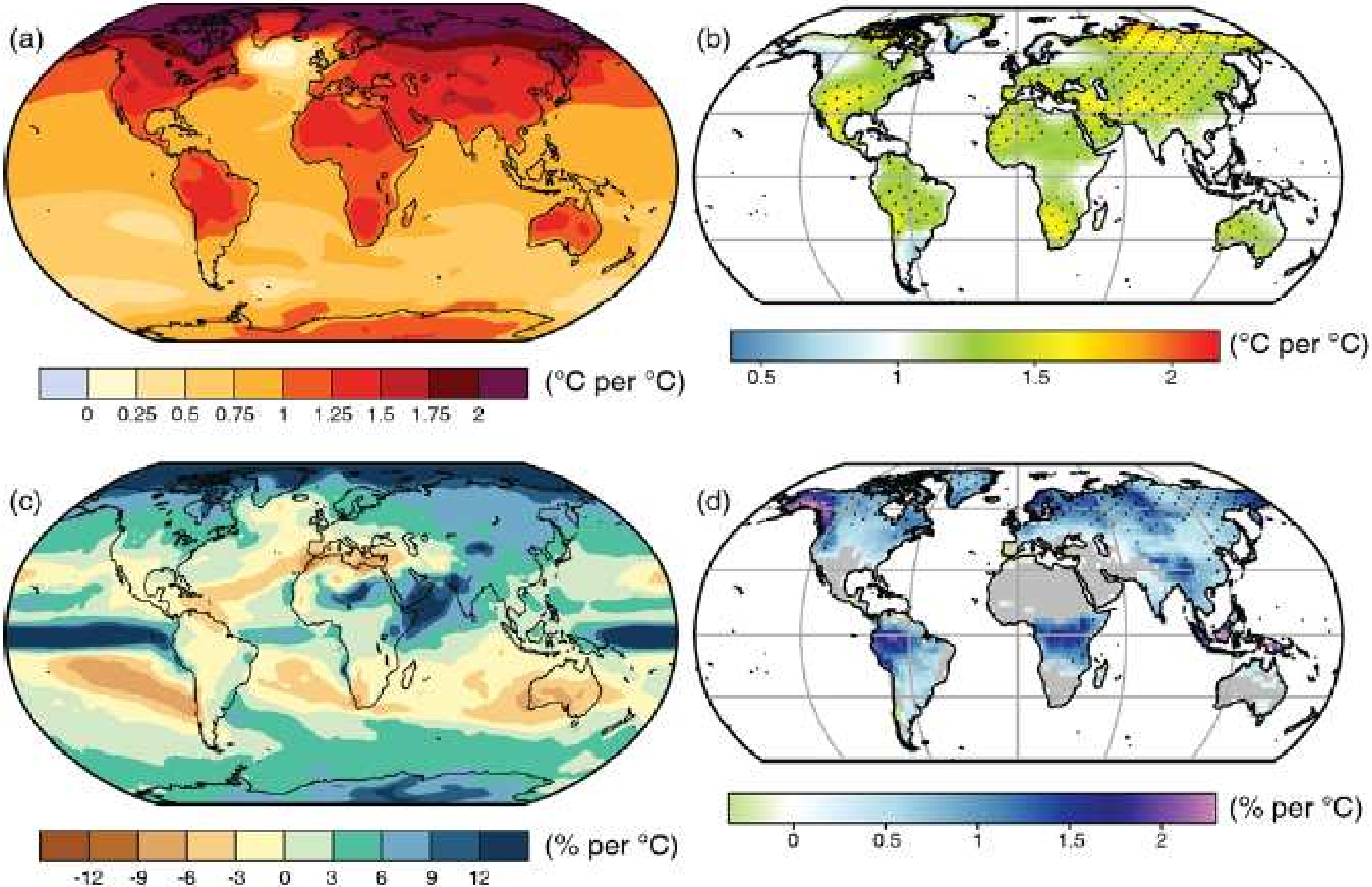
Temperature rise

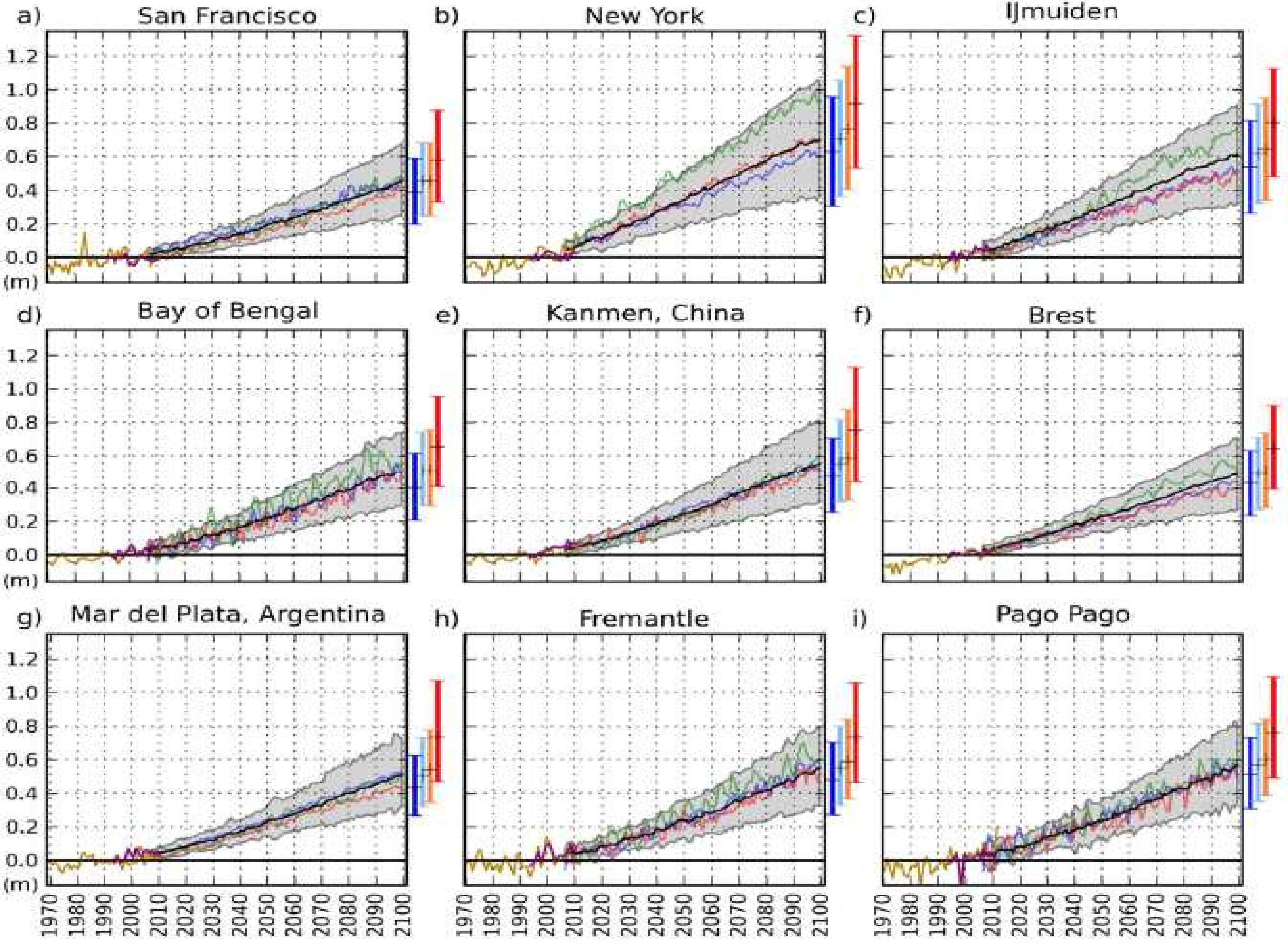
(a)



Observed globally averaged combined land and ocean surface temperature anomaly1850–2012
Annual average
Decadal average
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Anomaly (°C) relative to 1961-1990
1850
1900
1950
2000
Year

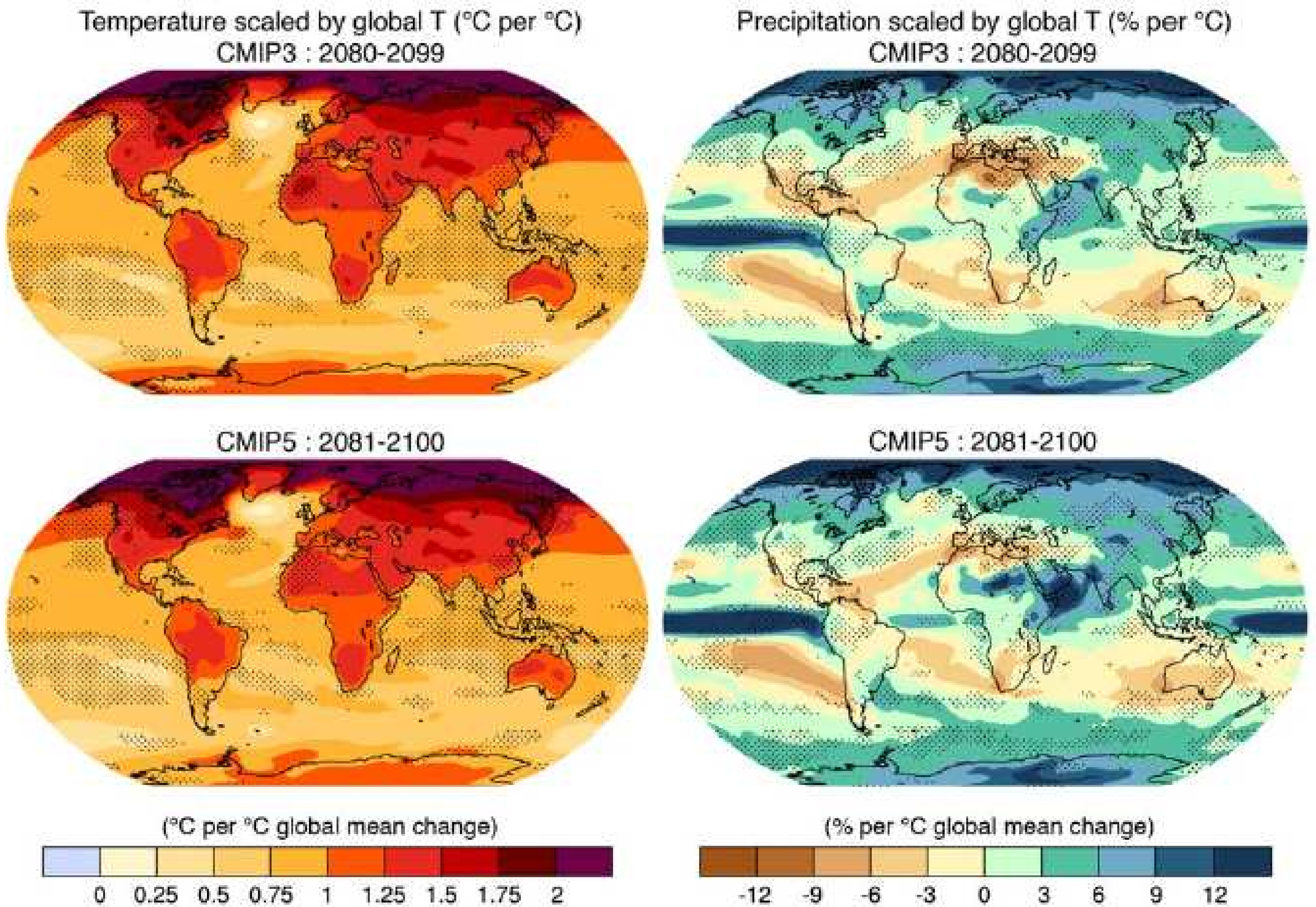
Annual means of extreme temperatures

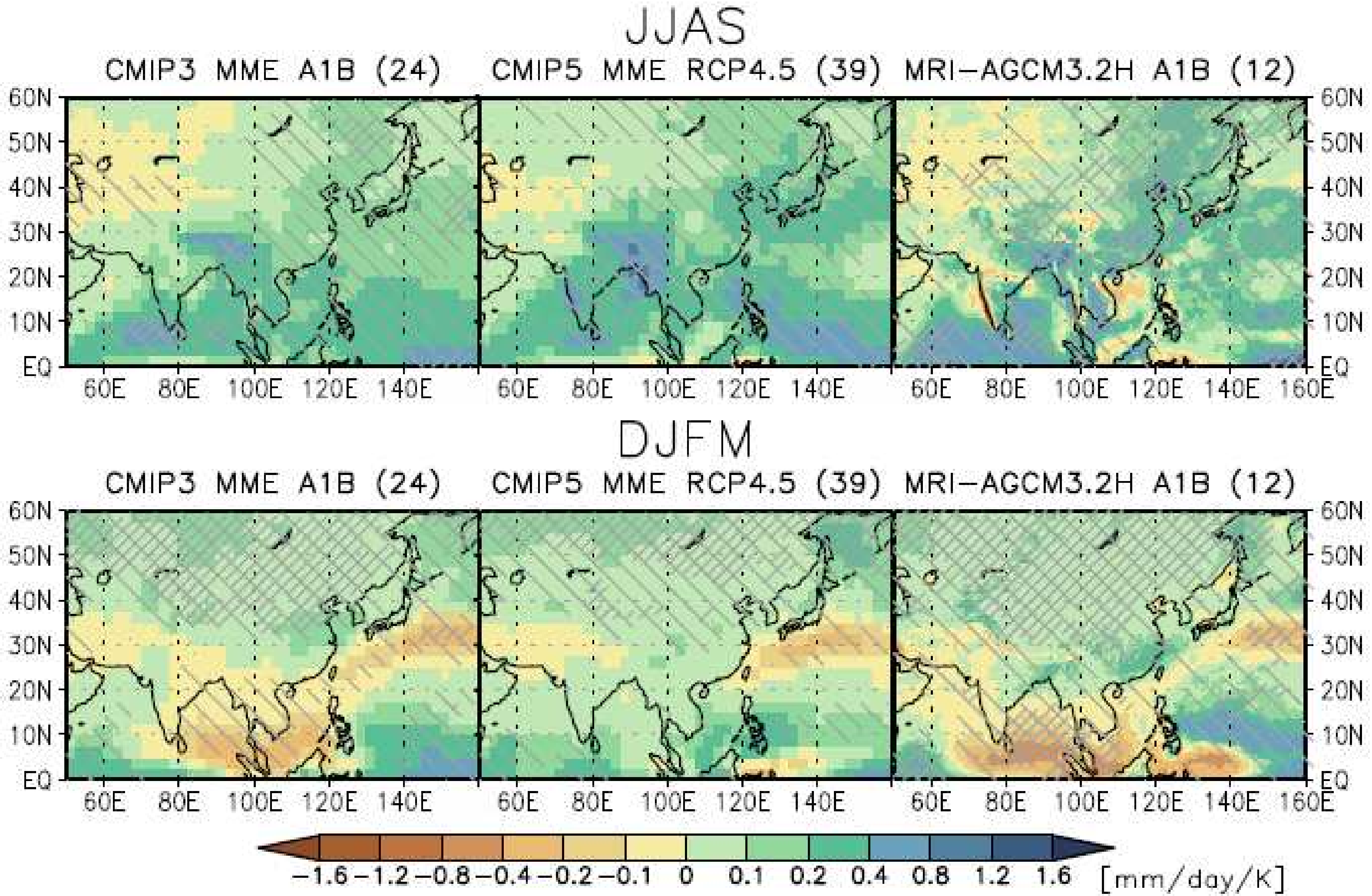




a)
San Francisco
b)
New York
c)
IJmuiden
d)
Bay of Bengal
e)
Kanmen, China
f)
Brest
g)
Mar del Plata, Argentina
h)
Fremantle
i)
Pago Pago
1.2
1.0
0.8
0.6
0.4
0.2
0.0
(m)
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100

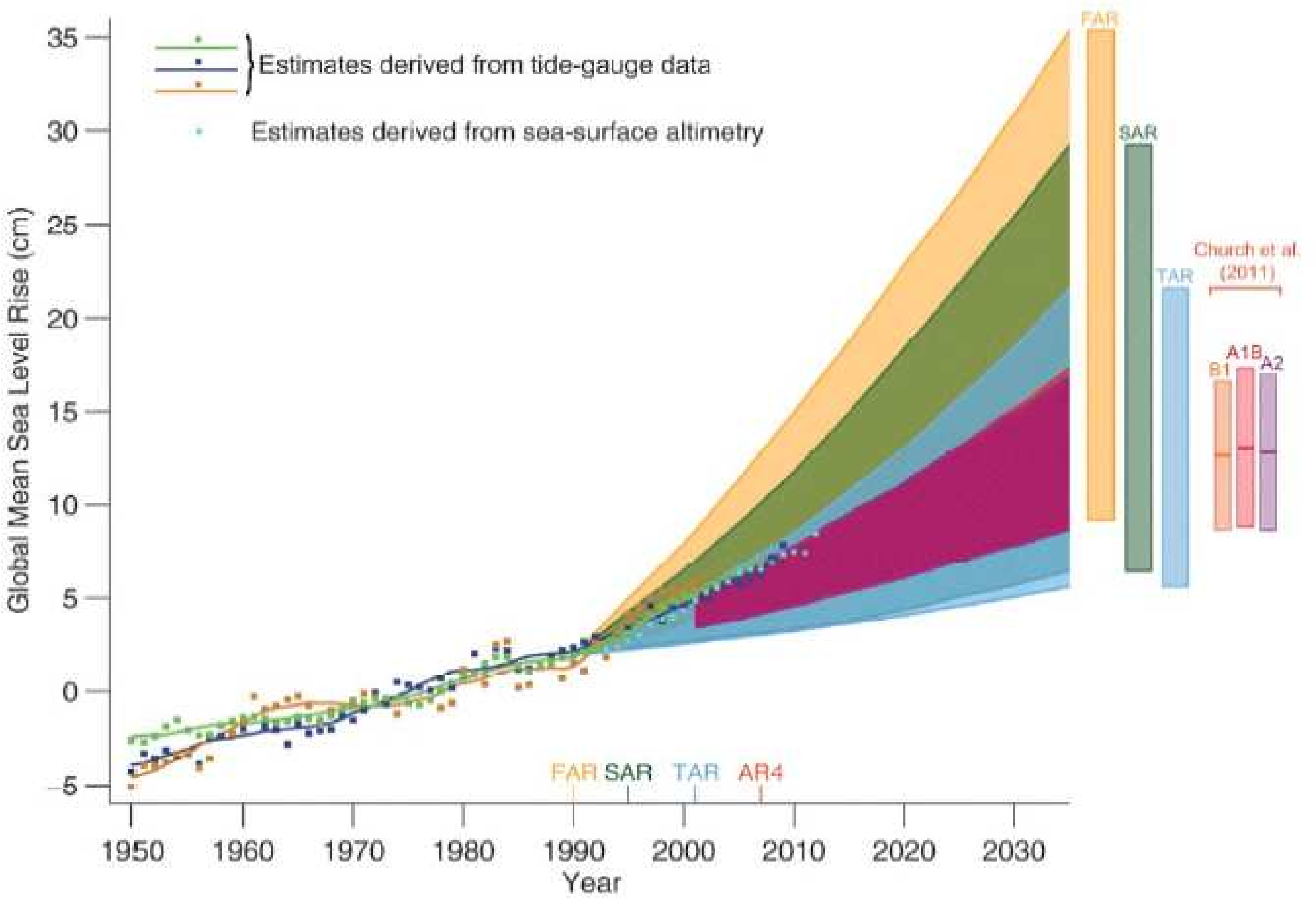
Patterns of temperature and precipitation changes



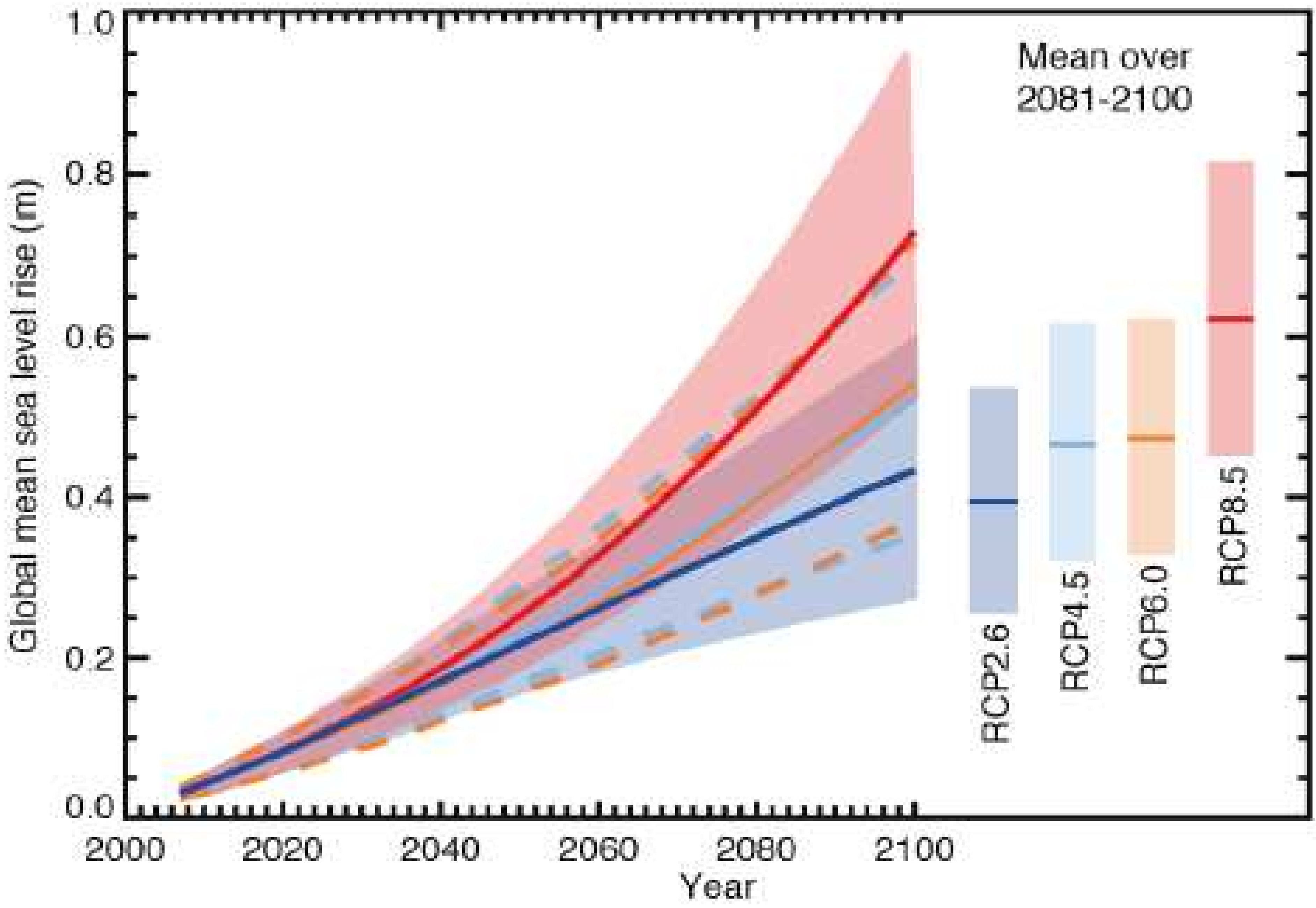


Precipitation changes in Asia

ipcc climate change WMO UNEP



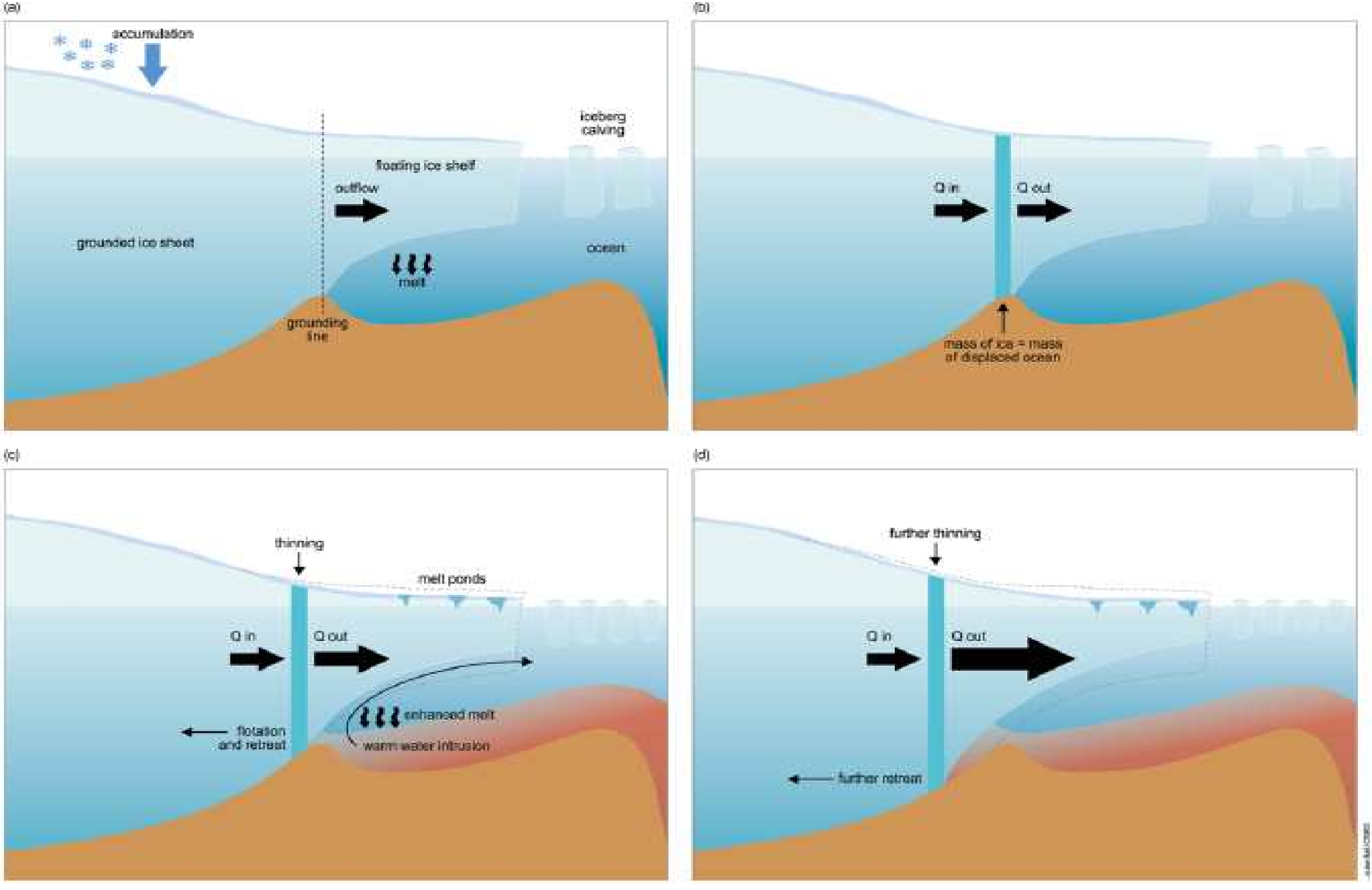
Sea level rise



Sea level rise

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP



Box 13.2, Figure 1: Schematic of the processes leading to the potentially unstable retreat of a grounding line showing (a) geometry and ice fluxes of a marine ice sheet, (b) the grounding line in steady state, (c) climate change triggering mass outflow from the ice sheet and the start of grounding line retreat, and (d) self-sustained retreat of the grounding line.

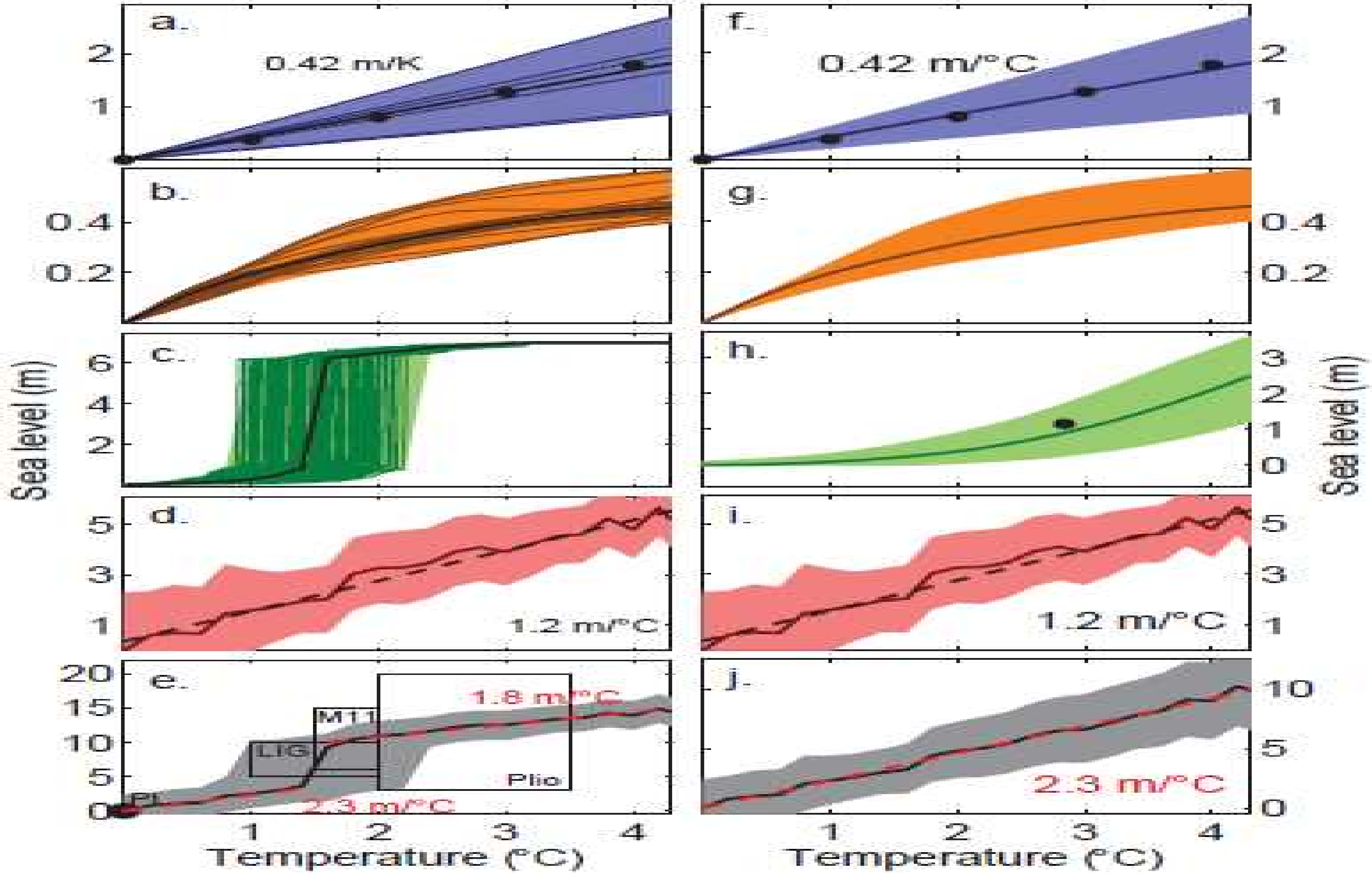
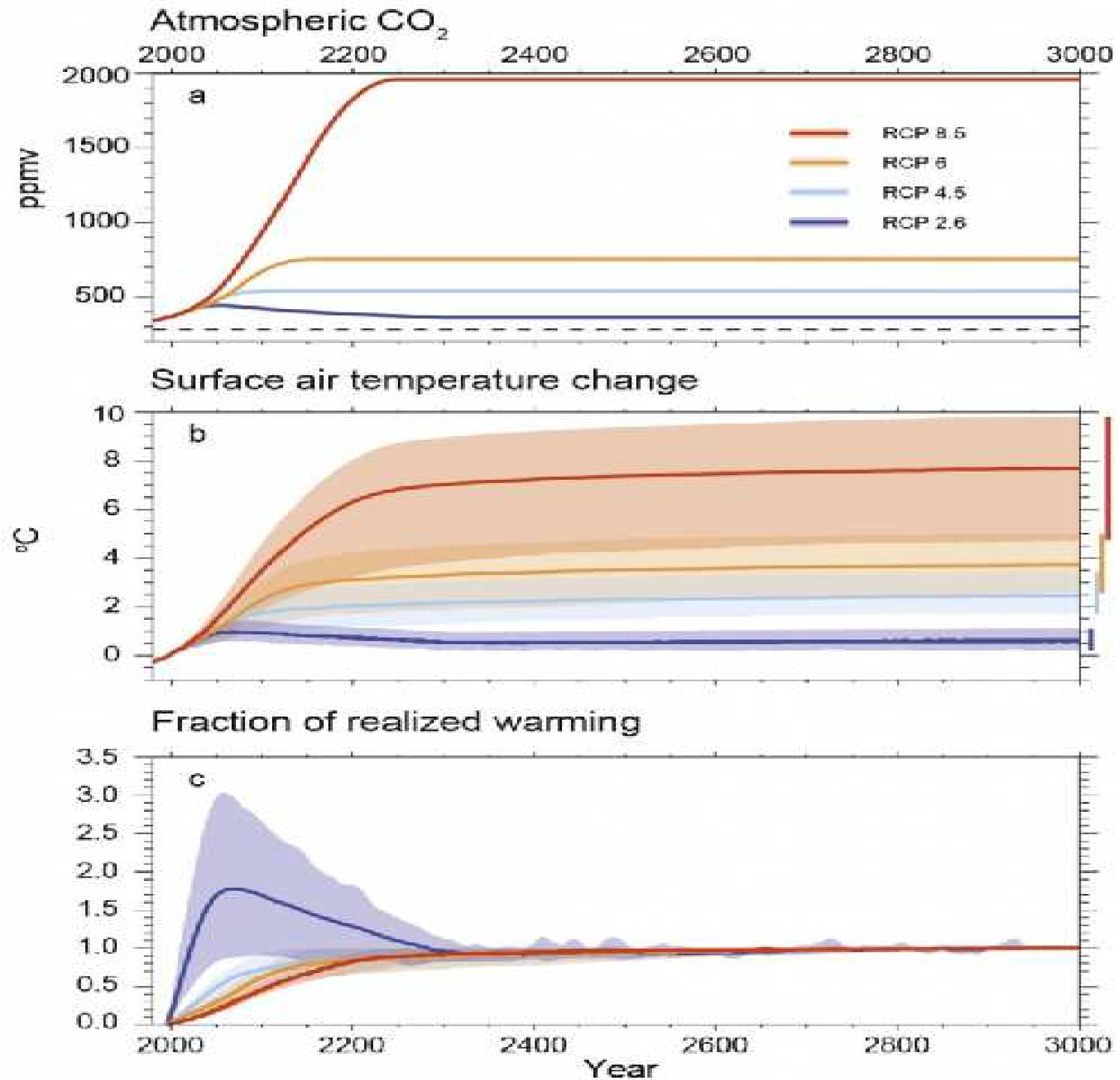
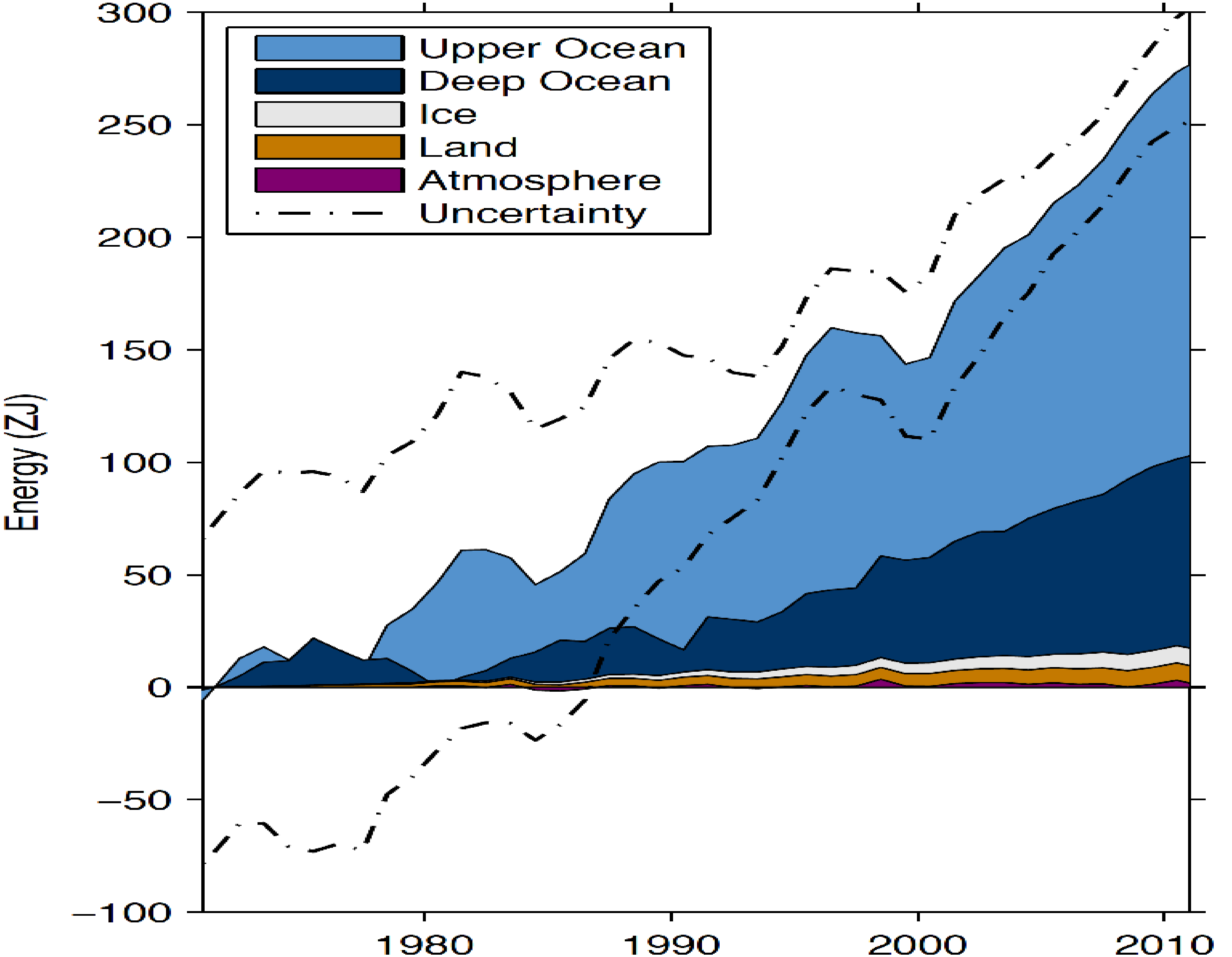


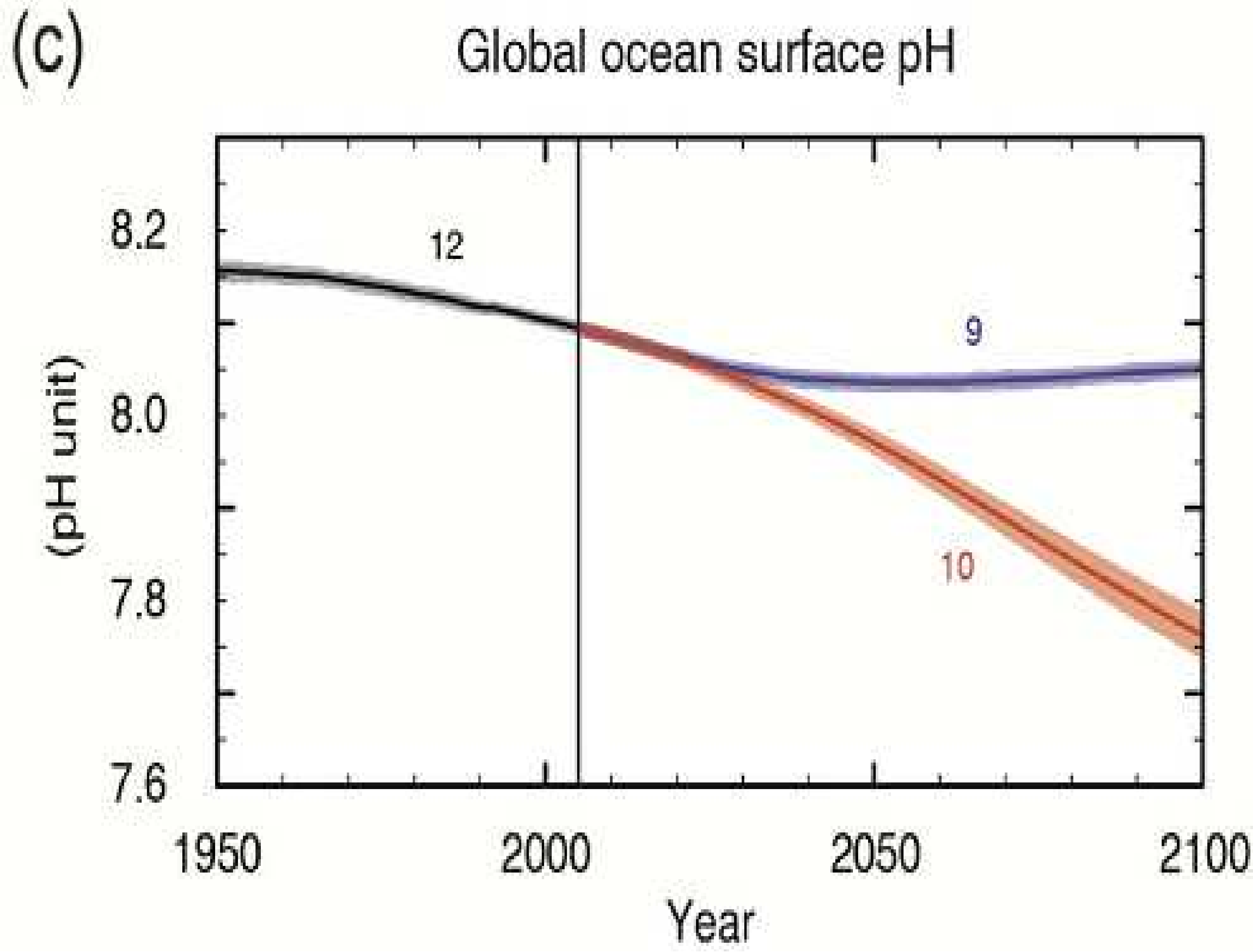
Figure 13.14: Left column: multi-millennial sea level commitment per degree of warming as obtained from physical model simulations of (a) ocean warming, (b) mountain glaciers, (c) the Greenland and (d) the Antarctic ice sheet. (e) The corresponding total sea level commitment, compared to paleo-estimates from past warm periods (PI = pre-industrial, LIG = last interglacial period, M11 = Marine Isotope Stage 11, Plio = Mid-Pliocene). Temperatures are relative to pre-industrial. Dashed lines provide linear approximations in (d) & (e) constant slopes of 1.2, 1.8 and 2.3 m $°C^{-1}$. Shading as well as the vertical line represents the uncertainty range as detailed in the text. Right column: 2000-year-sea level commitment. The difference in total sea level commitment (j) compared to the fully equilibrated situation (e) arises from the Greenland Ice Sheet which equilibrates on tens of thousands of years. After 2000 years one finds a non-linear dependence on the temperature increase (h) consistent with coupled climate-ice-sheet simulations by Huybrechts et al. (2011) (black dot). The total sea level commitment after 2000 years is quasi-linear with a slope of 2.3

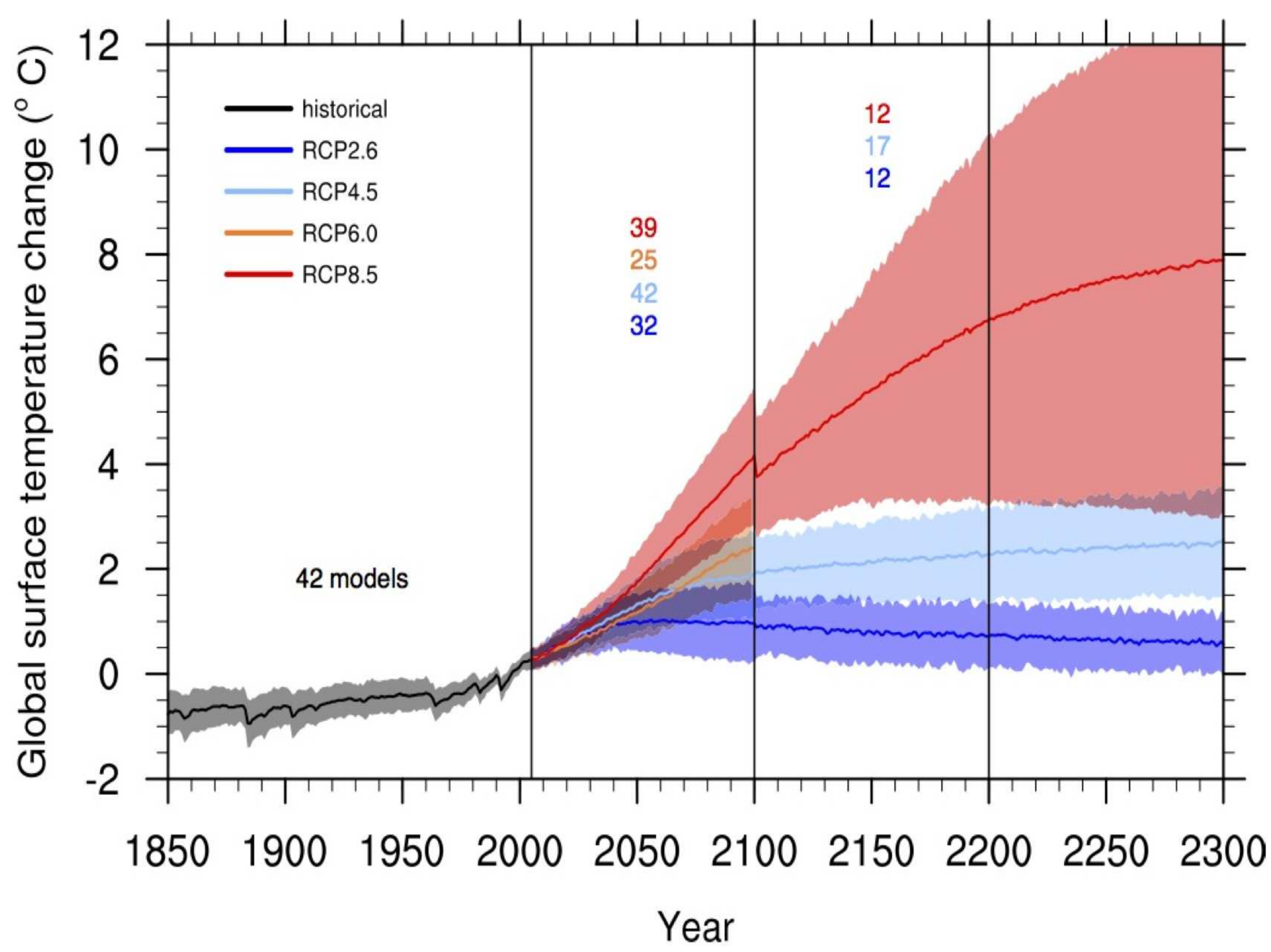


- Atomos-pheric CO2
- Surgface t change
- Fraction of realized warming

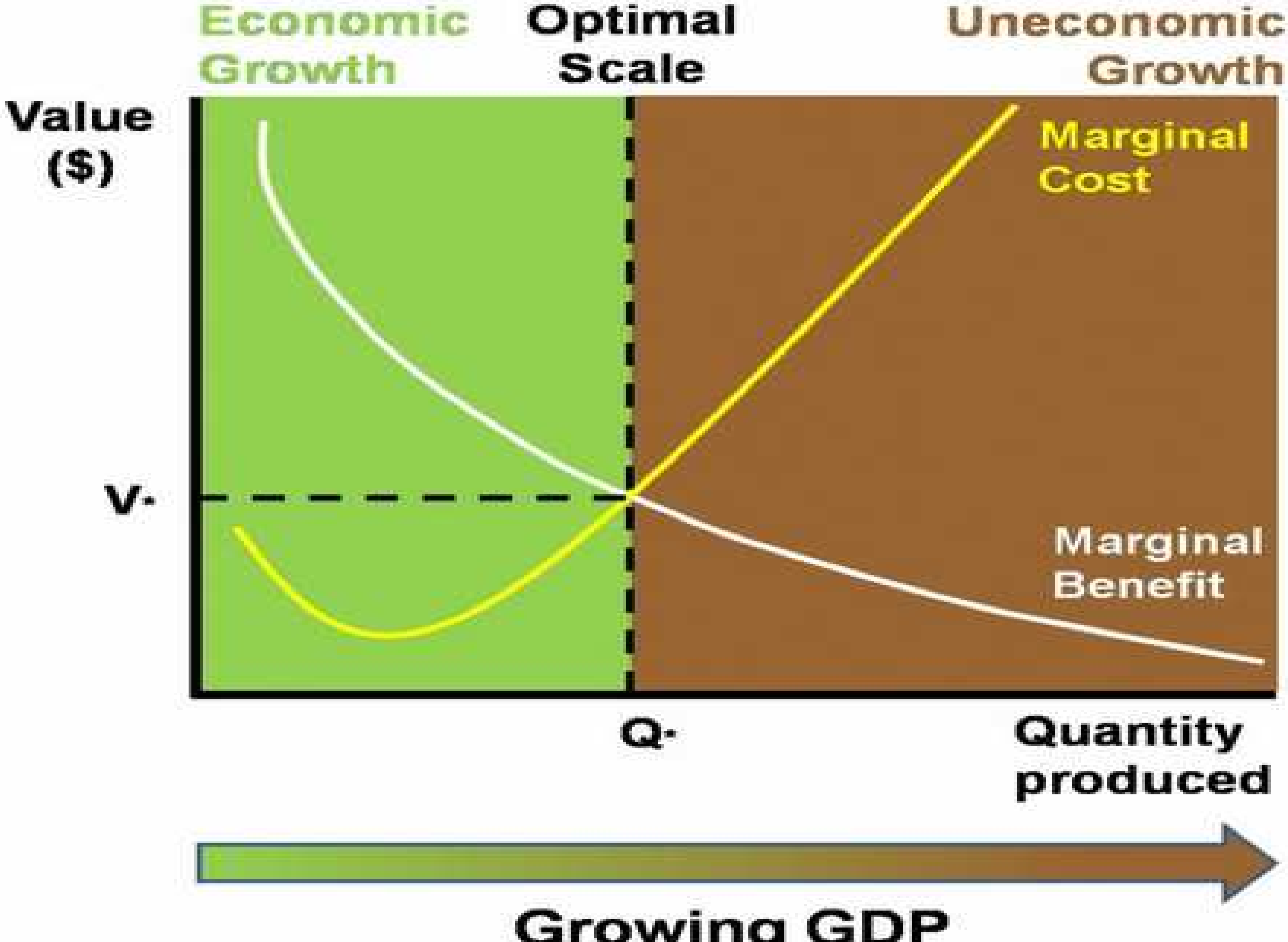


Upper Ocean
Deep Ocean
Ice
Land
Atmosphere
Uncertainty
Energy (ZJ)
300
250
200
150
100
50
0
−50
−100
1980
1990
2000
2010


(c)
Global ocean surface pH
12
9
10
8.2
8.0
7.8
7.6
(pH unit)
1950
2000
2050
2100
Year



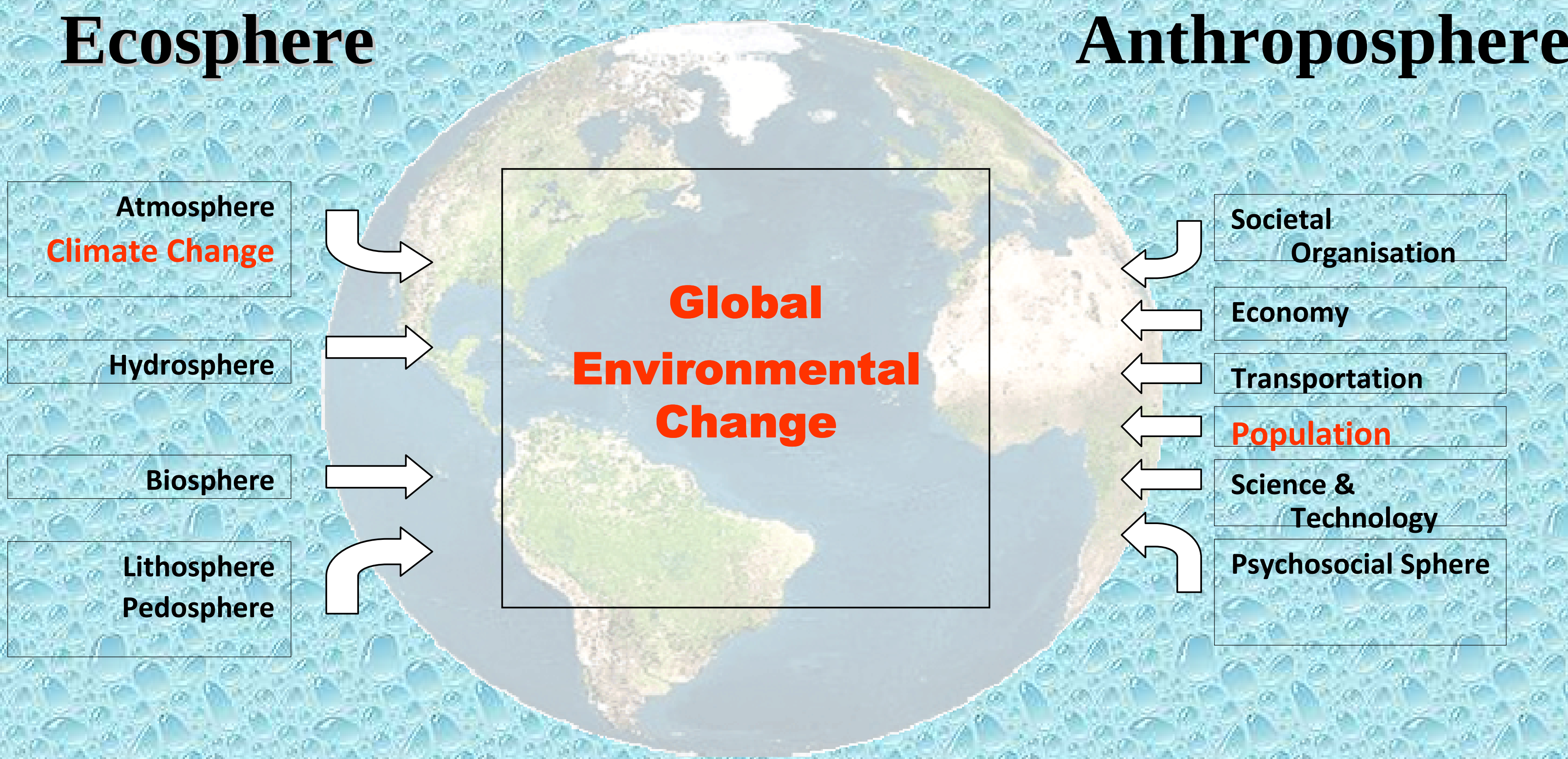
Global surface temperature change (° C)
12
10
8
6
4
2
0
-2
historical
RCP2.6
RCP4.5
RCP6.0
RCP8.5
42 models
39
25
42
32
12
17
12
1850
1900
1950
2000
2050
2100
2150
2200
2250
2300
Year



Economic Growth
Optimal Scale
Uneconomic Growth
Value ($)
Marginal Cost
V·
Marginal Benefit
Q·
Quantity produced
Growing GDP

Changes in Phenomenon	Confidence in observed changes (latter half of the 20th century)			Confidence in projected changes (up to 2100)		
IPCC Assessment Report	**TAR**	**AR4**	**SREX**	**TAR**	**AR4**	**SREX**
Higher maximum temperatures and more hot days	Likely over nearly all land areas	Very Likely over most land areas	Very Likely at a global scale	Very Likely over nearly all land areas	Virtually Certain over most land areas	Virtually Certain at a global scale
Higher minimum temperatures, fewer cold days	Very Likely over nearly all land areas	Very Likely over most land areas	Very Likely at a global scale	Very Likely over nearly all land areas	Virtually Certain over most land areas	Virtually Certain at a global scale
Warm spells/heat waves, frequency, length or intensity increases	-	Likely over most land areas	Medium Confidence in many regions	-	Very Likely over most land areas	Very Likely over most land areas
Precipitation extremes	Likely[1], over many Northern Hemisphere mid- to high latitude land areas	Likely[2] over most areas	Likely[3]	Very Likely[1] over many areas	Very Likely[2]	Likely[2,4] in many land areas of the globe
Droughts or dryness	Likely[5], in a few areas	Likely[6], in many regions since 1970s	Medium Confidence in more intense and longer droughts in some regions , but some opposite trend exists	Likely[5], over most mid-latitude continental interiors (Lack of consistent projections in other areas)	Likely[6]	Medium Confidence[7] that droughts will intensify in some seasons and areas; Overall low confidence elsewhere
Changes in tropical cyclone activity (i.e. intensity, frequency, duration)	Not Observed[8], in the few analyses available	Likely[9], in some regions since 1970	Low confidence[10]	Likely[8], over some areas	Likely[9]	Likely[11]
Increase in extreme sea level (excludes tsunamis)	-	Likely	Likely[12]	-	Likely	Very Likely[13]

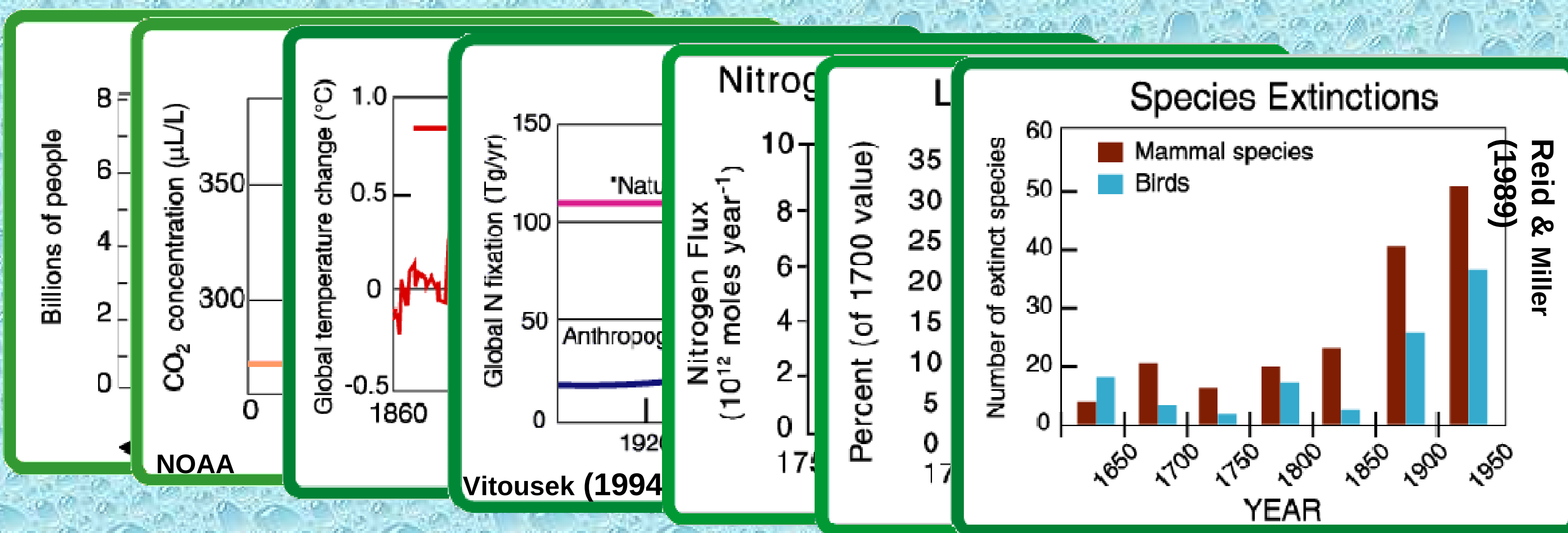
3. How is CC related to global environmental change (GEC)?

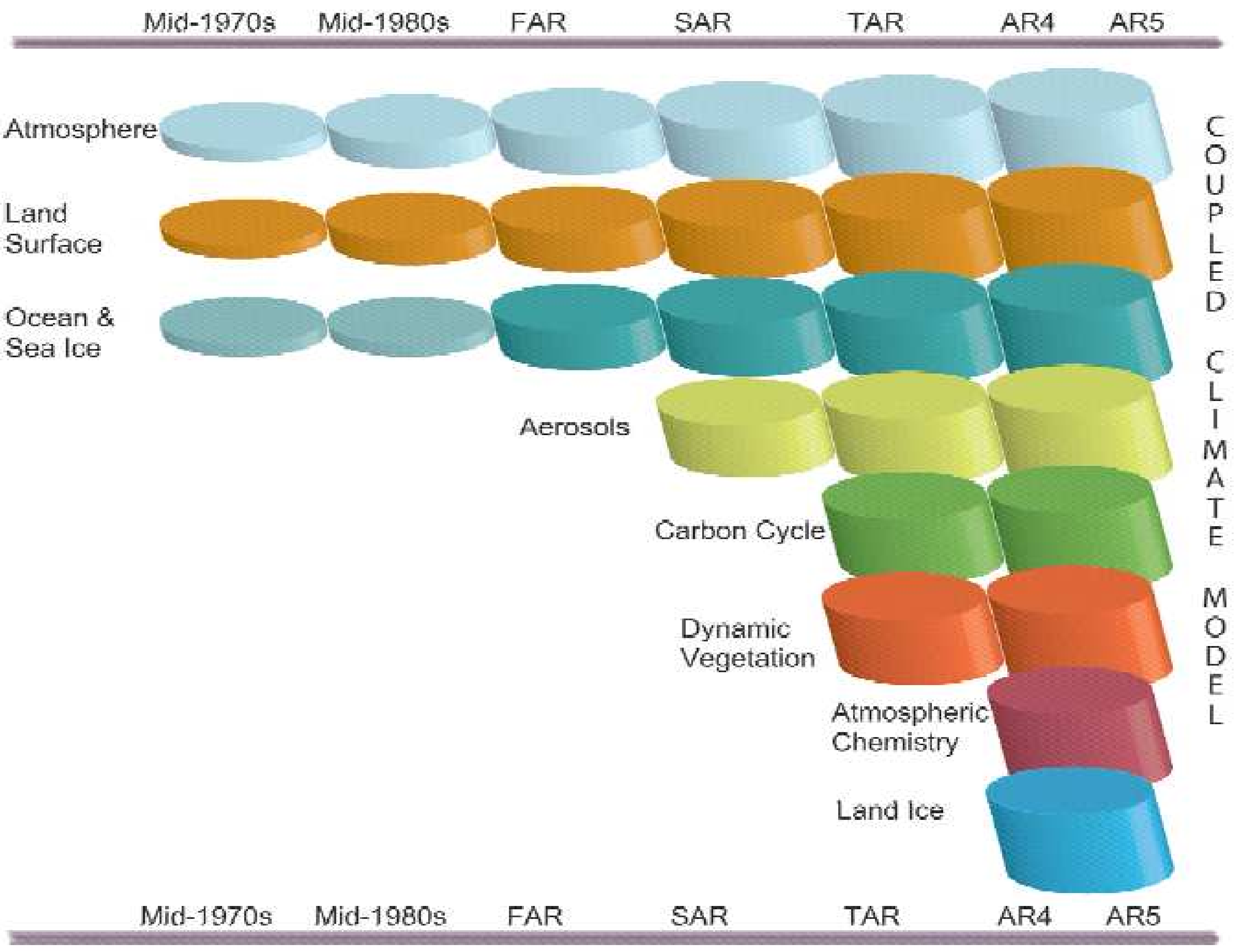


GEC poses threats, challenges, vulnerabilities and risks for international, national and human security and survival

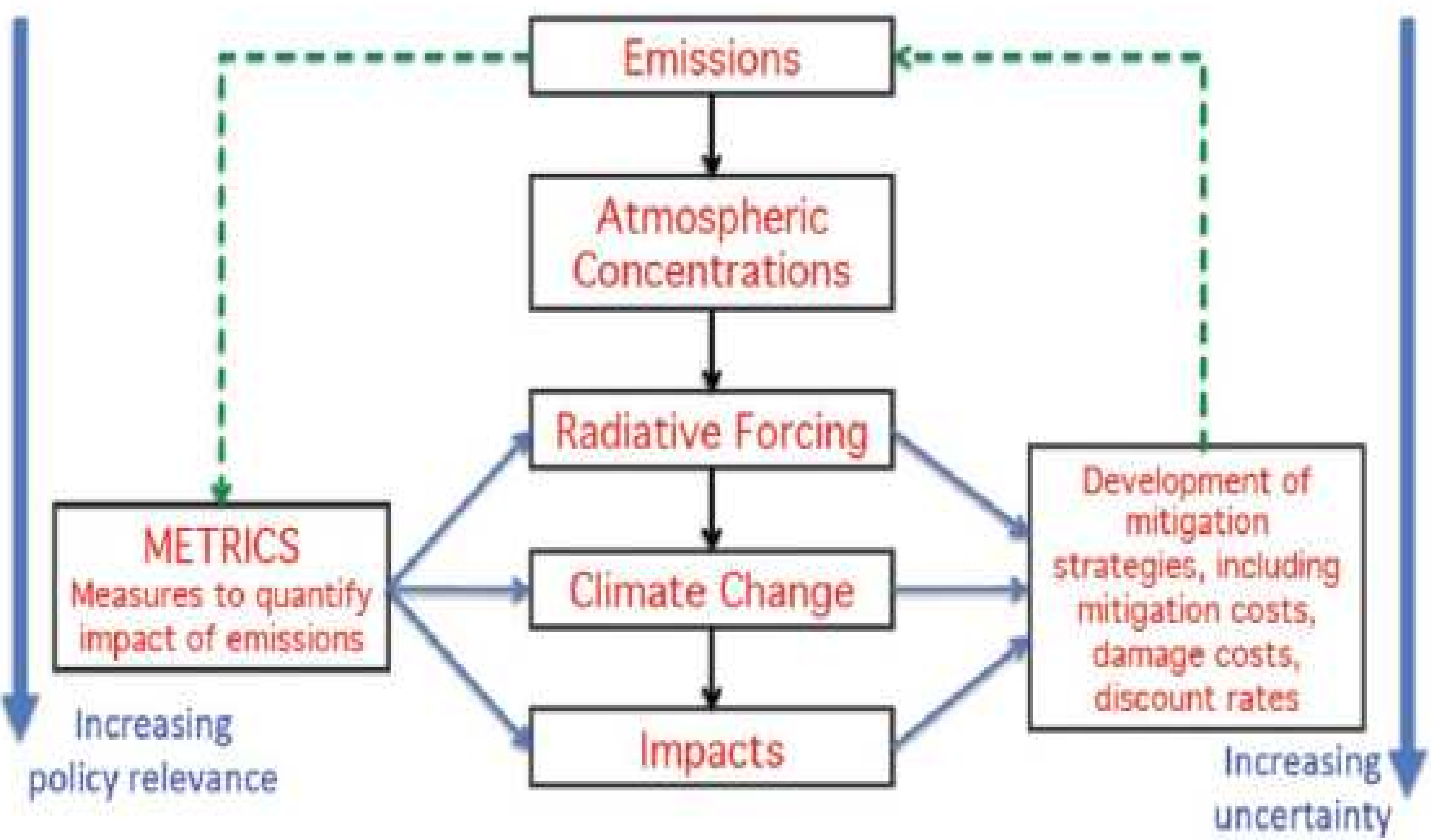
What is Global Environmental Change:GEC

- GEC is more than climate change
- Includes the natural **plus** the human components
- Represents a constellacion and interaction of multiple domains:

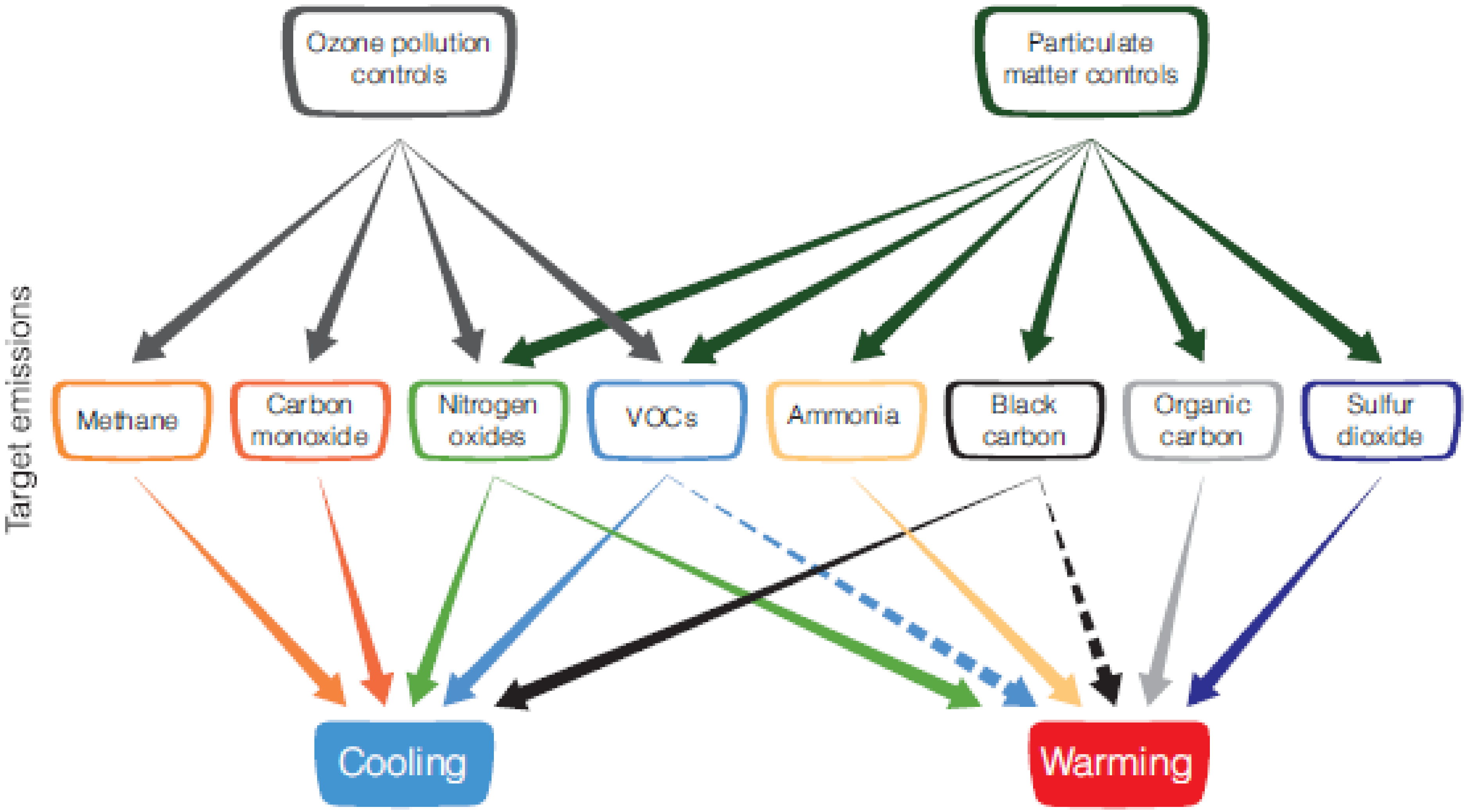



Mid-1970s
Mid-1980s
FAR
SAR
TAR
AR4
AR5
Atmosphere
Land Surface
Ocean & Sea Ice
Aerosols
Carbon Cycle
Dynamic Vegetation
Atmospheric Chemistry
Land Ice
COUPLED CLIMATE MODEL
Mid-1970s
Mid-1980s
FAR
SAR
TAR
AR4
AR5

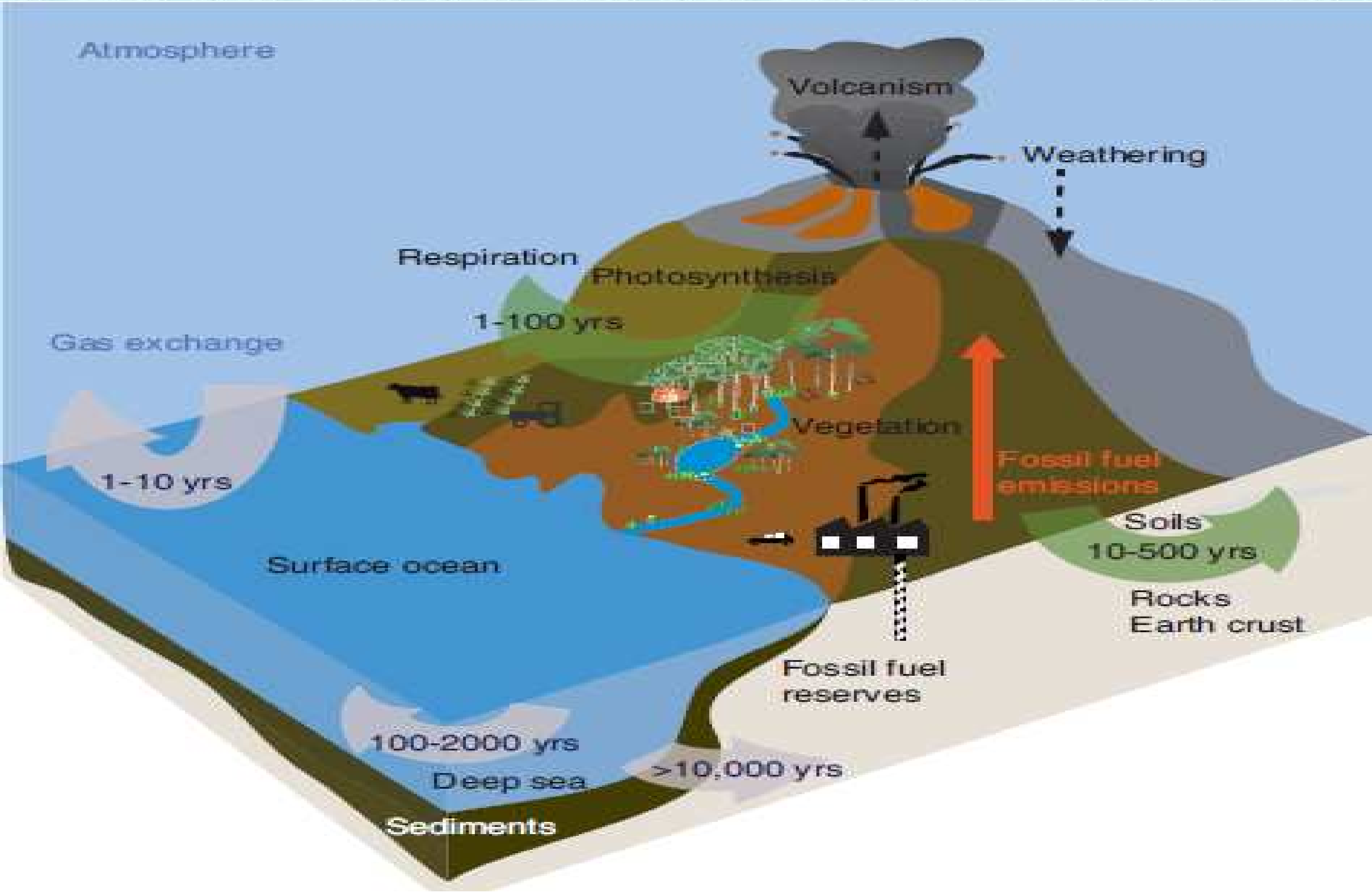
Cause-effect chain of GHE

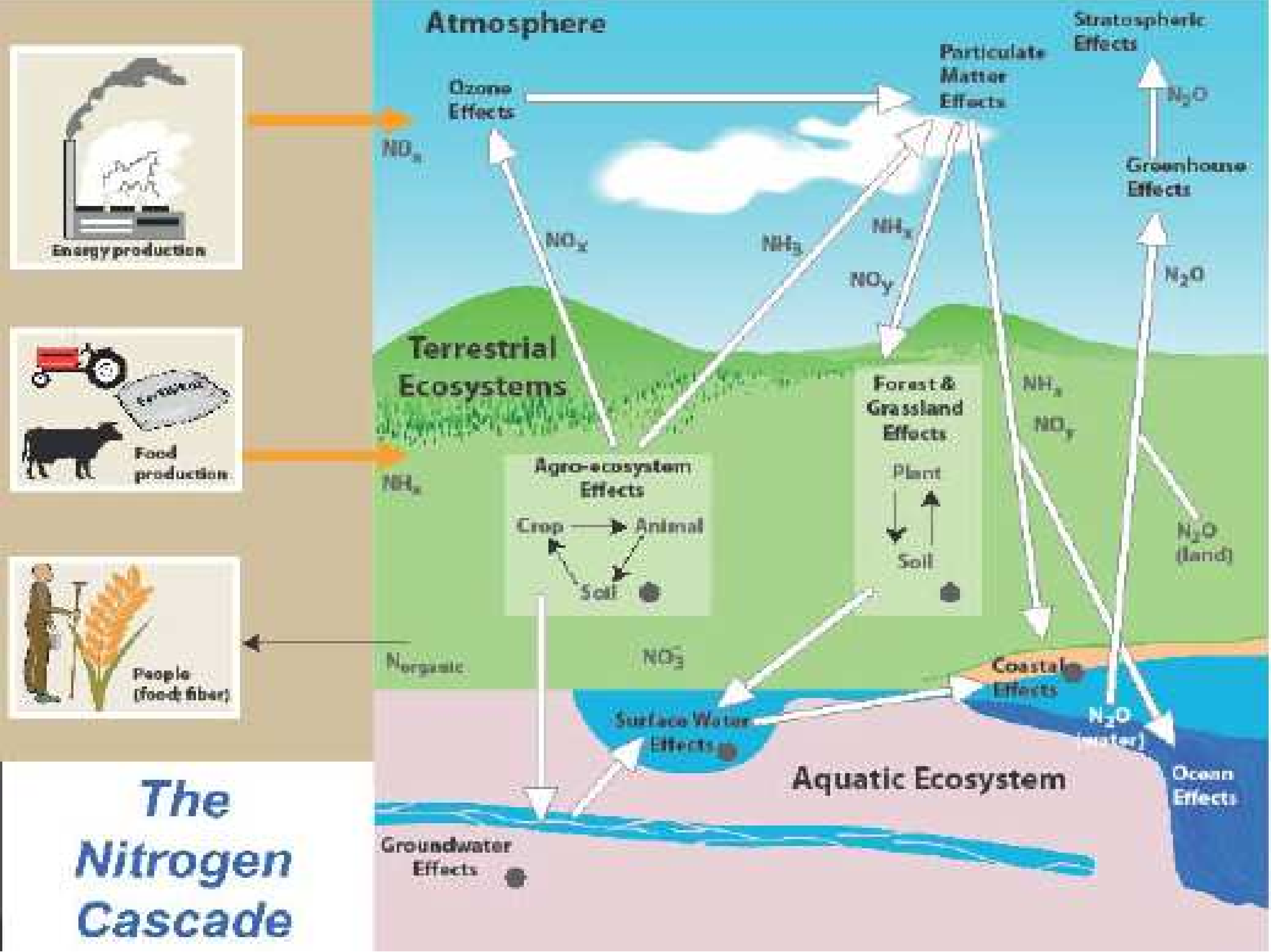


GHE: cooling and warming processes

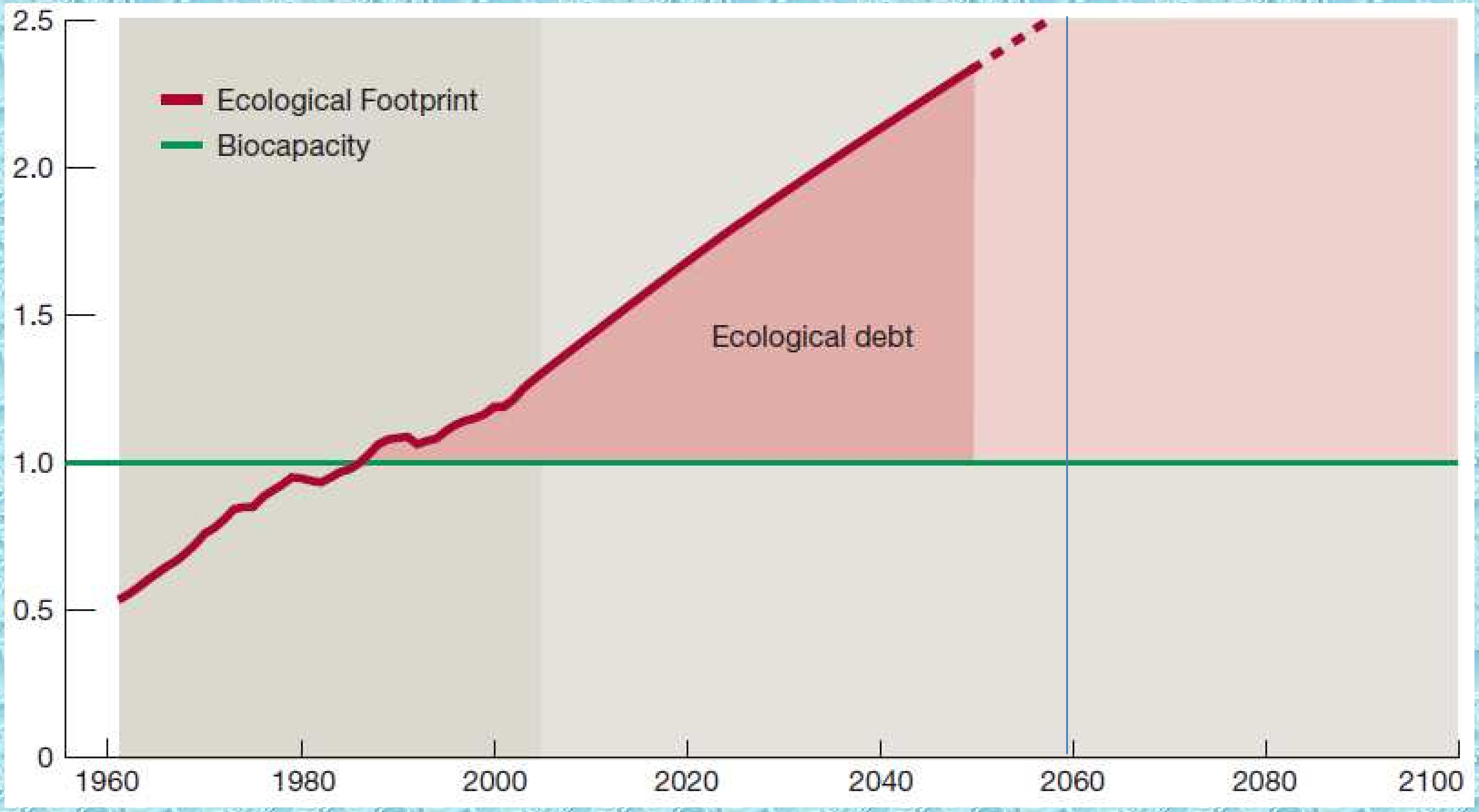


Global carbon cycle



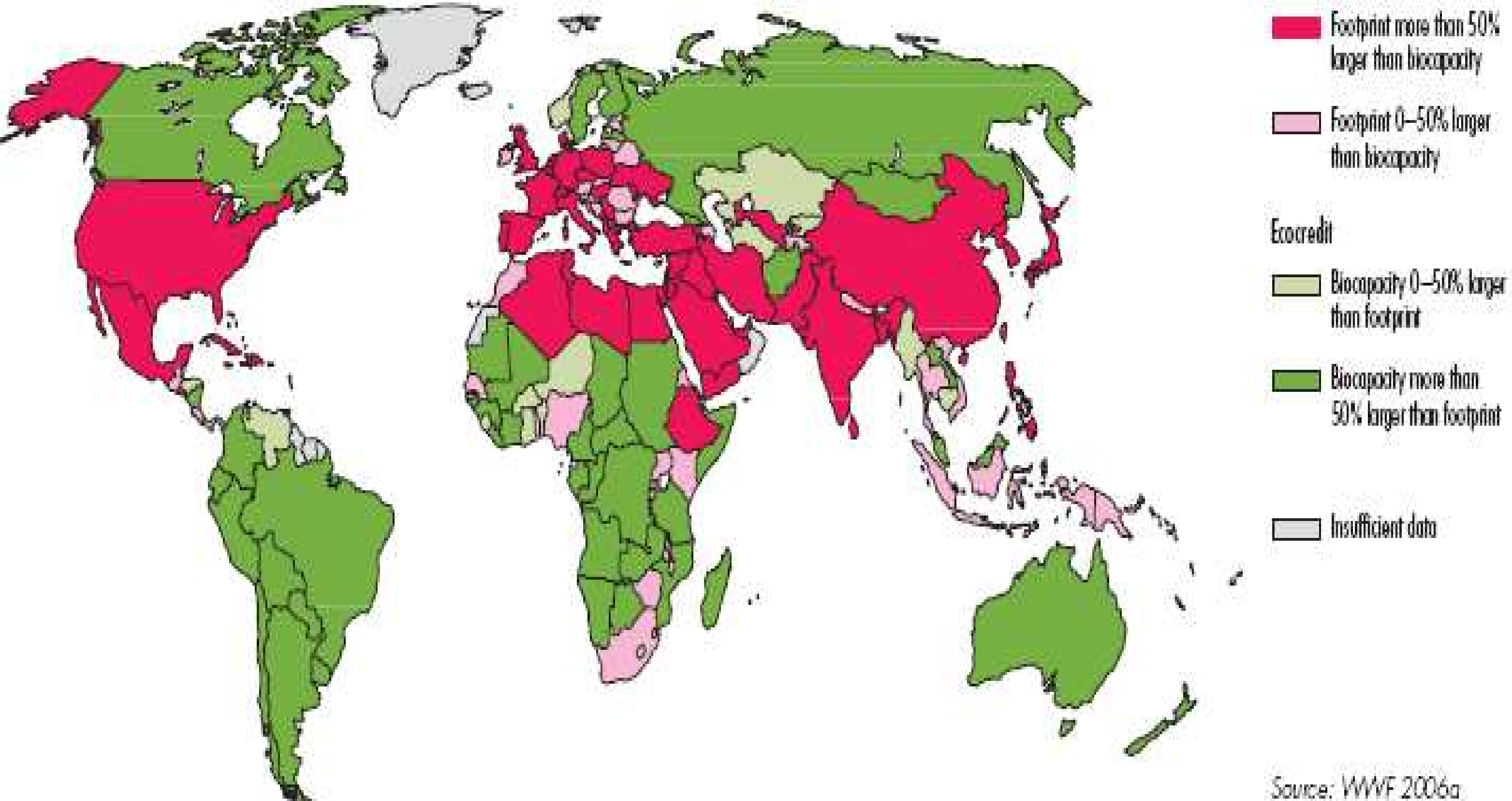

The Nitrogen Cascade
Energy production
Food production
Fertilizer
People (food; fiber)
Atmosphere
Ozone Effects
Particulate Matter Effects
Stratospheric Effects
Greenhouse Effects
NO_x
NH_x
$N_{organic}$
NH_3
NO_y
N_2O
N_2O (land)
N_2O (water)
NO_3^-
Terrestrial Ecosystems
Agro-ecosystem Effects
Crop
Animal
Soil
Forest & Grassland Effects
Plant
Soil
Coastal Effects
Surface Water Effects
Aquatic Ecosystem
Ocean Effects
Groundwater Effects

Biocapacity and Ecodebt



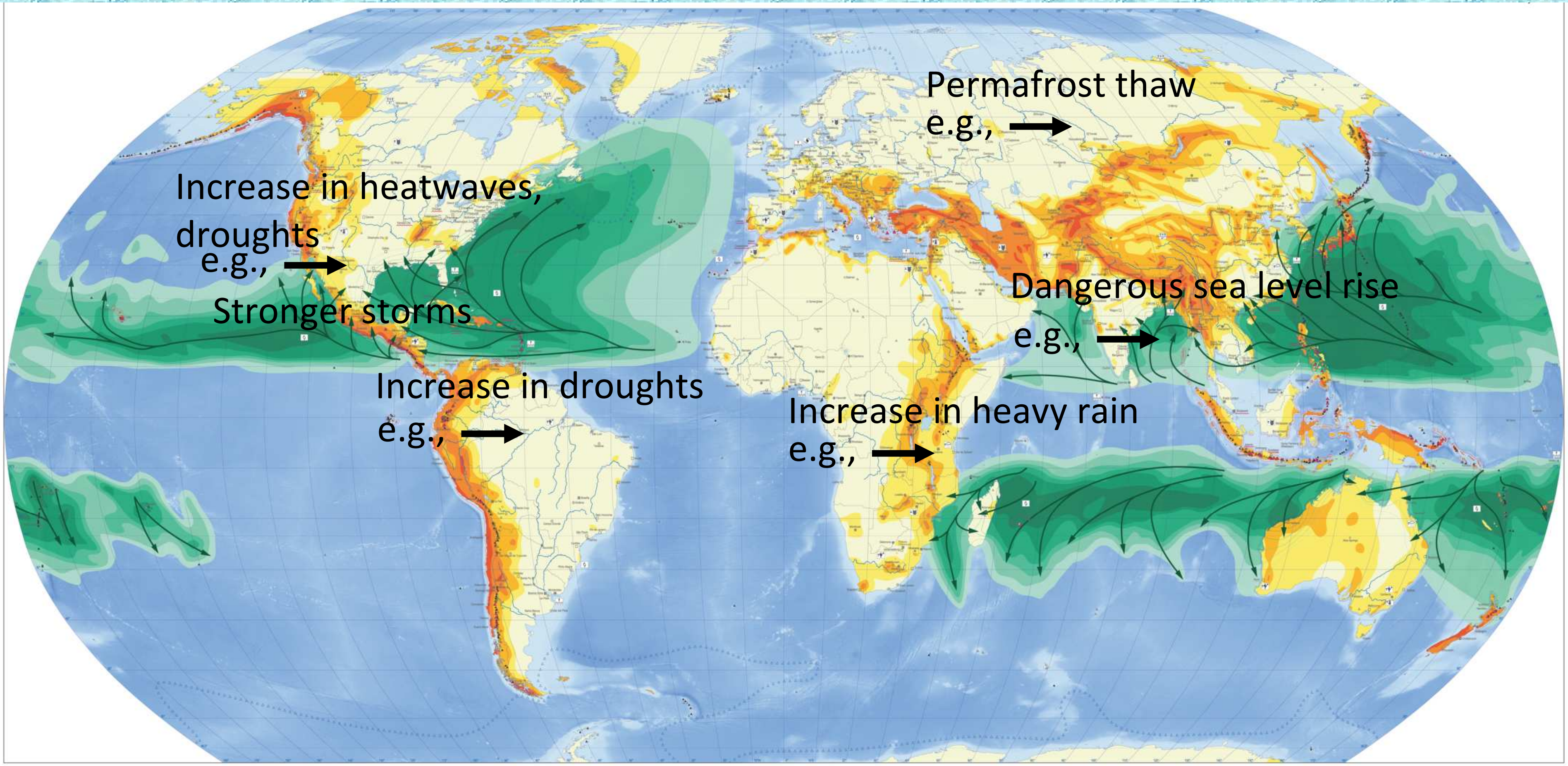
http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/

Bio-capacity and bio-debt



4. Dangers for Humankind: Potential Tipping points

Climate Threats, Disasters & Impacts



Earthquakes

- Zone 0: MM V
- Zone 1: MM VI
- Zone 2: MM VII
- Zone 3: MM VIII
- Zone 4: MM IX

MM: modified Mercalli scale

Tropical Hurricanes

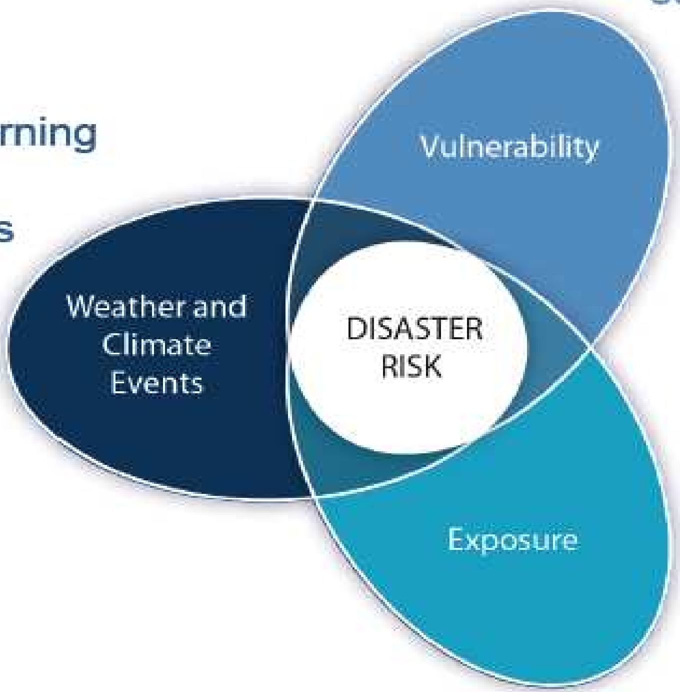
- Zone 0: 76–141 km/h
- Zone 1: 142–184 km/h
- Zone 2: 185–212 km/h
- Zone 3: 213–251 km/h
- Zone 4: 252–299 km/h
- Zone 5: ≥ 300 km/h

Münchener Rück
Munich Re Group

Environmental & social vulnerability, exposure and disaster risks reduction managemnt (DRRM)

- poverty reduction
- better education and awareness
- sustainable development

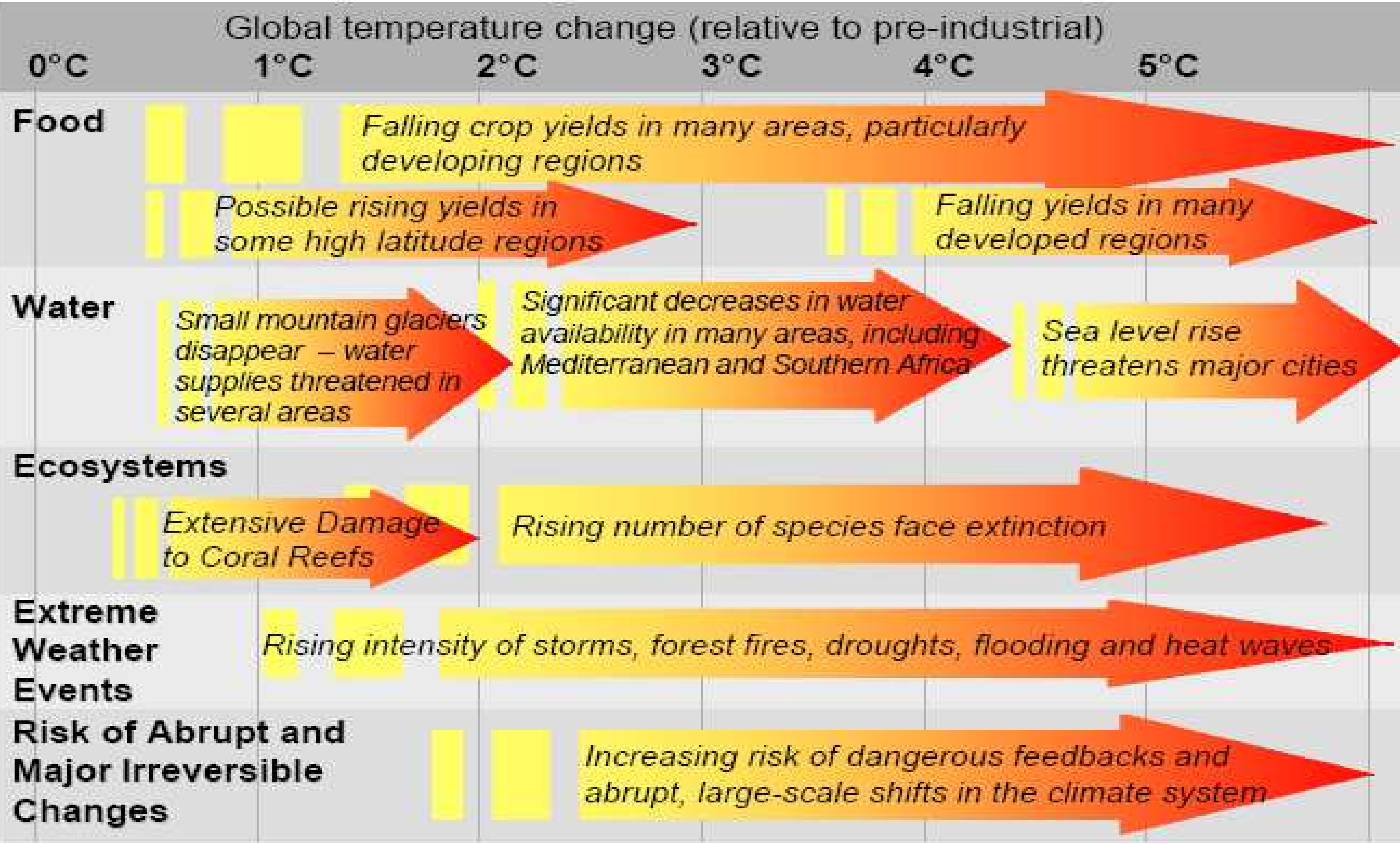
- improved forecasting for warning systems
- reduction of greenhouse gas emissions

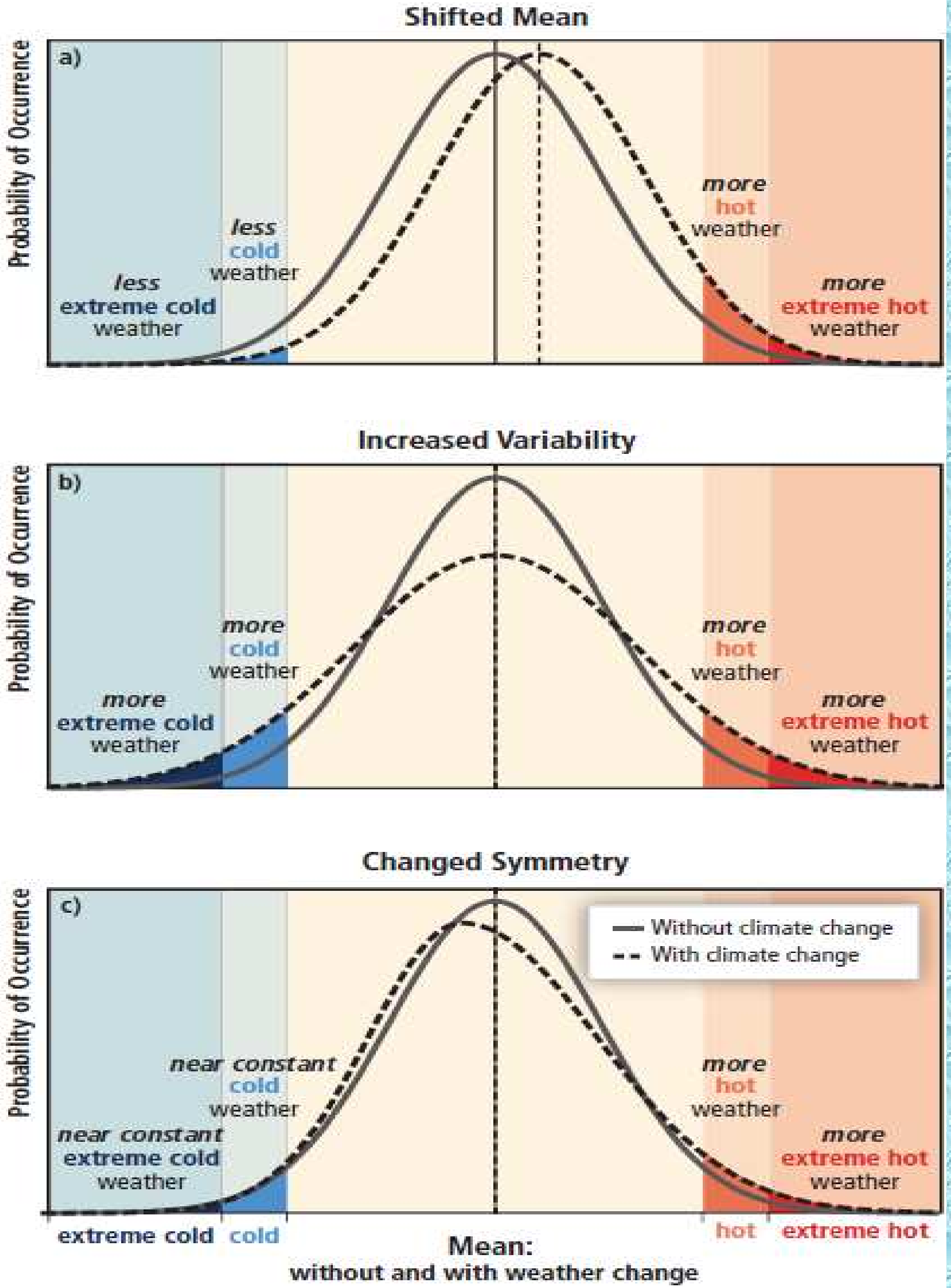


- asset relocation
- weather-proofing assets
- early warning systems

Climate change is effecting our environment, our societies and our cultures

Projected Impacts of Climate Change





Toward which future are we going?

IPCC-SREX, 2012

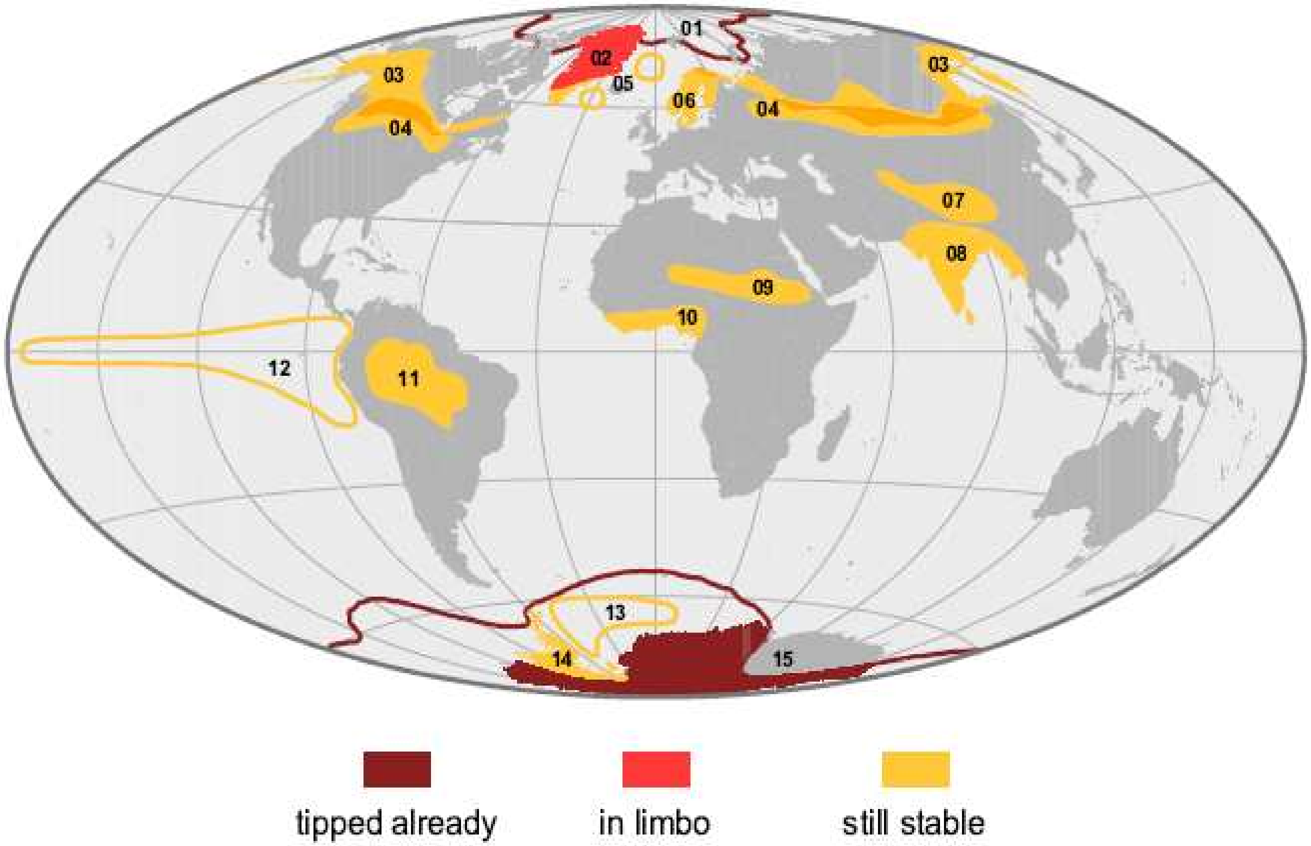
Dangers for Humankind: Potential Tipping points

Chaotic processes: nonlinear & abrupt climate change

- collapse of Atlantic thermohaline circulation (Gulf)
- dieback of Amazon rain forest
- change in ENSO cycle
- alteration of the Indian monsoon
- decay of the Greenland ice sheet
- climate induce ozone hole
- greening of Sahara desert
- boreal forest dieback
- Atlantic deep water formation

Potential anthropogenic tipping points in earth system

Source: H.J. Schellnhuber (2008)



01 Arctic Sea Ice Loss
02 Greenland Ice Sheet
03 Thawing Permafrost / Methan Escape
04 Boreal Forest Dieback
05 Suppression of Atlantic Deep Water Formation
06 Climatic Change-Induced Ozon Hole over Northern Europe
07 Albedo Tibetan Plateau
08 Indian Monsoon
09 Re-Greening Sahara / Sealing of Dust Sources
10 West African Monsoon
11 Dieback of Amazon Rainforest
12 Southern Pacific Climate Oscillation
13 Antarctic Deep Water Formation / Nutrients Upwelling
14 Westantarctic Ice Sheet
15 Antarctic Ozone Hole

Thank you very much for your attention

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