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21st Global Conference of Actuaries

17th - 19th February 2020 | Mumbai, India

# THE SCIENCE OF CLIMATE CHANGE


## Prof. G Bala, CAOS
## Indian Institute of Science


18 February 2020

# Take Home Messages

**Climate Change is already underway (1ºC)**

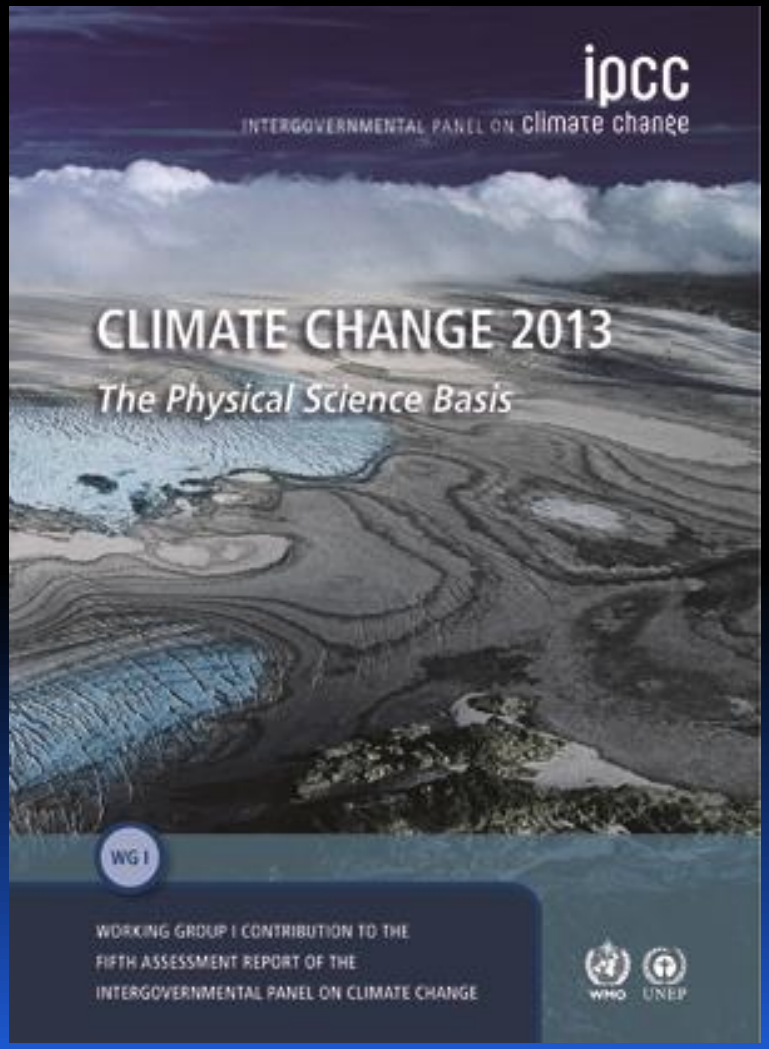
**Strong link between Climate Change, $CO_2$ and our energy usage (our life style)**

**Climate change impacts could be severe and long lasting**

**Climate change adaptation and mitigation could bring new opportunities**

# Current Climate Change

# Climate change: IPCC 2013 report




**Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.**

# 1.5 deg Special report (2018)

ipcc

INTERGOVERNMENTAL PANEL ON climate change

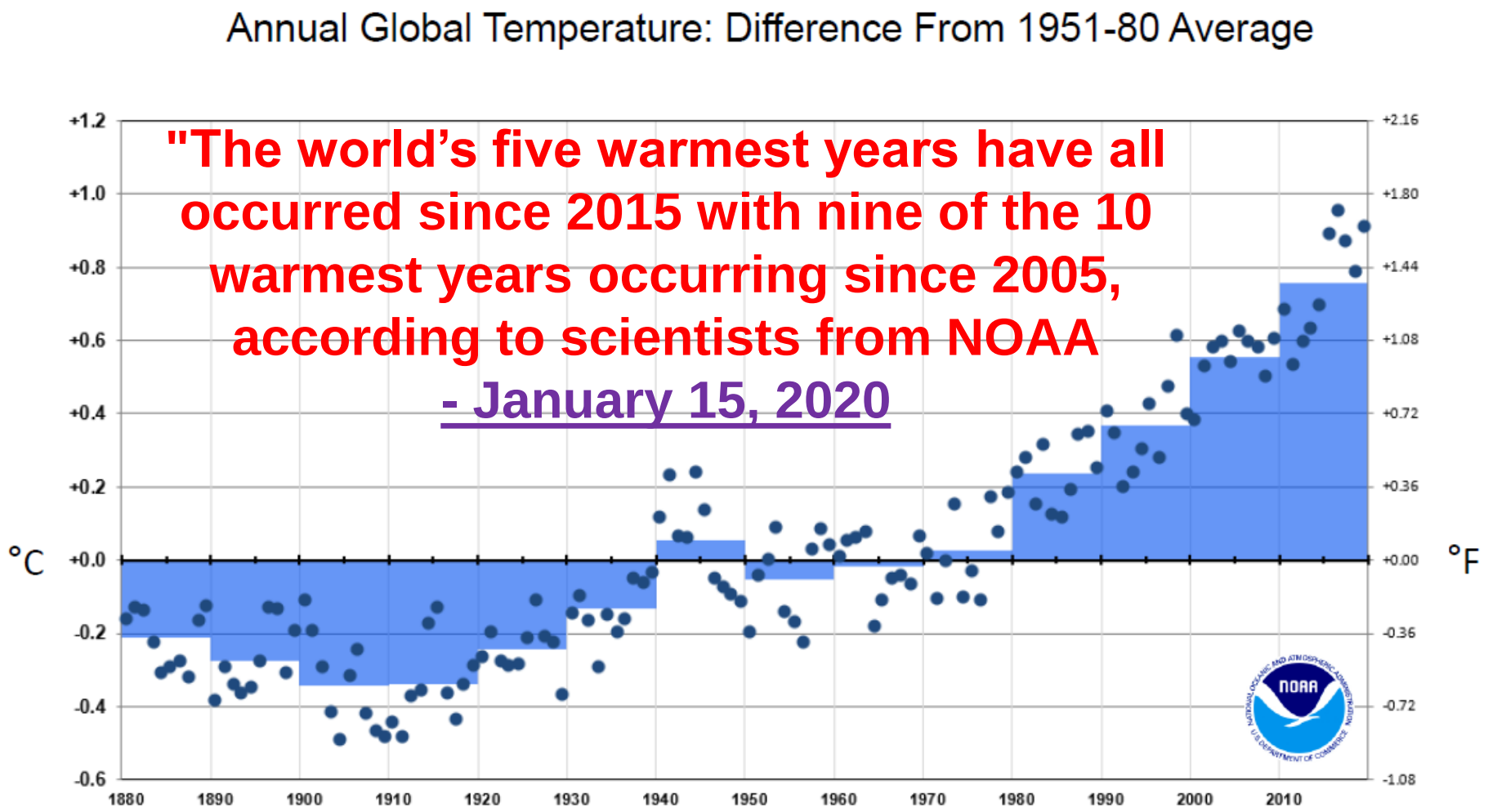
# Global Warming of 1.5°C

An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty

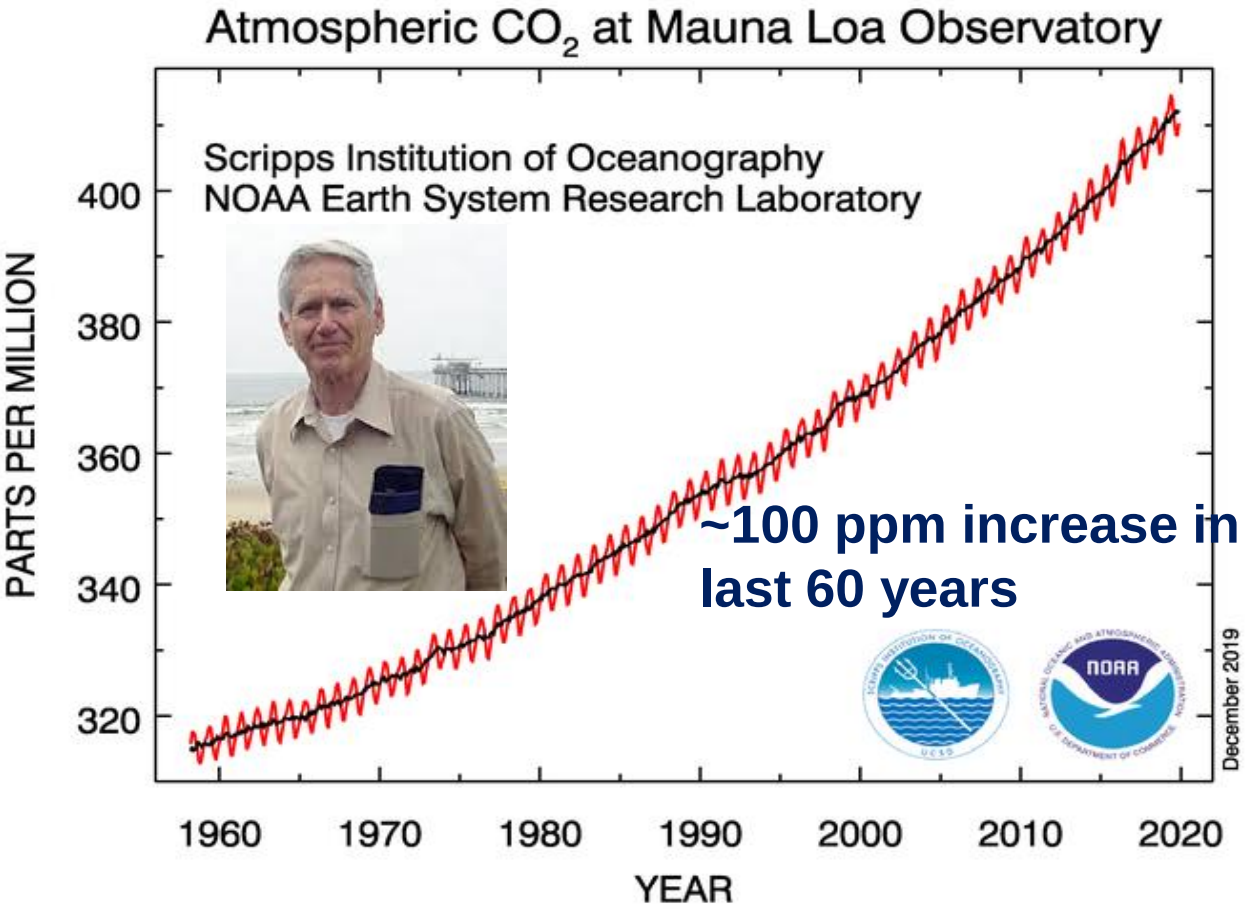
Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. (*high confidence*)

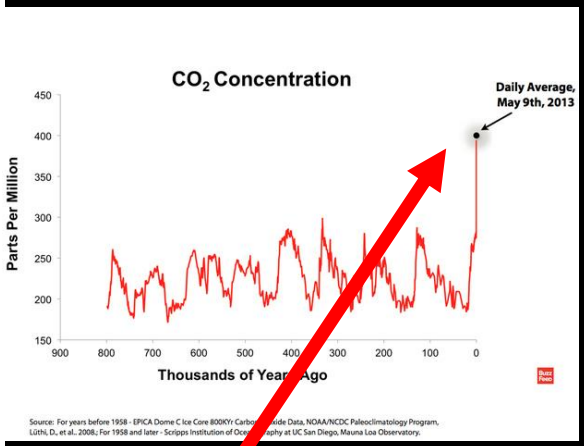
Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system, such as sea level rise, with associated impacts (*high confidence*), but these emissions alone are unlikely to cause global warming of 1.5°C (*medium confidence*).

# 2019 is the 2nd warmest on record



# Atmospheric $CO_2$ is now well above 400 ppm : 120 ppm above the pre-industrial level

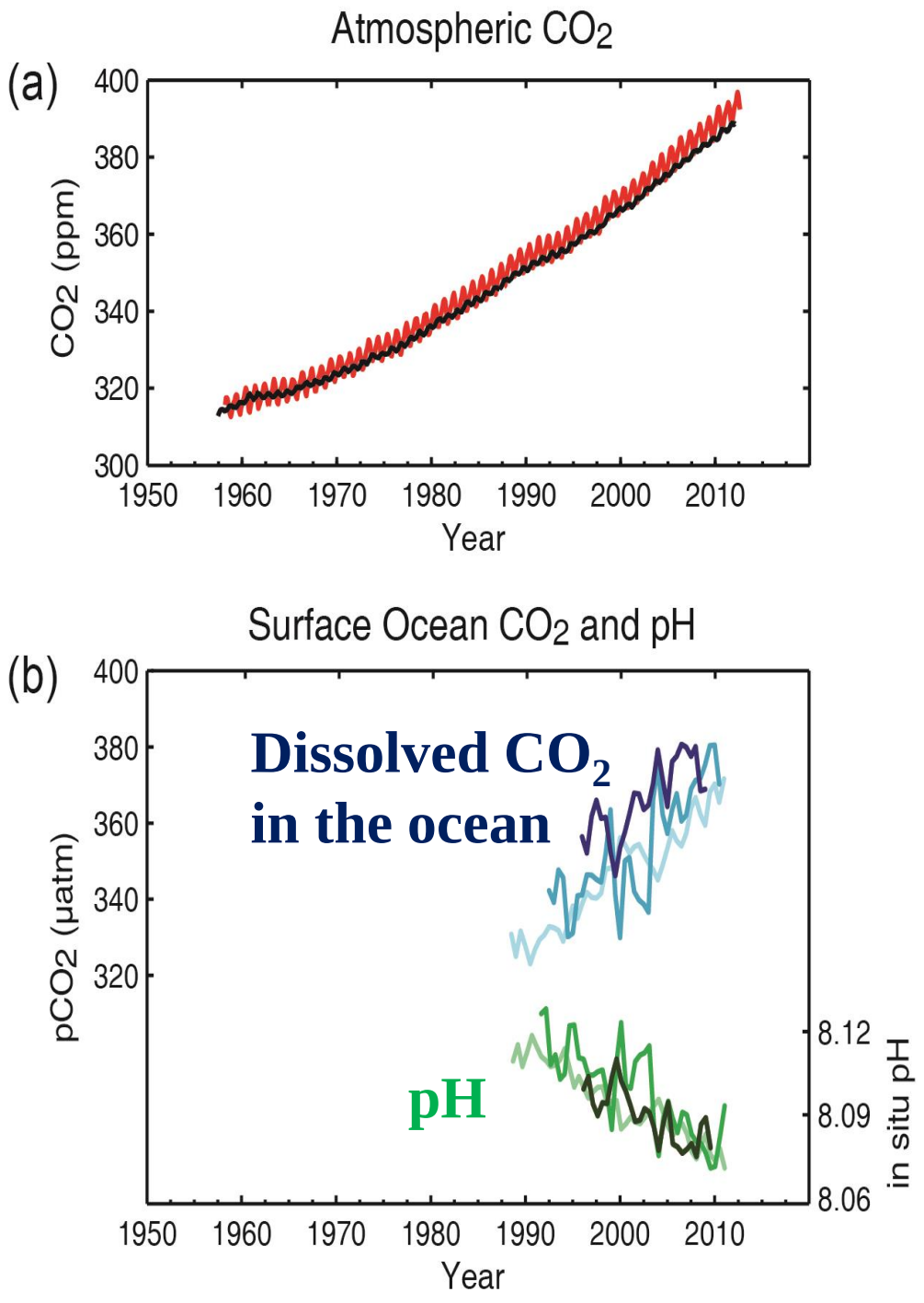


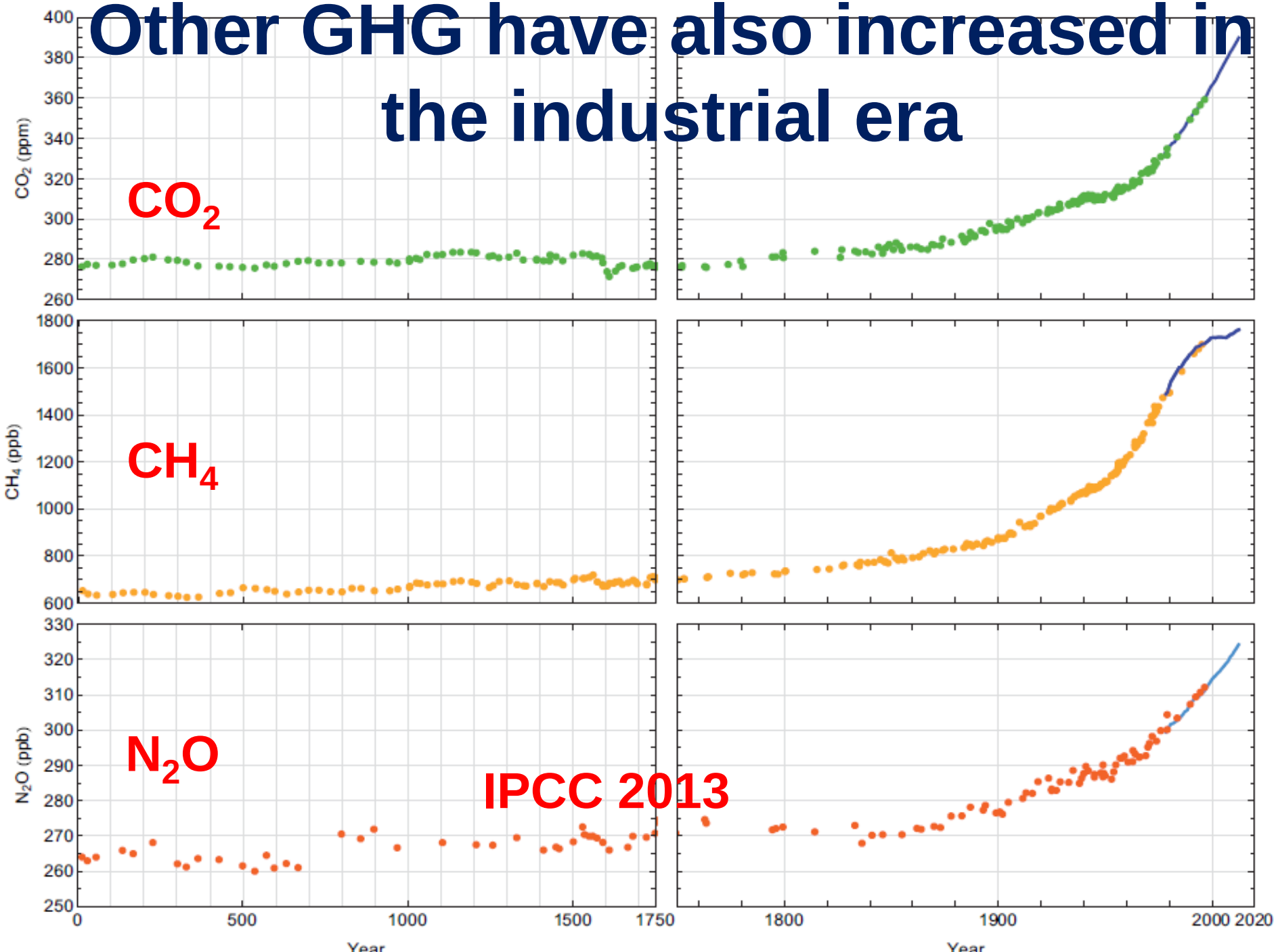

**Unprecedented in the last 1 million years and possibly in the last 20 M years.**

# The atmospheric $CO_2$ has increased and the ocean is acidifying

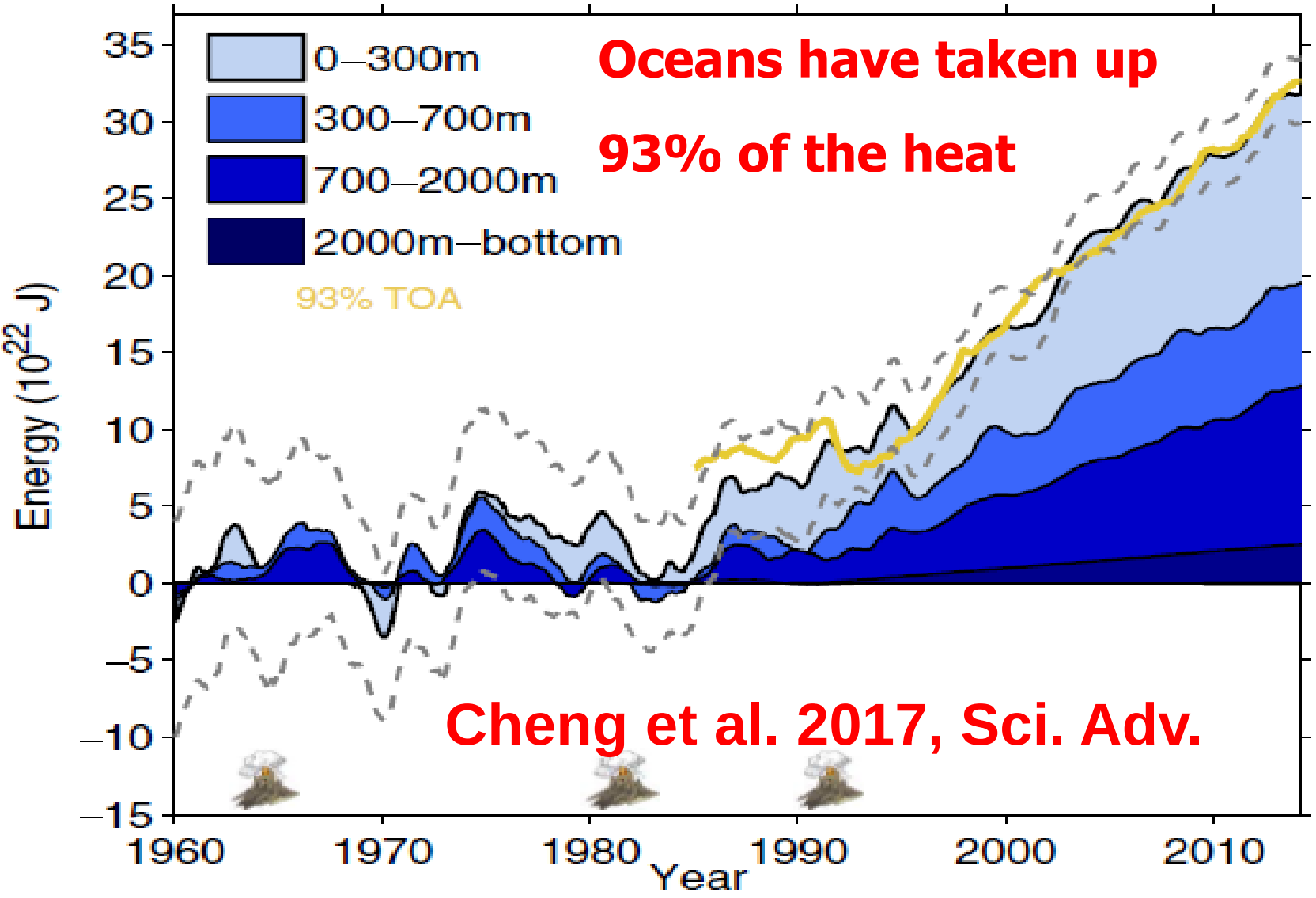
IPCC, 2013



# Other GHG have also increased in the industrial era

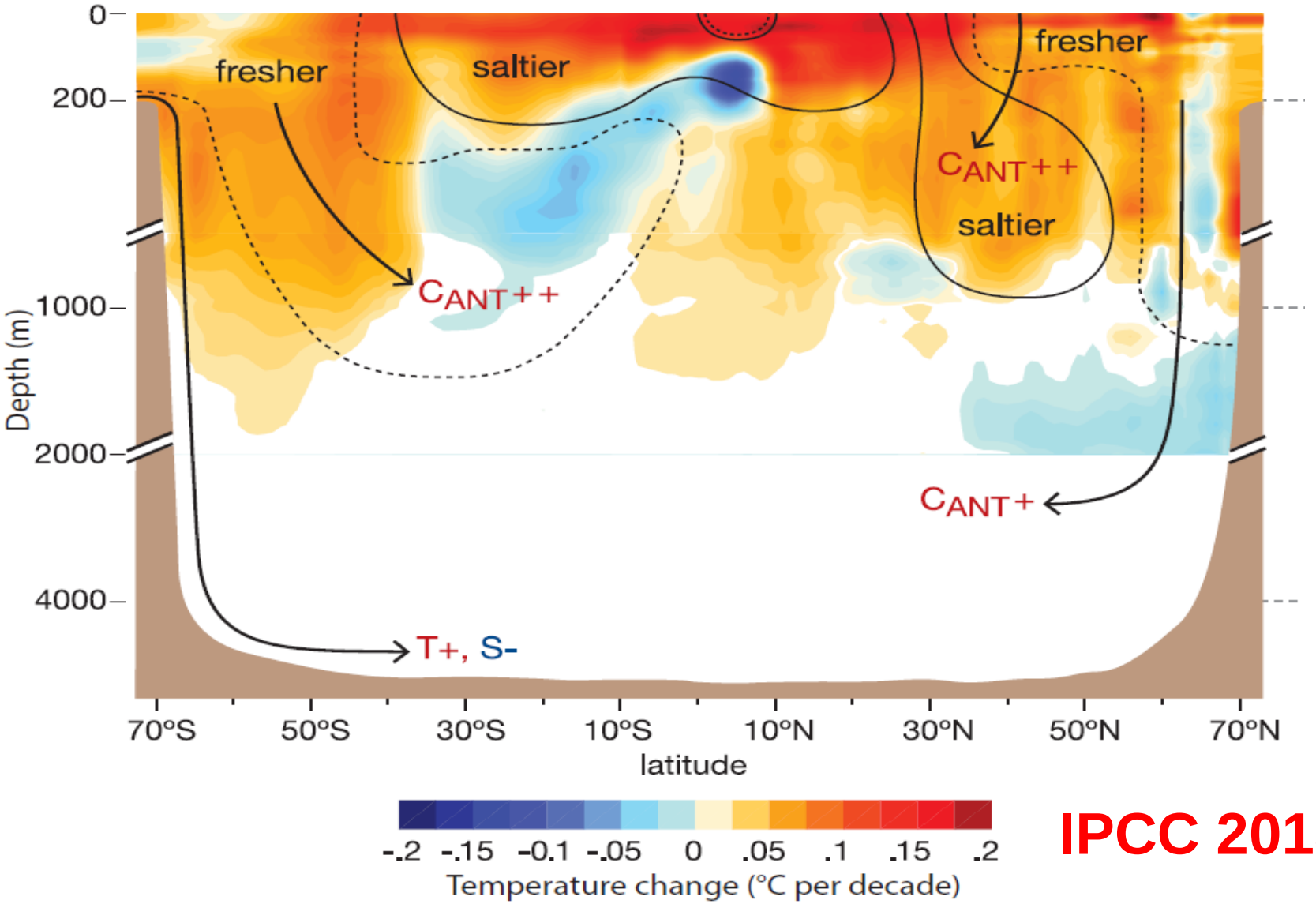


# Oceans have soaked up 100s of zeta ($10^{21}$) joules of heat in recent decades



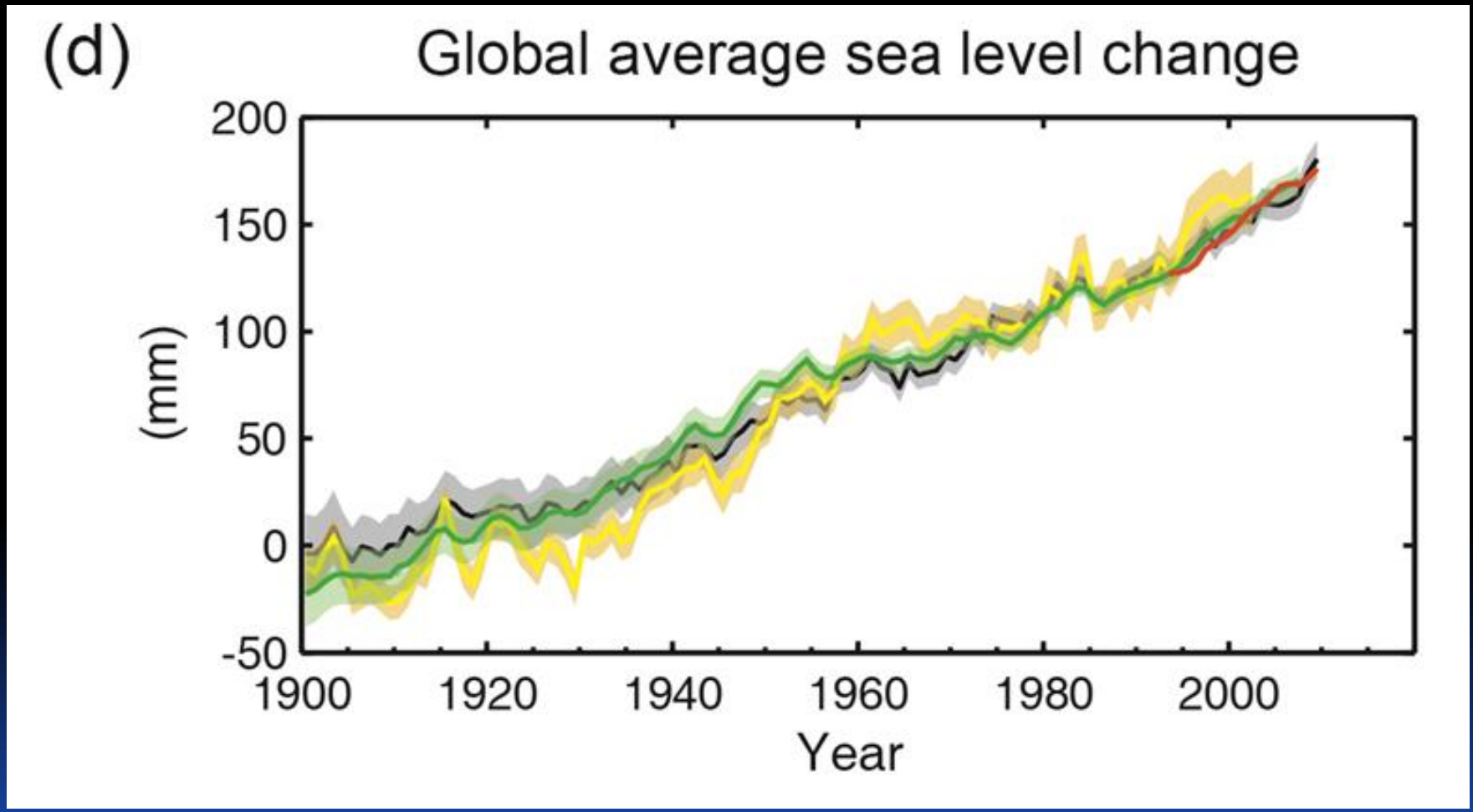
# Heat has penetrated to only a km deep

## Oceans could take a lot more in the future



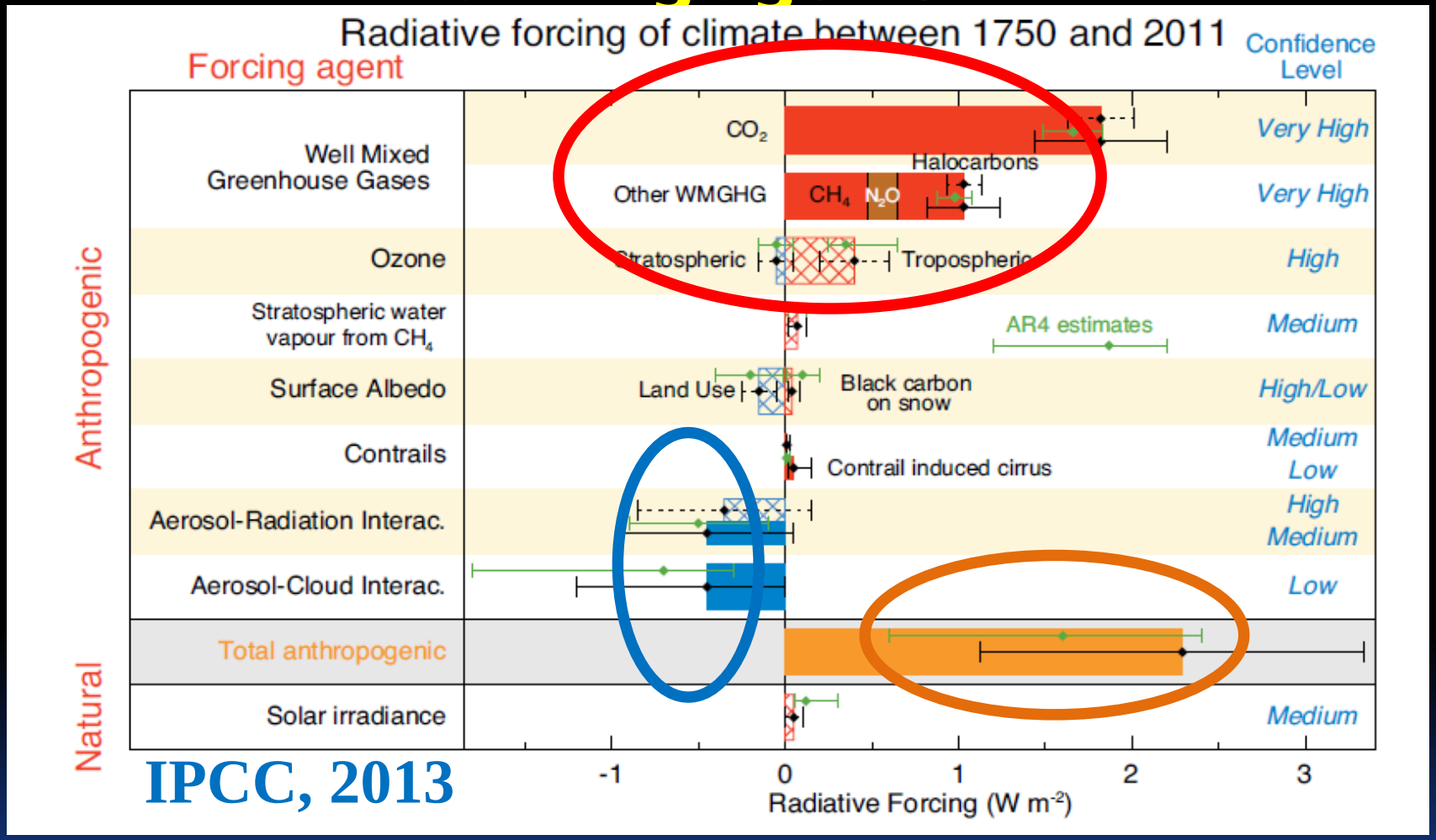

IPCC 2013

# Sea level has increased by 20 cm since 1900




IPCC, 2013

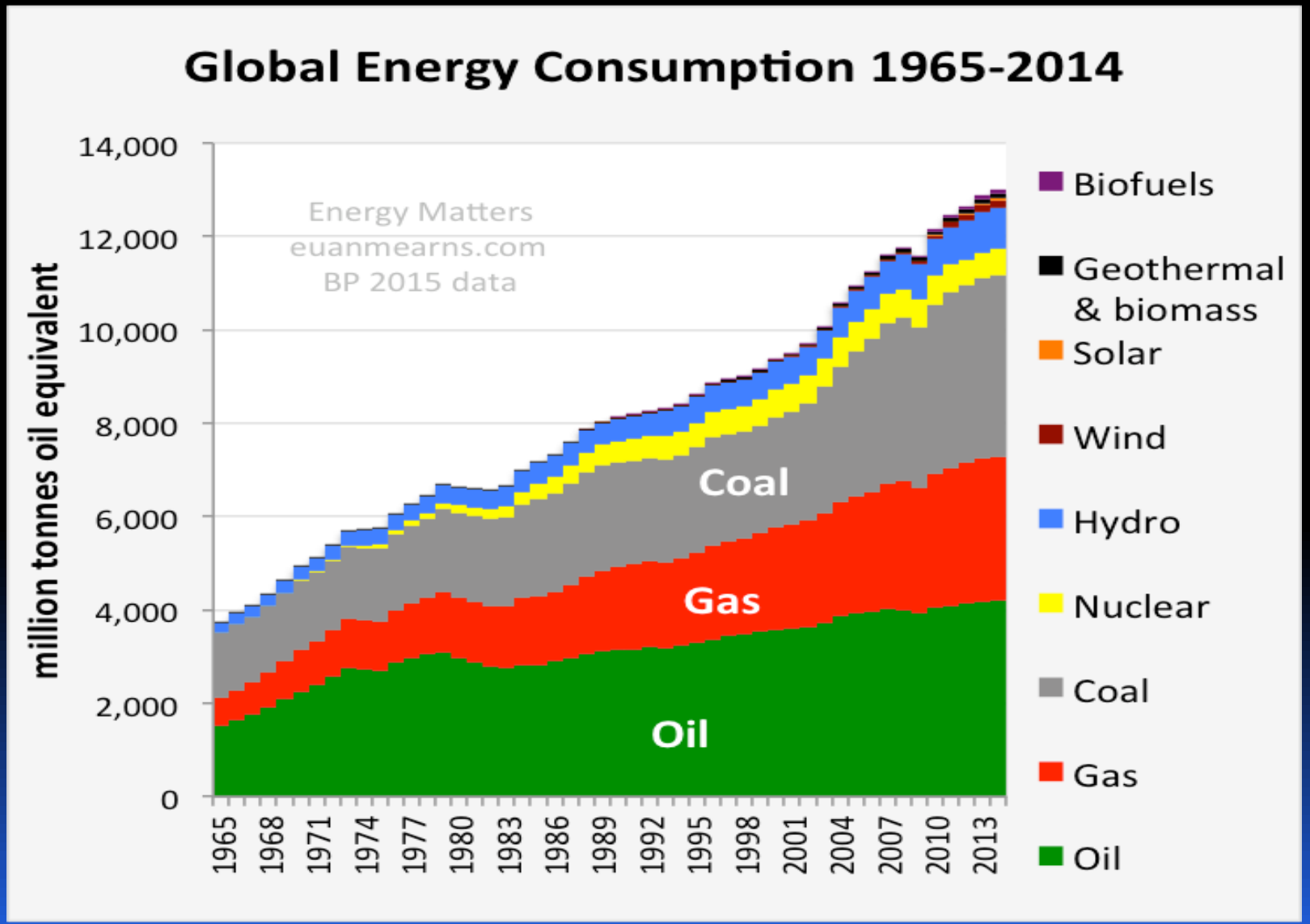
# Greenhouse gases are the dominant warming agents




**The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of $CO_2$ since 1750 (see Figure SPM.5)**

# $CO_2$ emissions are the main drivers of Current Climate Change

# Global Energy consumption tripled in 50 years

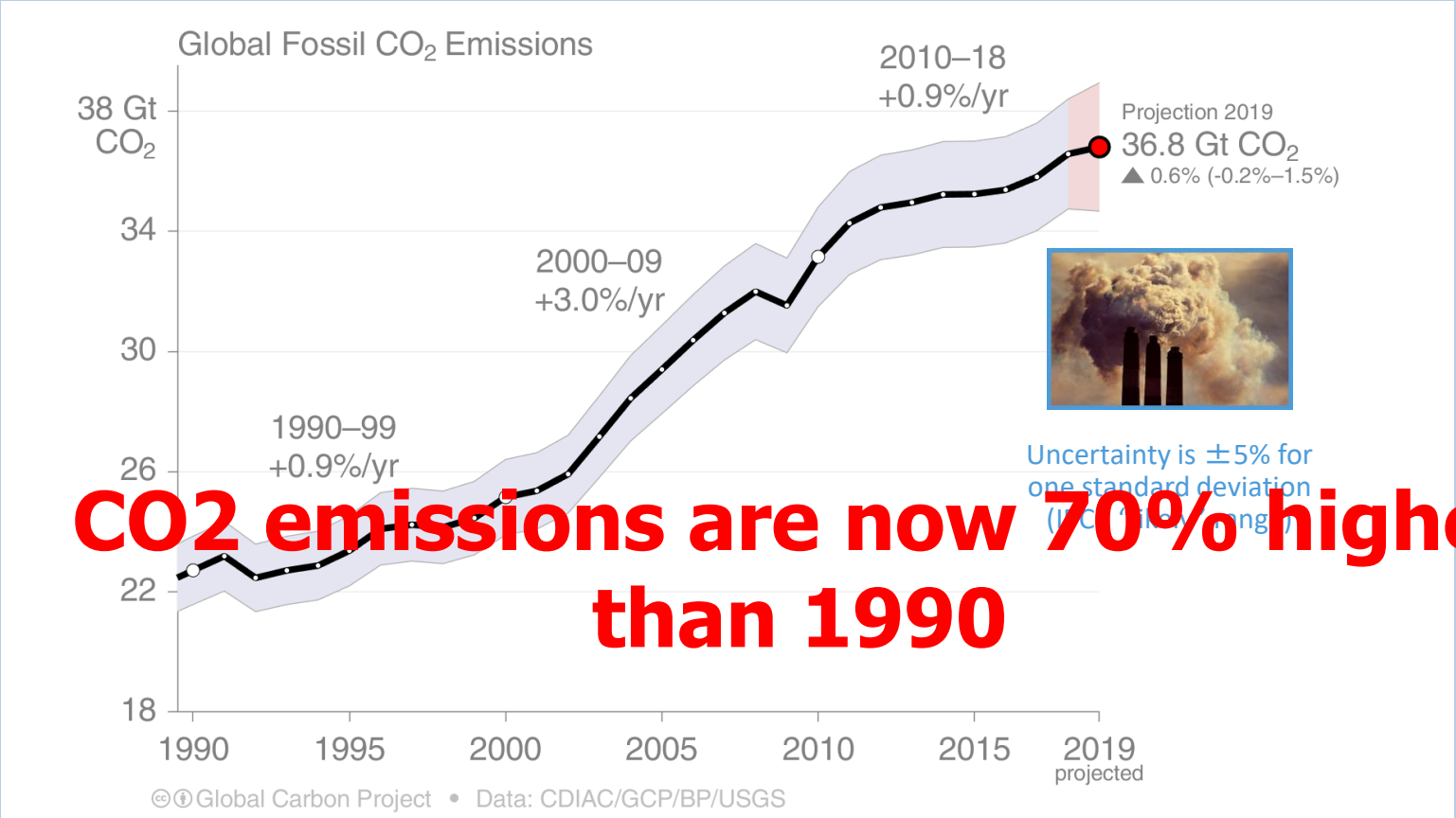


# Global Fossil $CO_2$ Emissions

**Global fossil $CO_2$ emissions: 36.6 ± 2 $GtCO_2$ in 2018, 61% over 1990**

**Projection for 2019: 36.8 ± 2 $GtCO_2$, 0.6% higher than 2018 (range -0.2% to 1.5%)**

**Fossil $CO_2$ emissions will likely be more than 4% higher in 2019 than the year of the Paris Agreement in 2015**



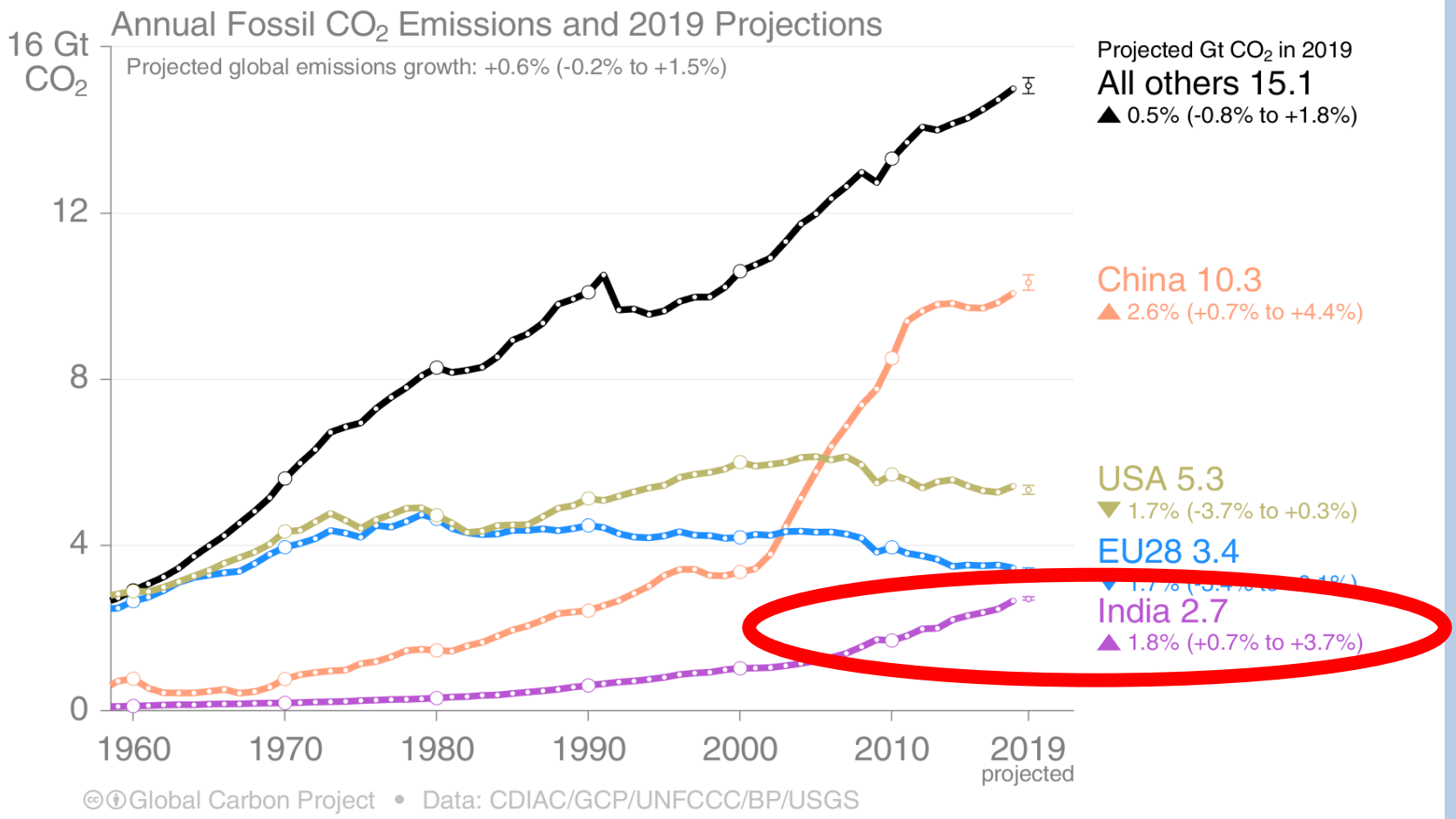

**CO2 emissions are now 70% higher than 1990**

**The 2019 projection is based on preliminary data and modelling.**

**Source: CDIAC; Friedlingstein et al 2019; Global Carbon Budget 2019**

# Emissions Projections for 2019

**Global fossil $CO_2$ emissions are projected to rise by 0.6% in 2019**
**The global growth is driven by the underlying changes at the country level.**



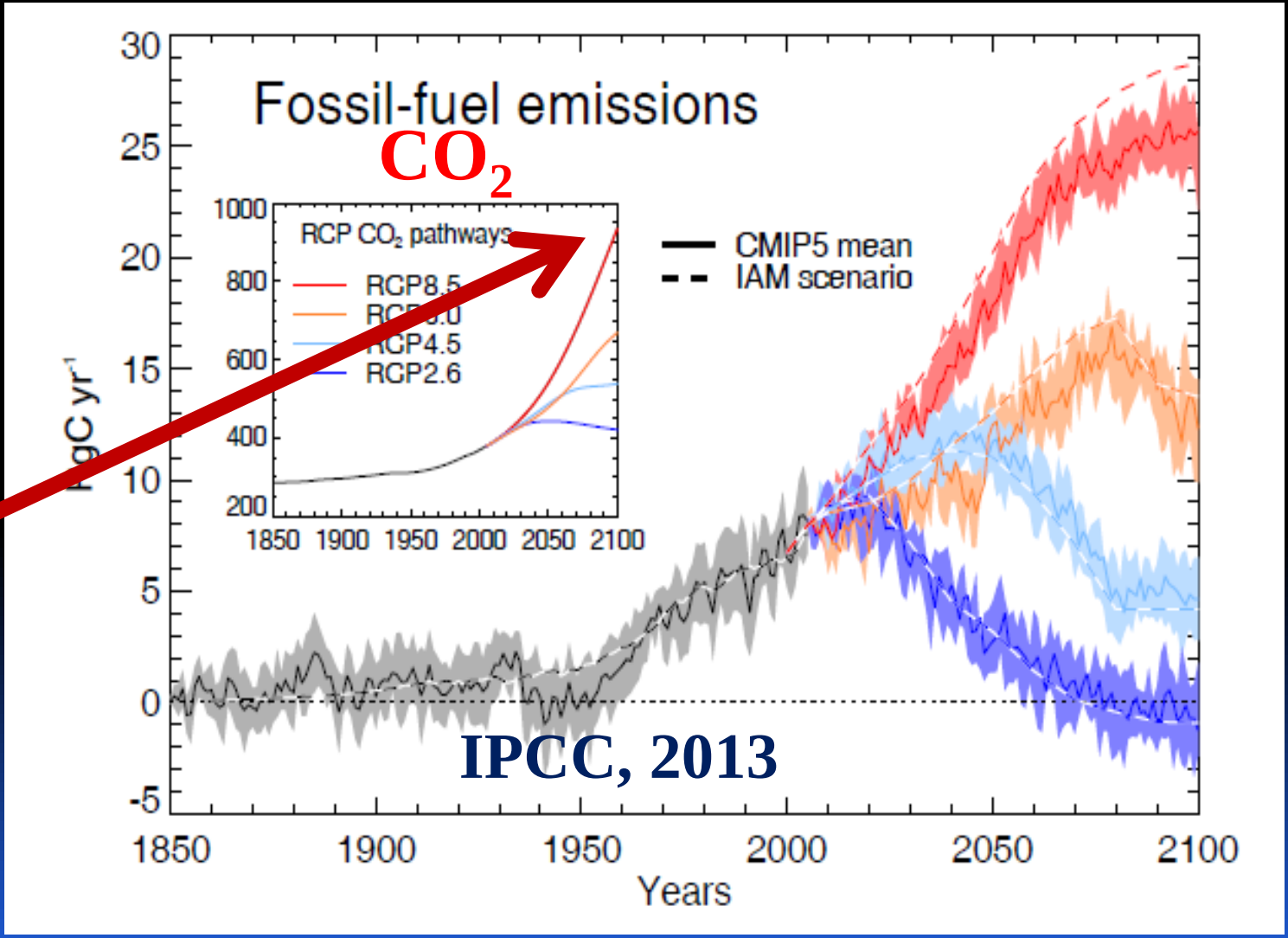

Source: CDIAC; Peters et al 2019; Friedlingstein et al 2019; Global Carbon Budget 2019

**As a country, India is number 3 now in $CO_2$ emissions after China and USA today**

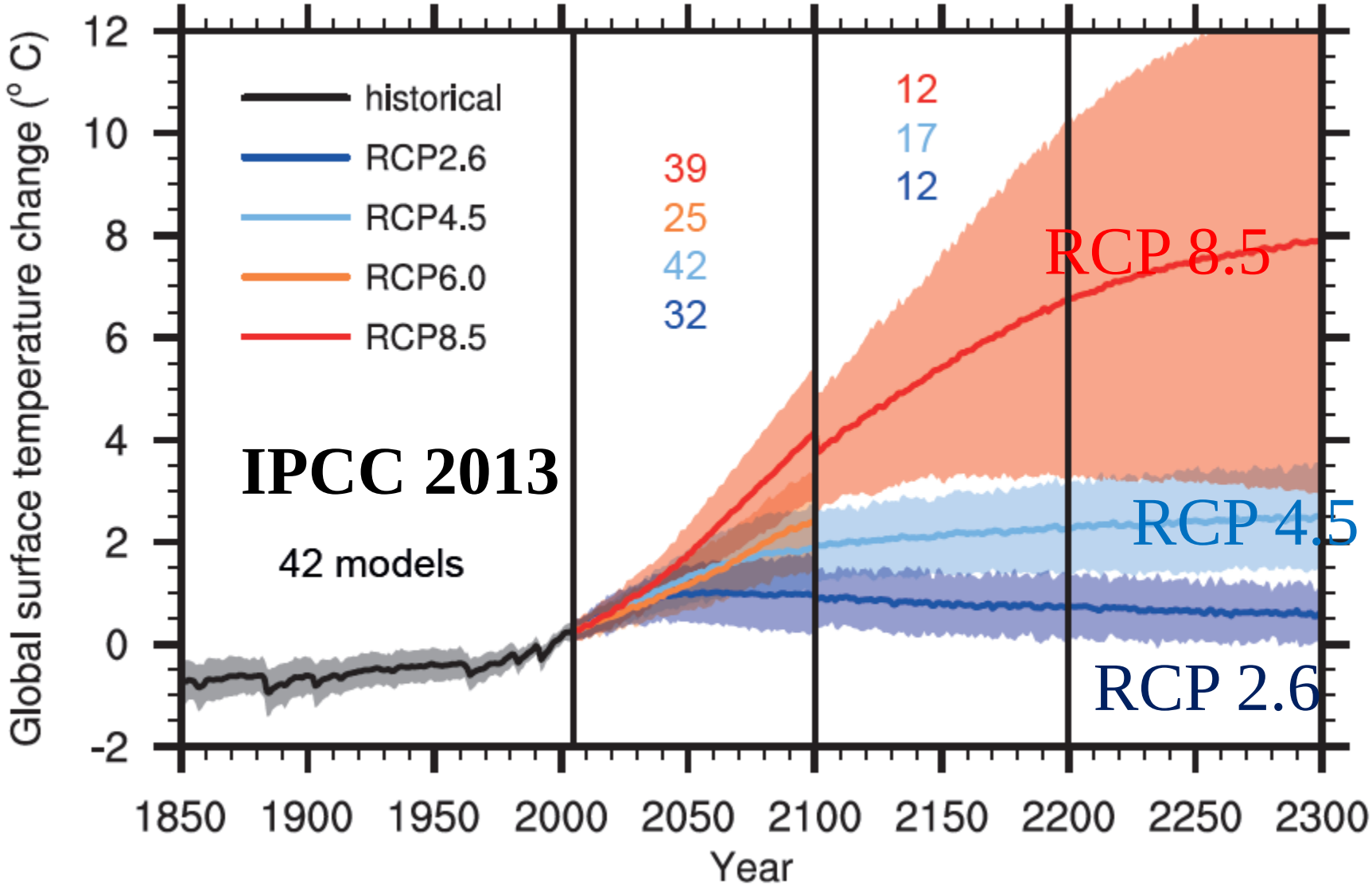
# Future Climate Change

# $CO_2$ emissions by 2100 could more than double from today

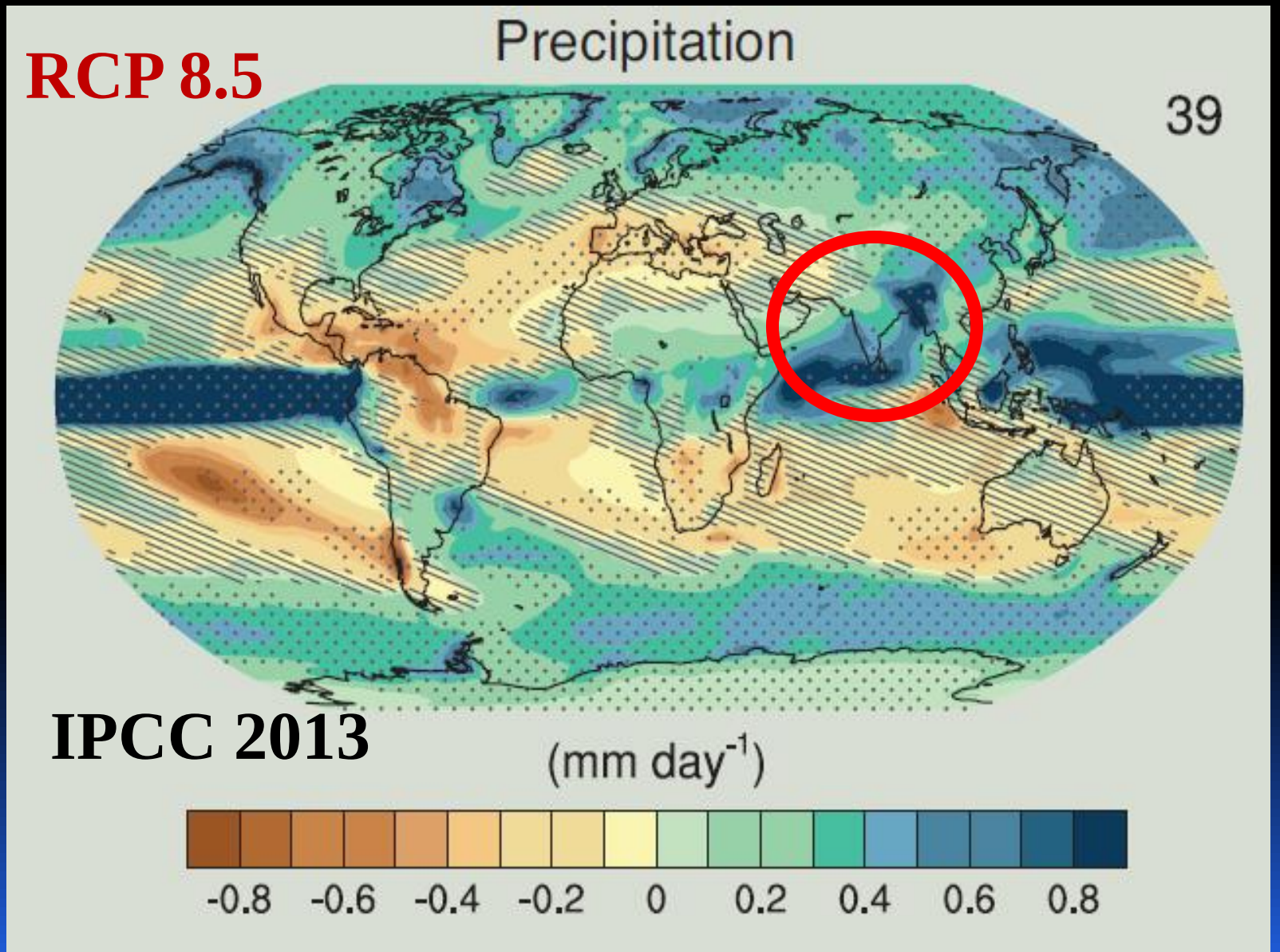
1000 ppm
By 2100?



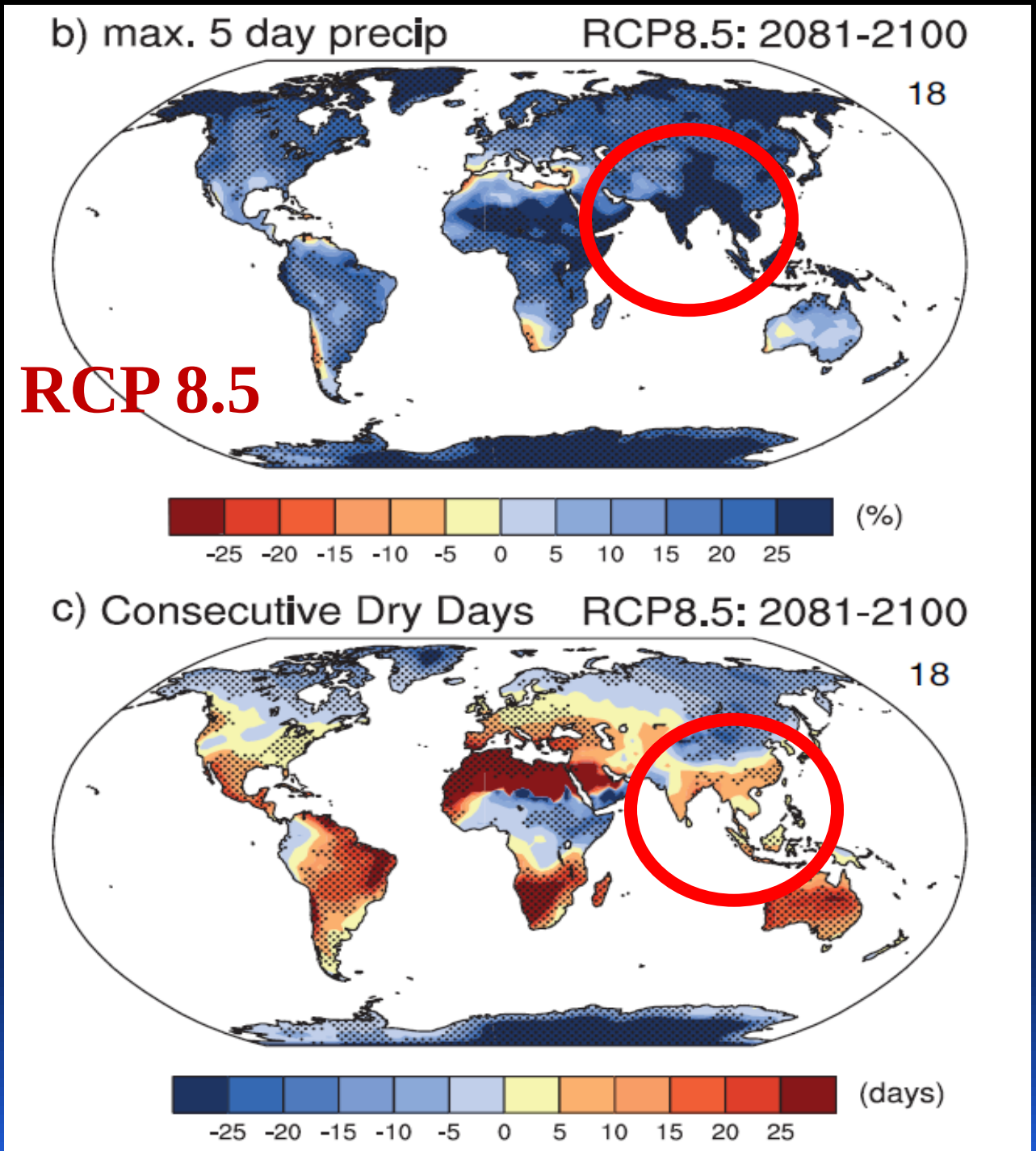
# Long term (2300) warming could be huge



# Rainfall Change (2081-2100)

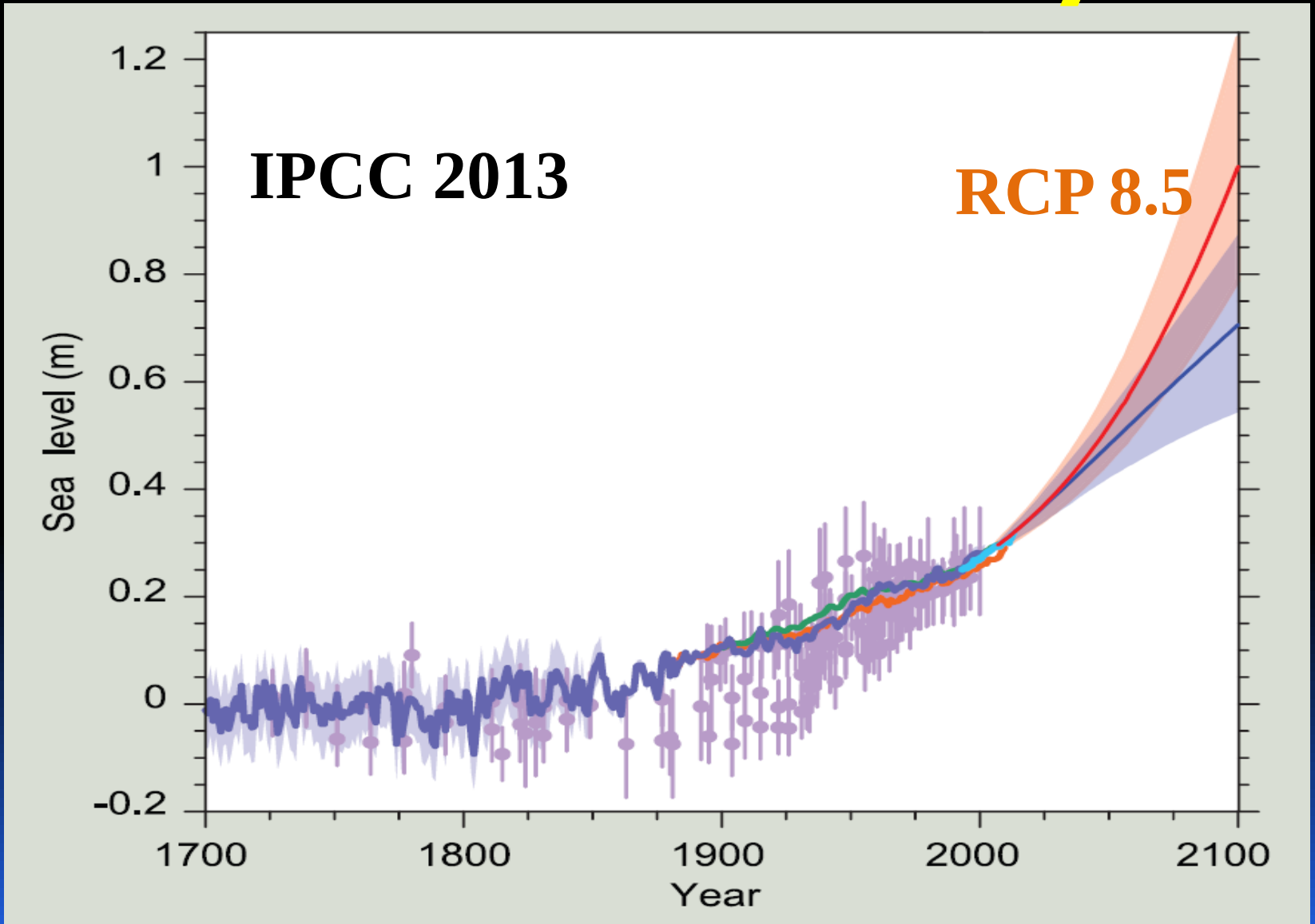


# Extremes Increase

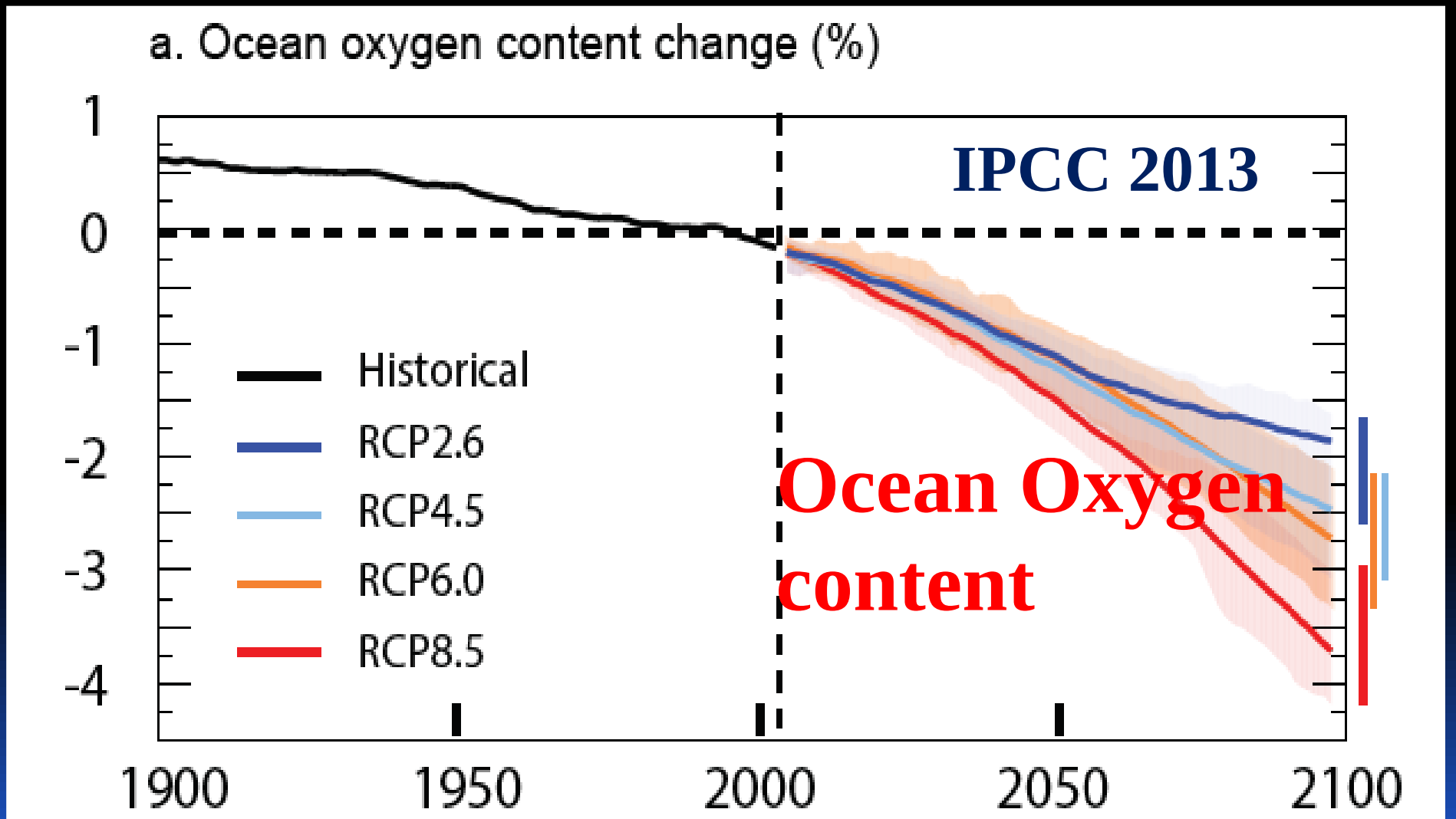



IPCC 2013

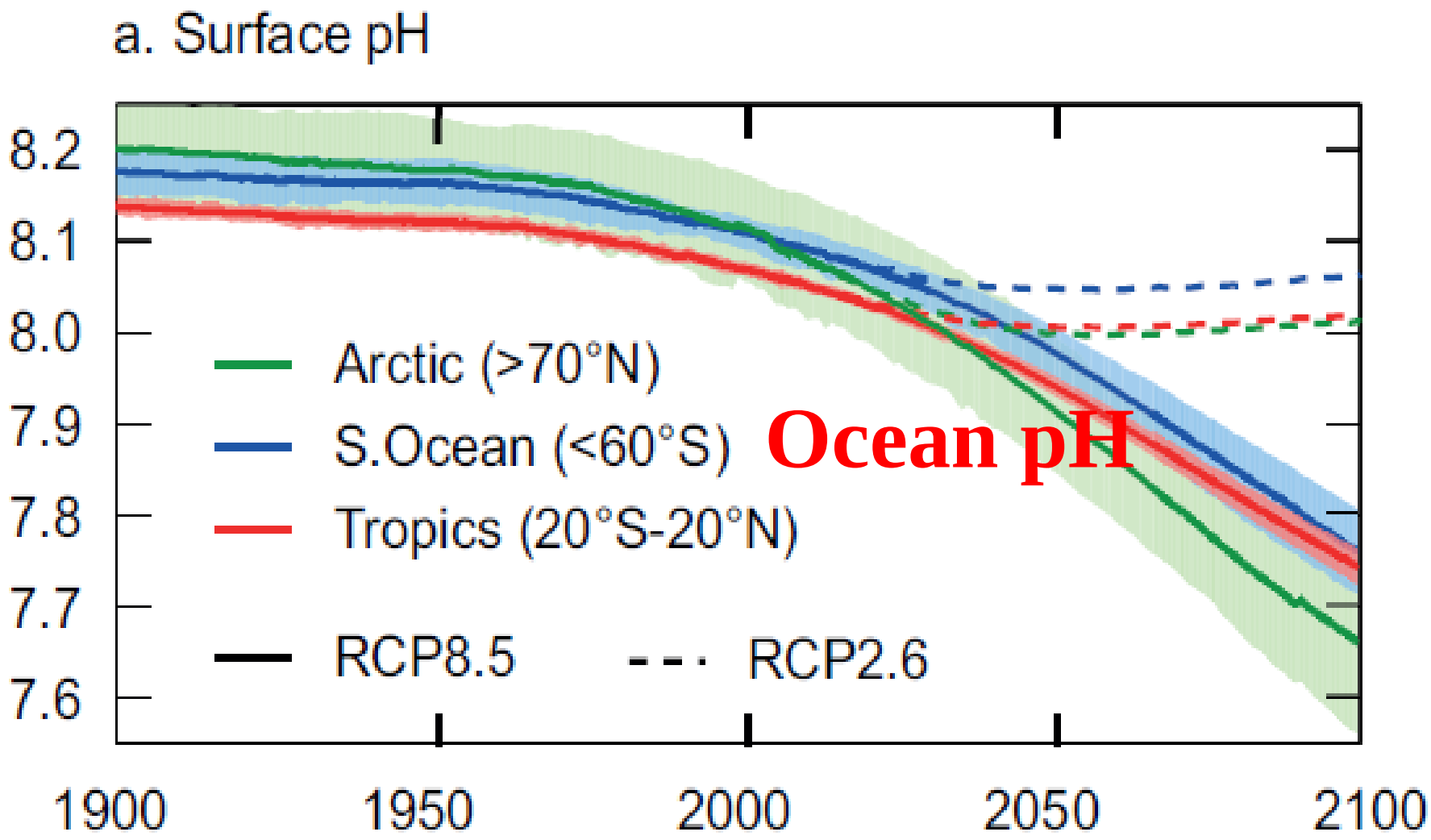
# Sea level could rise by a meter this century



# Oxygen content of seawater would decline



# Oceans would get acidified

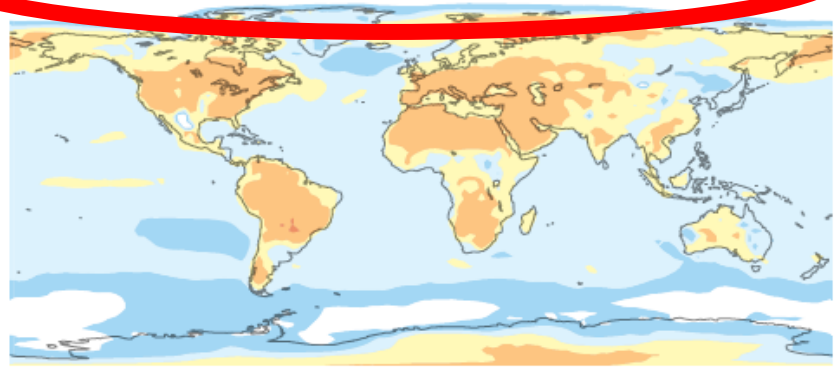


# Every 0.5 deg C of global warming matters

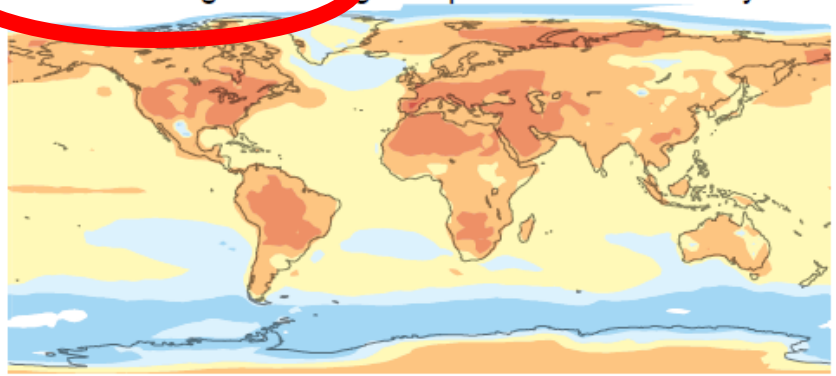
FAQ3.1: **Impact of 1.5°C and 2.0°C global warming**

Temperature rise is not uniform across the world. Some regions will experience greater increases in the temperature of hot days and cold nights than others.

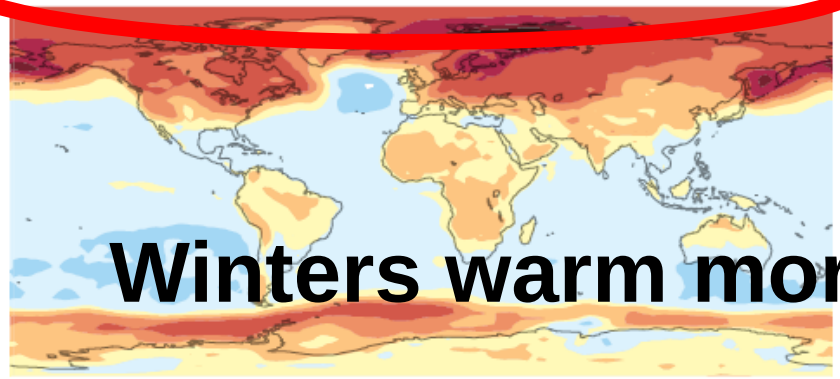
**+ 1.5°C:** Change in average temperature of hottest days



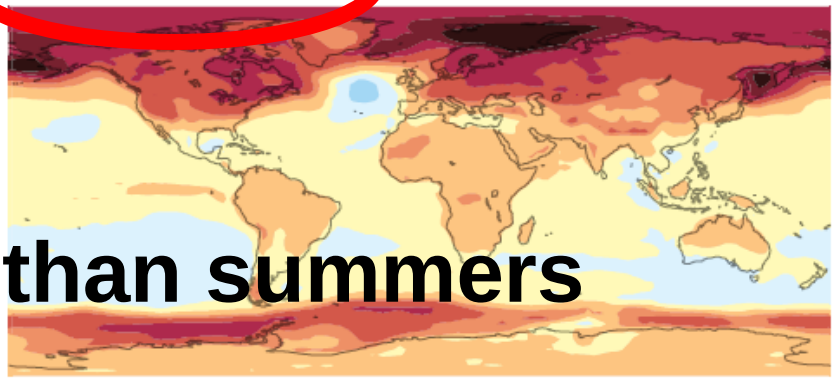
**+ 2.0°C:** Change in average temperature of hottest days



**+ 1.5°C:** Change in average temperature of coldest nights



**+ 2.0°C:** Change in average temperature of coldest nights



**Winters warm more than summers**

°C

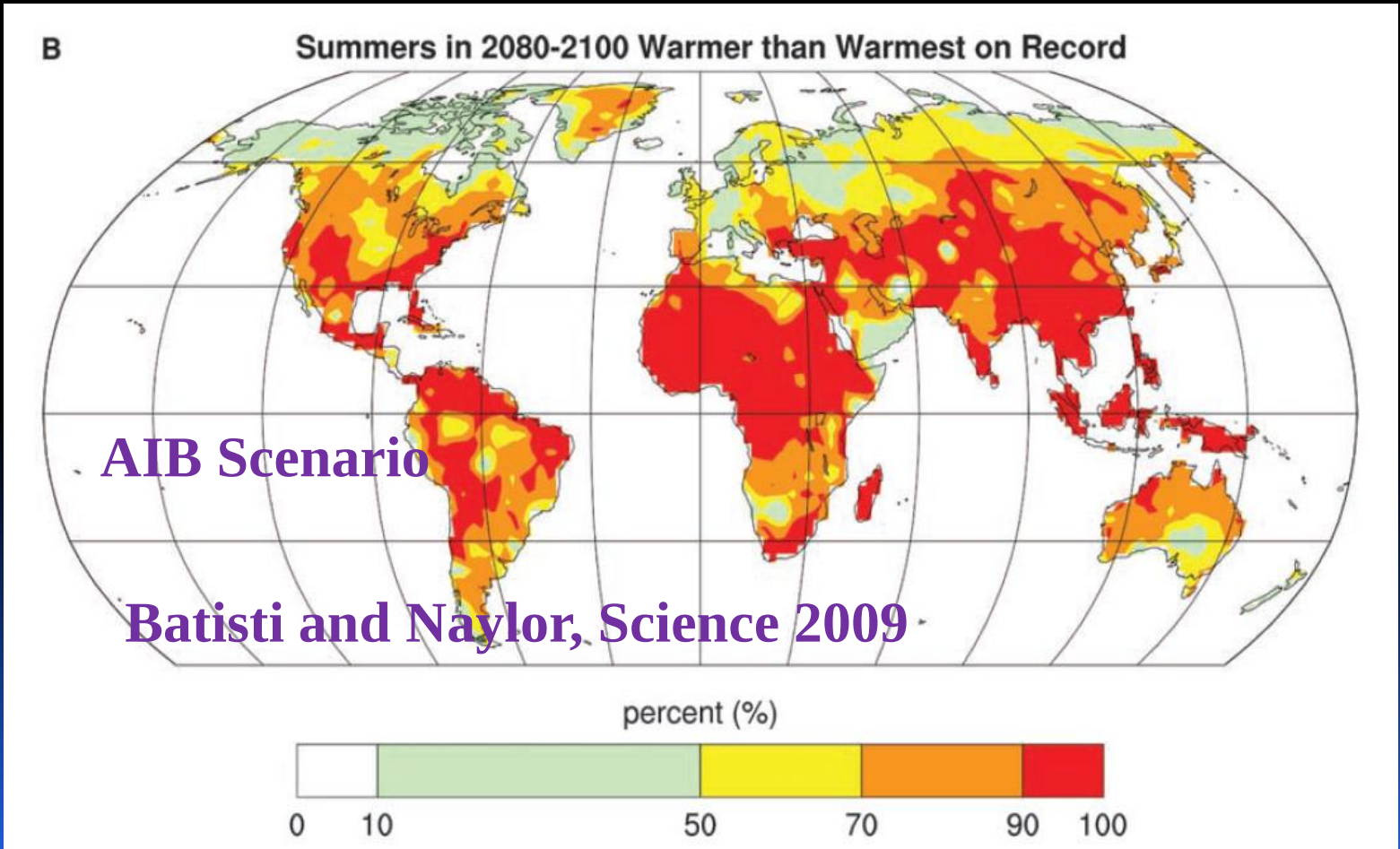
0.0 0.5 1.0 1.5 2.0 3.0 4.0 6.0 8.0 10.0

# Climate Change Impacts

# Climate Change Impacts

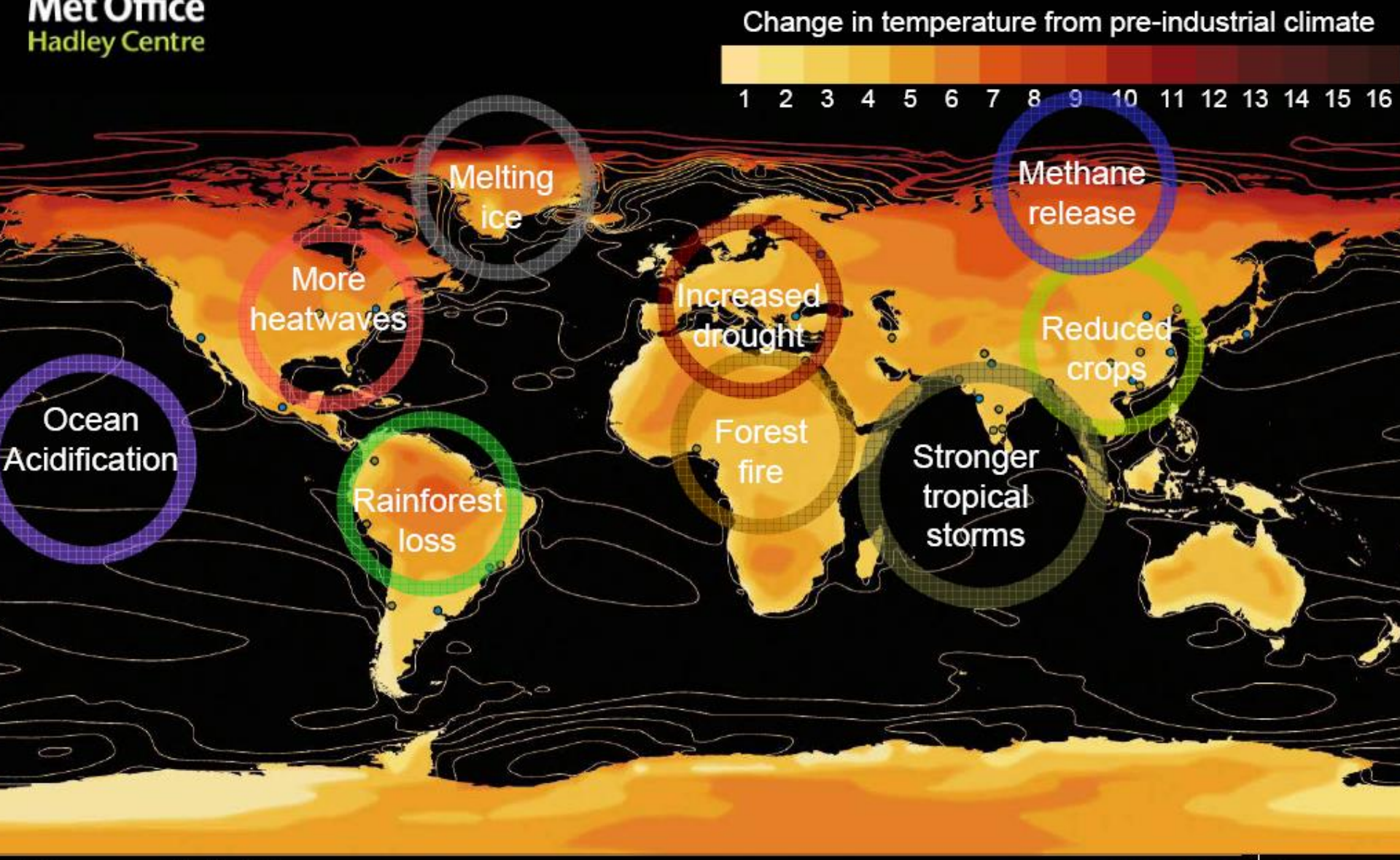
- More intense heat waves
- Frequent floods and droughts
- Intense hurricanes
- Sea Level rise ~ 1 meter per century
- Glaciers melt away → water resources?
- Loss of plants and animal species (biodiversity)
- Infectious disease spread and Human health
- Ocean acidification → extinction of marine life
- Climate refugees

**Big concern for us:** >90% chance that summer-mean T will exceed the warmest T on record (1900-2006) by 2100 in most tropical regions

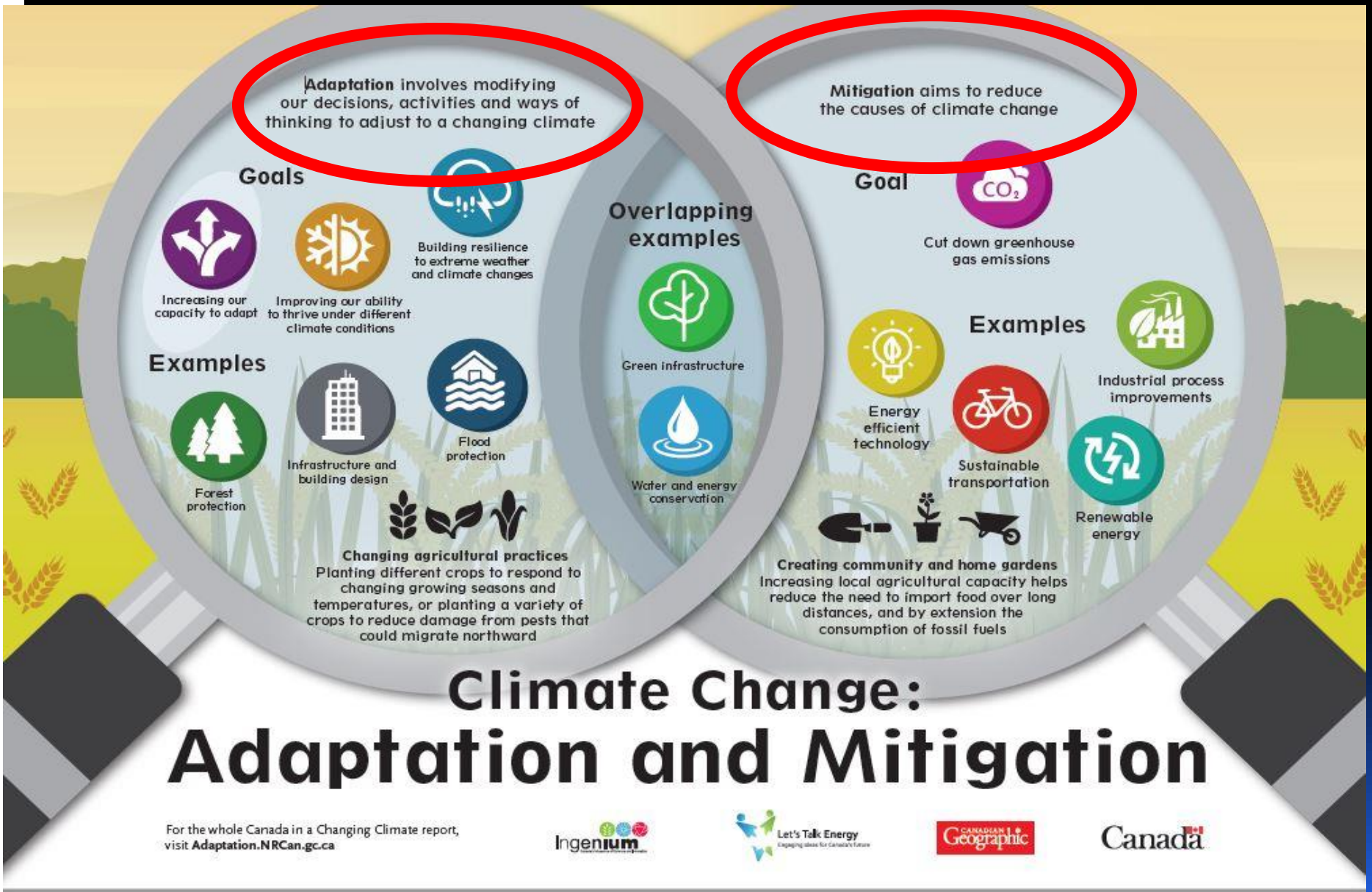


# The impact of a global temperature rise o 4 ºC

Met Office
Hadley Centre



# Conventional Solution



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# Thank You