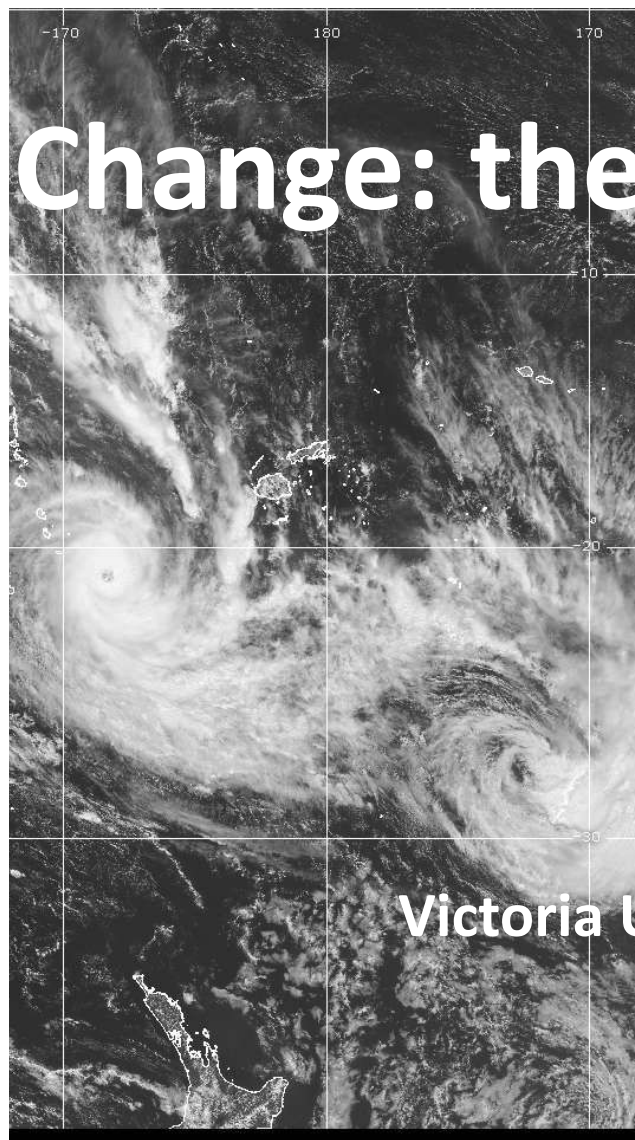


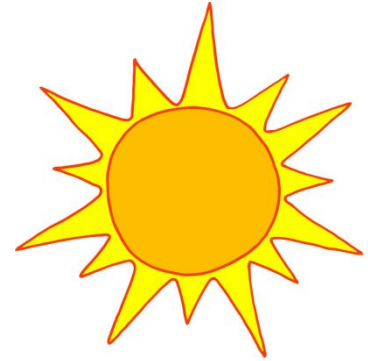
# Climate Change: the Science



**James Renwick**  
Victoria University of Wellington  
*james.renwick@vuw.ac.nz*  
*@CubaRaglanGuy*

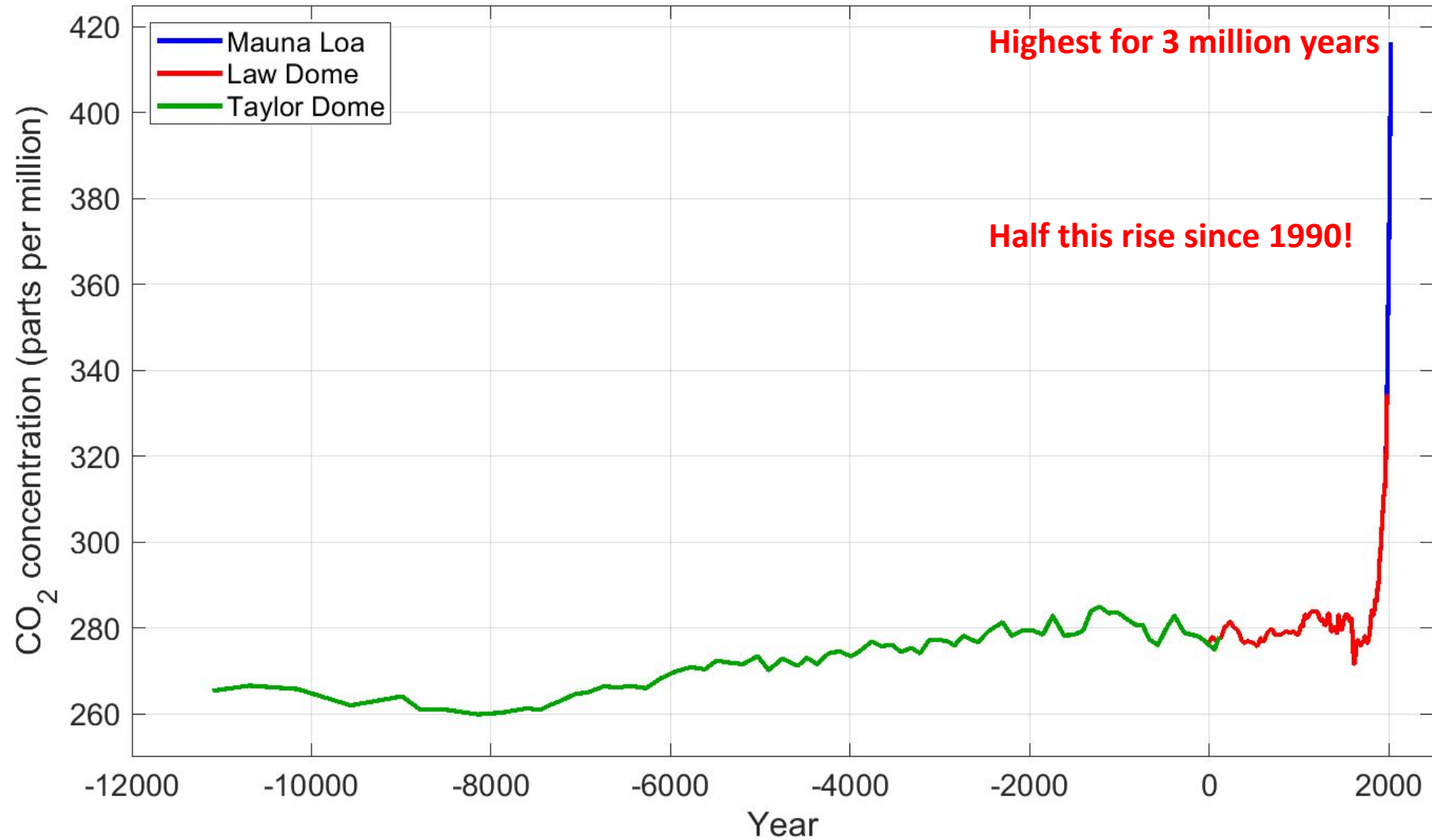
# Climate Change 101

- The sun emits (mostly) visible light
  - Absorbed by the earth
- The earth emits heat (infrared) radiation
  - Absorbed (and re-radiated) by the atmosphere
    - By “greenhouse” gases (carbon dioxide, water vapour, etc)
- Change the climate by
  - Changing sunlight
  - Changing greenhouse gas amounts



# The problem today

## Carbon dioxide concentration





[Credit: NASA]

“Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.”



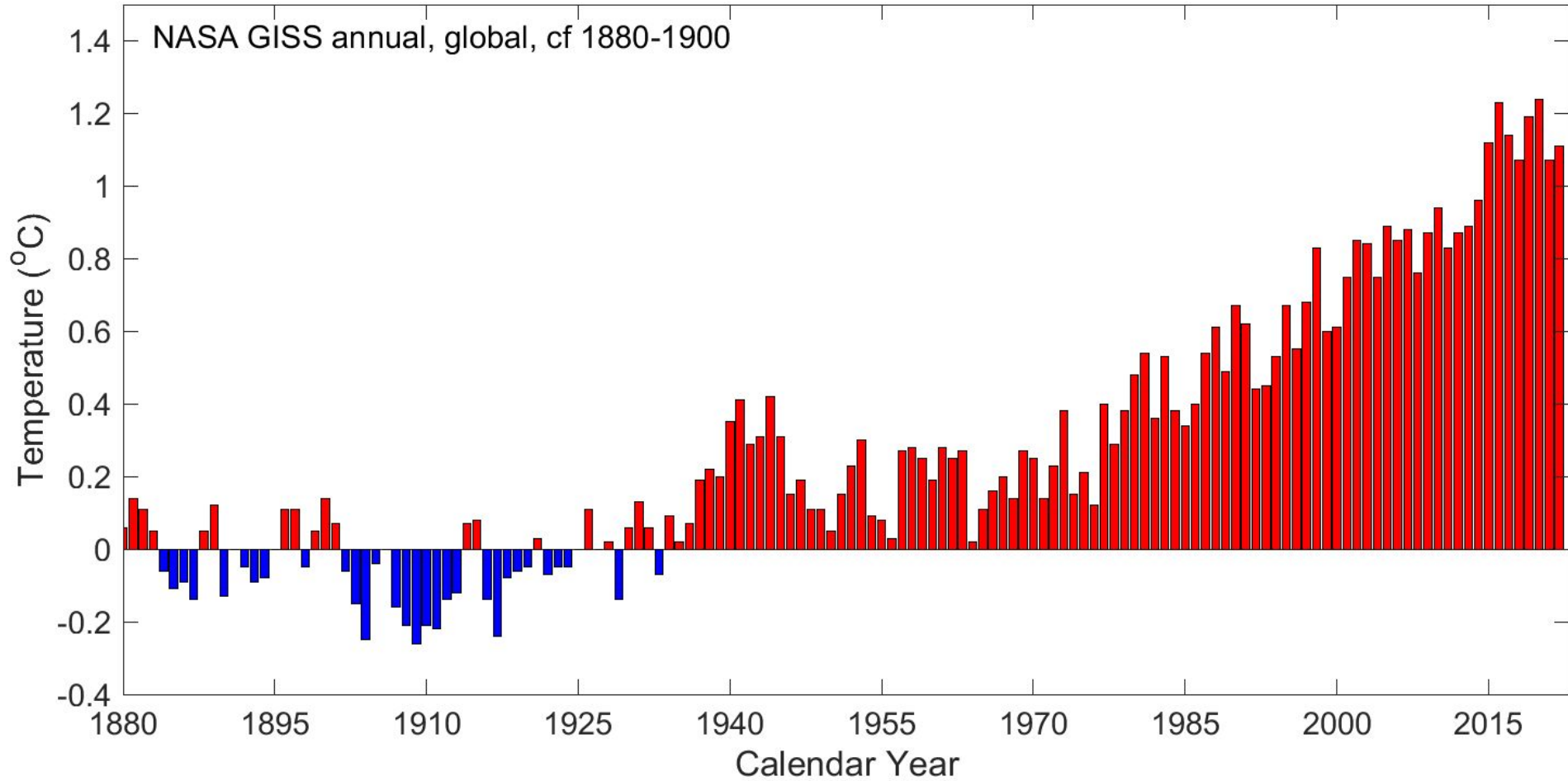
[Credit: Hong Nguyen | [Unsplash](#)]

“ Climate change is already affecting every region on Earth, in multiple ways.

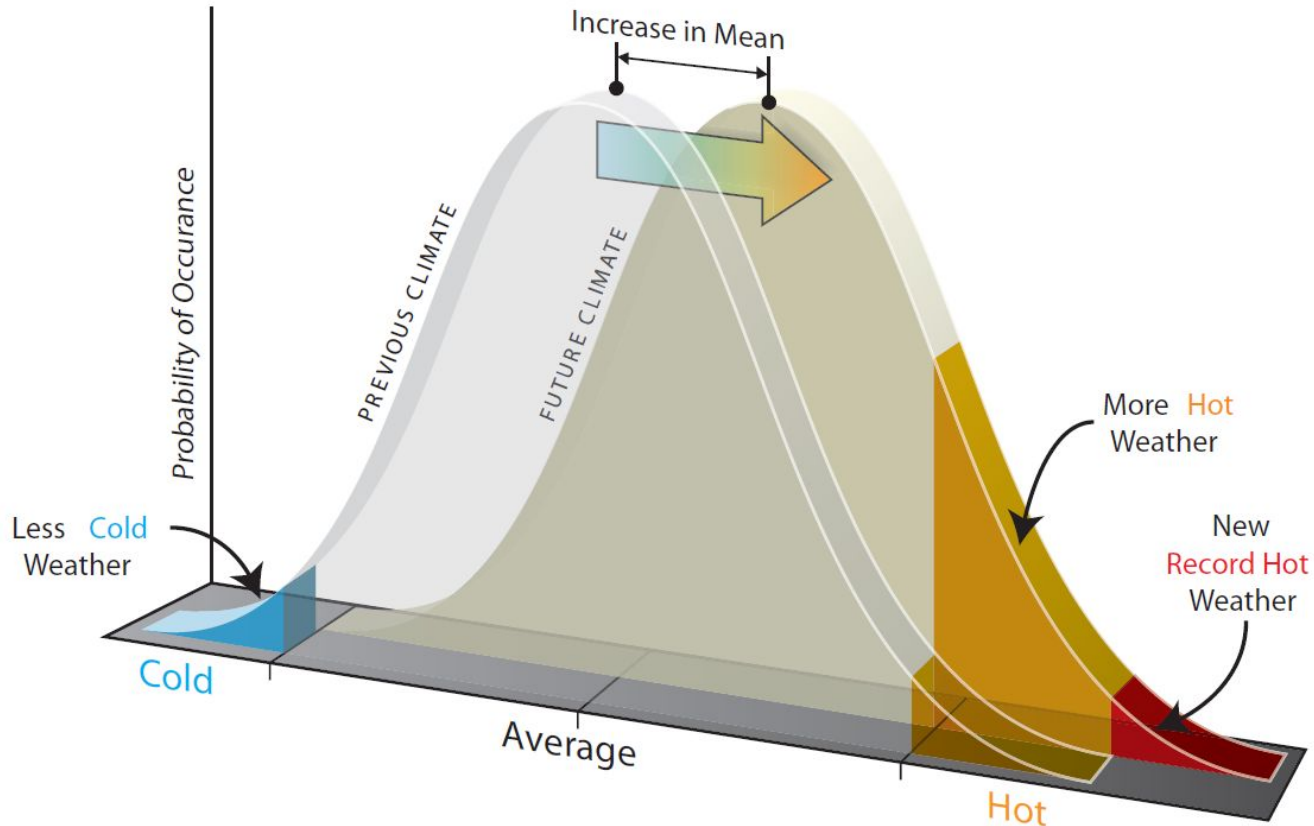
The changes we experience will increase with further warming.

# Temperature Change

1.5°C



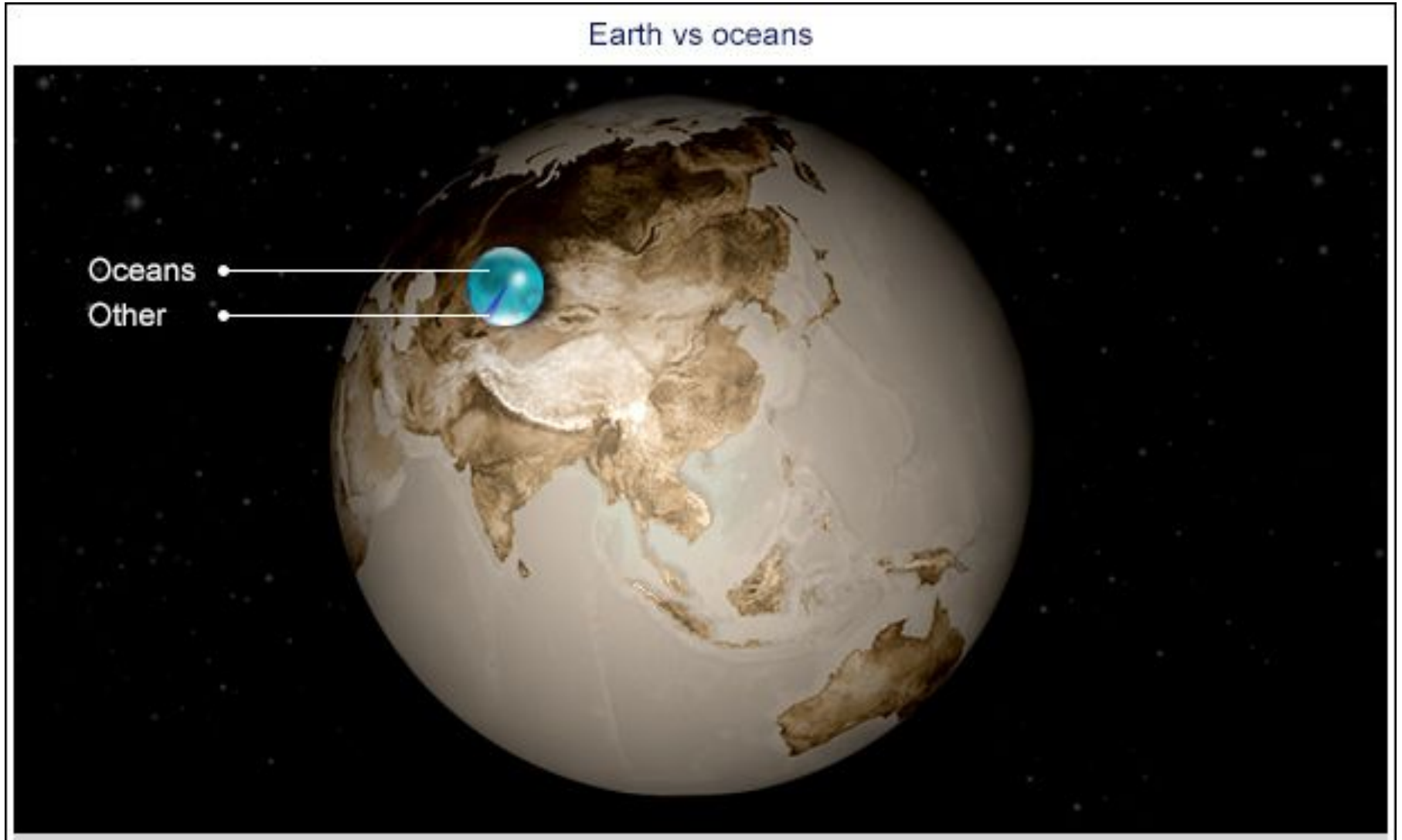
# Changes in extremes: temperature



Reisinger (2009)

- Small increase in the average
  - Big increase in risk of extremes
    - Including new, unprecedented extreme values

# The Earth and its water

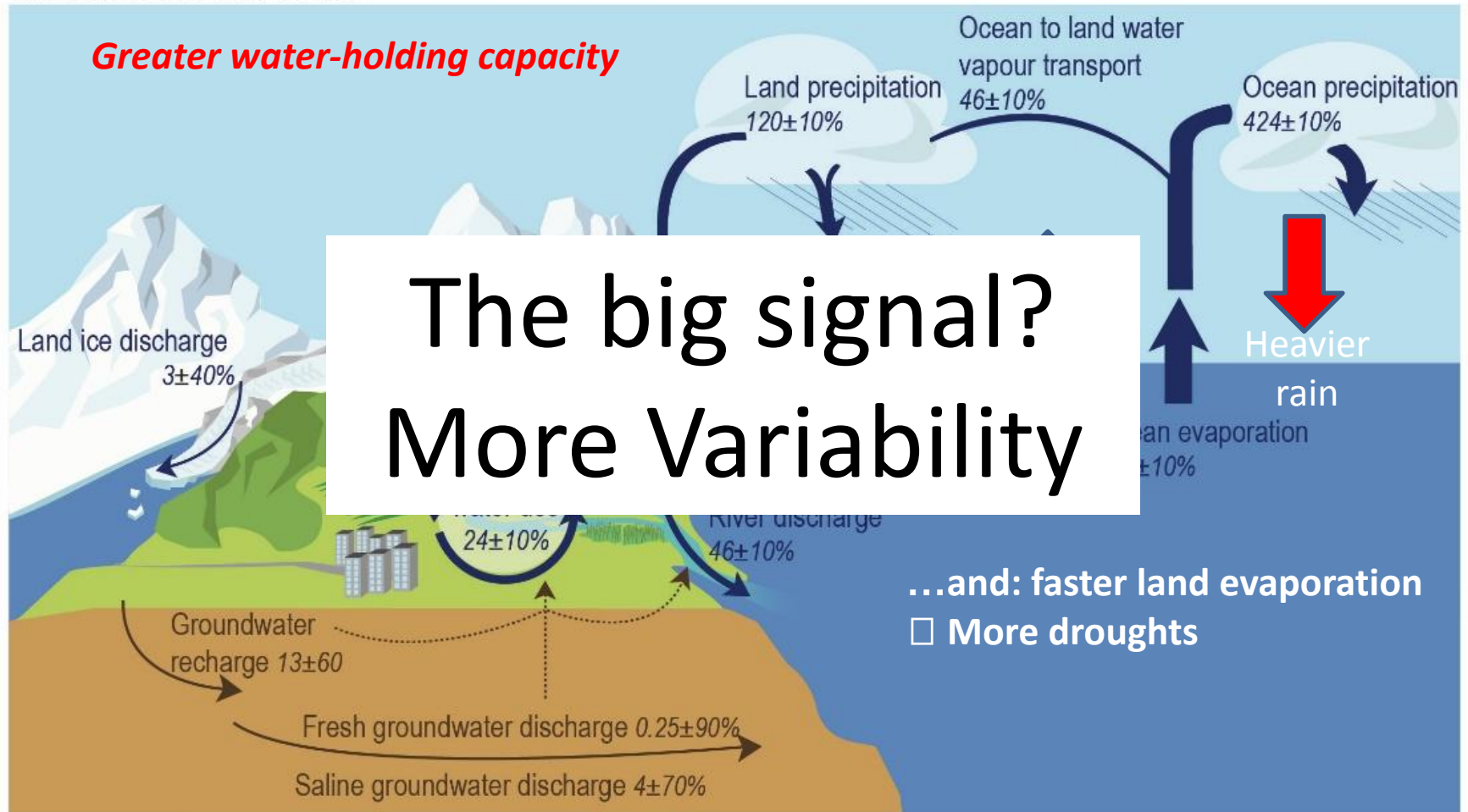




# Water and Climate Change

## (b) Water fluxes

Units in thousands of km<sup>3</sup> per year





[Credit: Yoda Adaman | Unsplash]

“ It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

# Heatwaves & droughts



*Yangtze River, Wuhan, 19 August*



# And floods



*Auckland International Airport, RNZ*

# NIWA summary

## CLIMATE SUMMARY



### RAINFALL



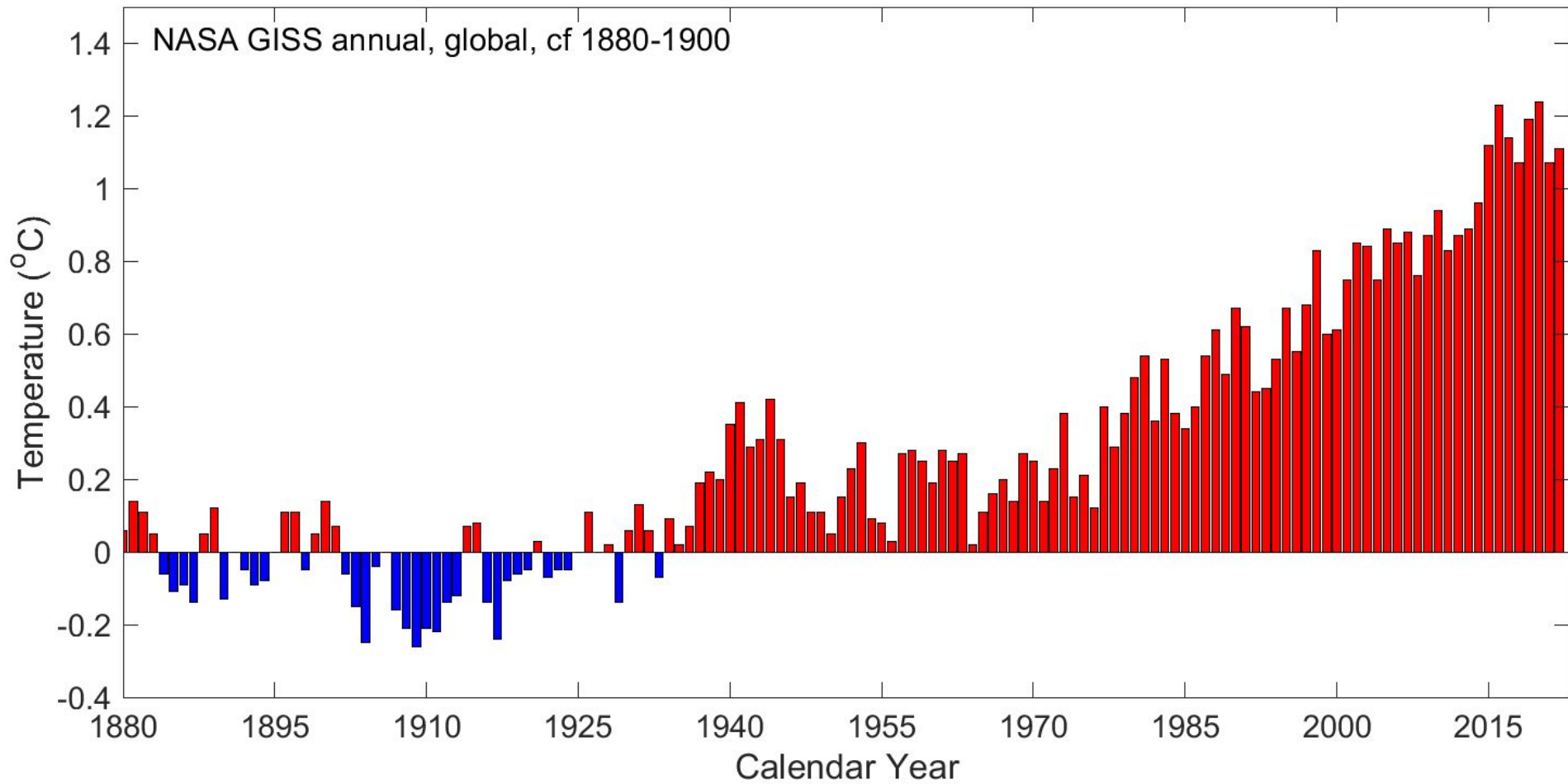
**2023**  
AUTUMN

**WETTEST**  
**AUTUMN**  
ON RECORD FOR

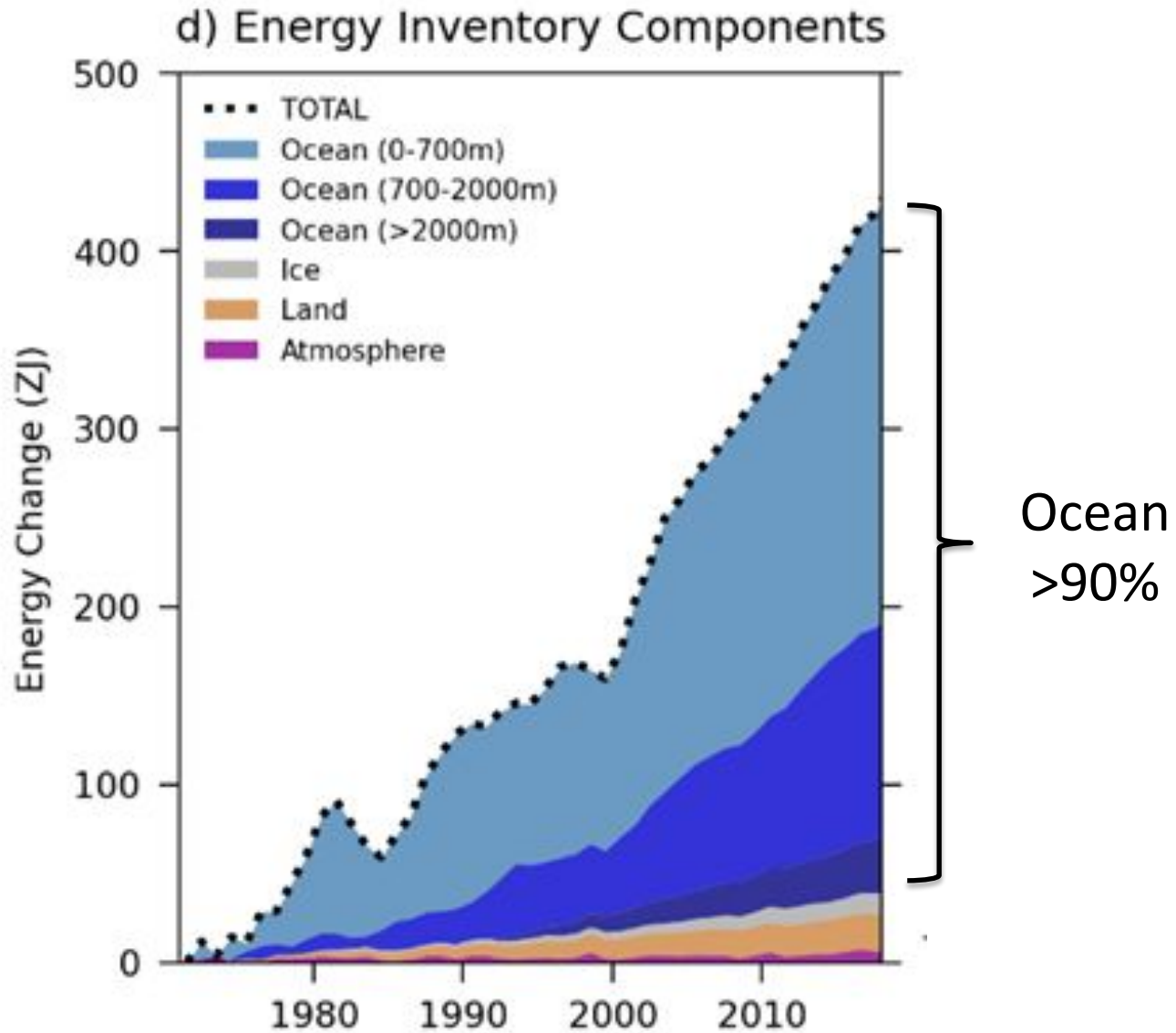
**KAIKOHE**  
**HOKITIKA**  
**ŌKĀRITO**  
**TARA HILLS**  
**FIVE RIVERS**

KAIKOHE RECEIVED  
**252%**  
OF NORMAL RAINFALL  
FOR AUTUMN

# Temperature Change



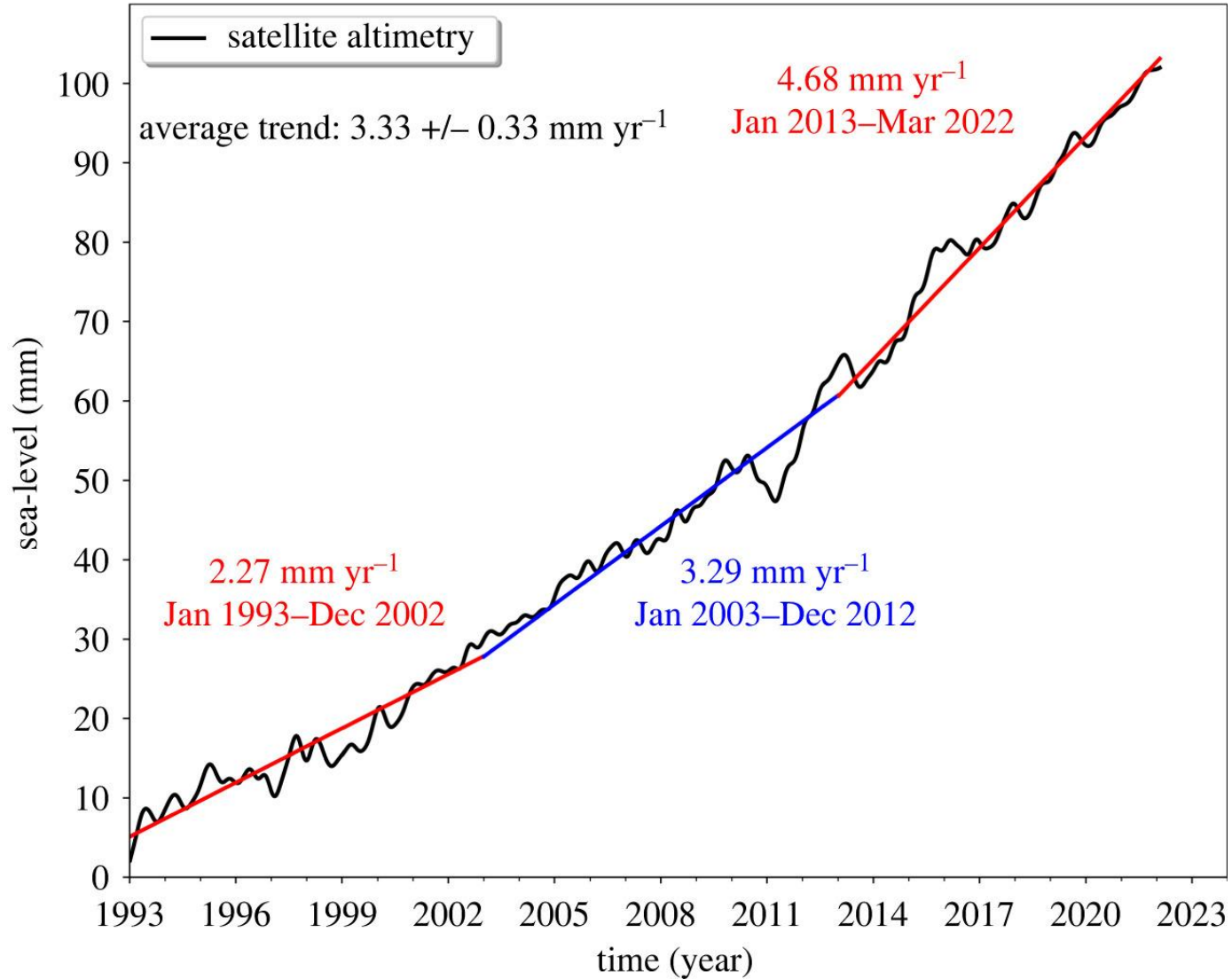
# Distribution of heating





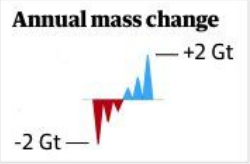
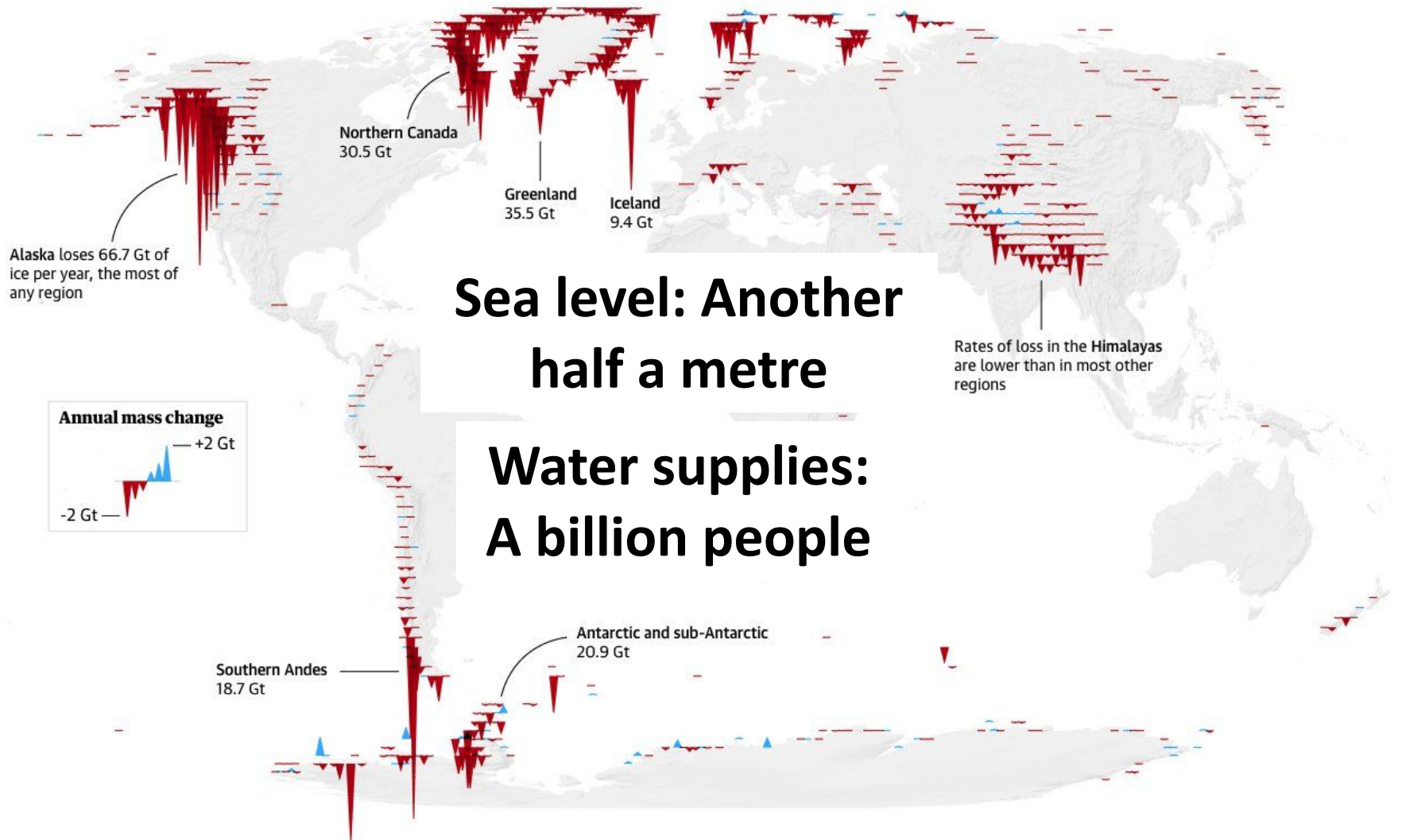
# Global sea level

global mean sea-level

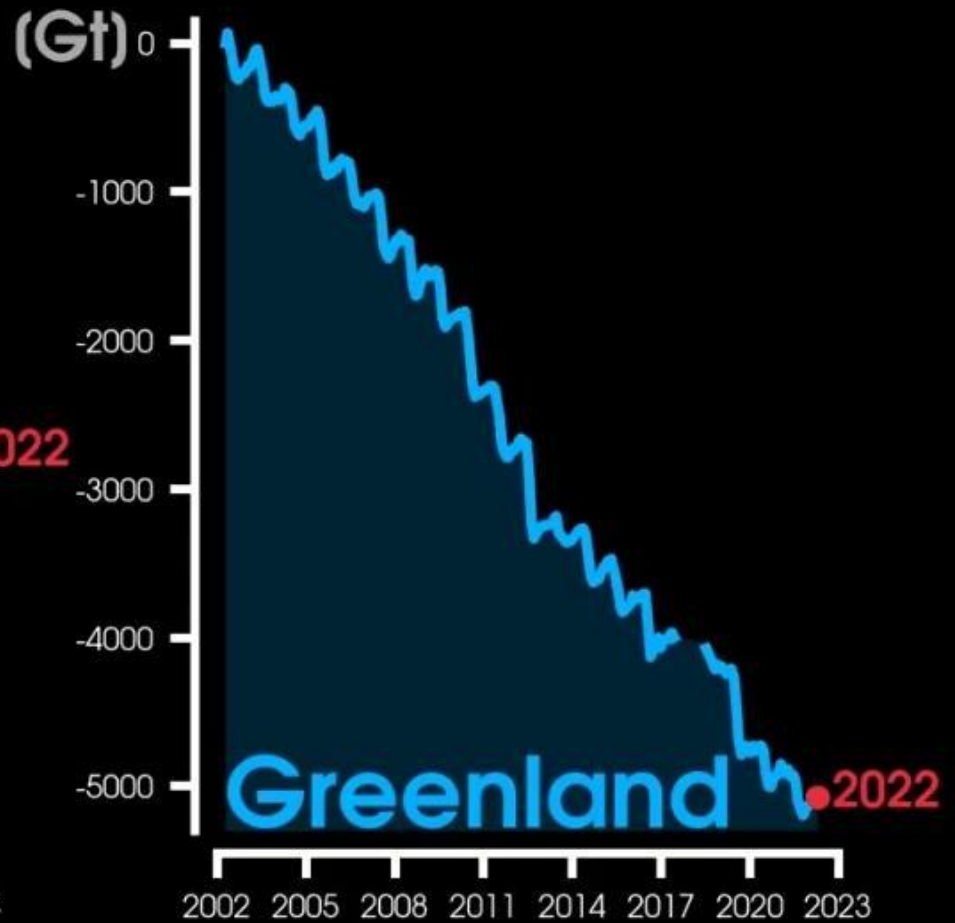
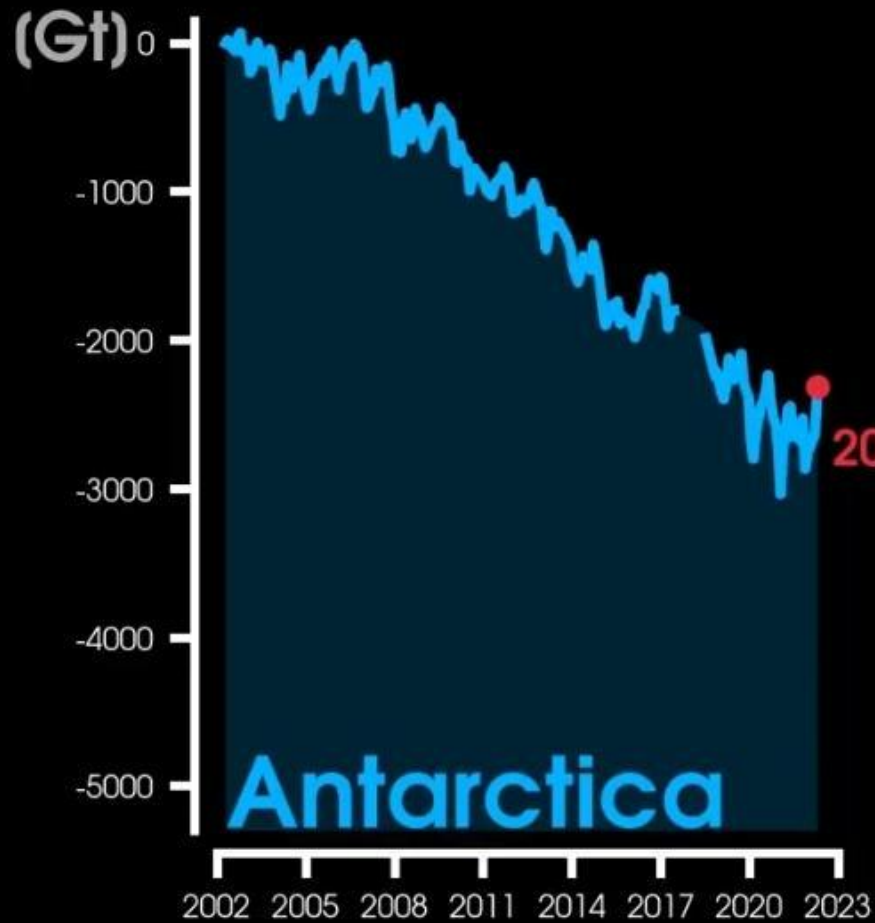


# Glacier melt

The world's glaciers are losing 267 gigatonnes of ice per year, driving a fifth of global sea level rise *Hugonnet et al (2021)*



# Ice Sheet Melt

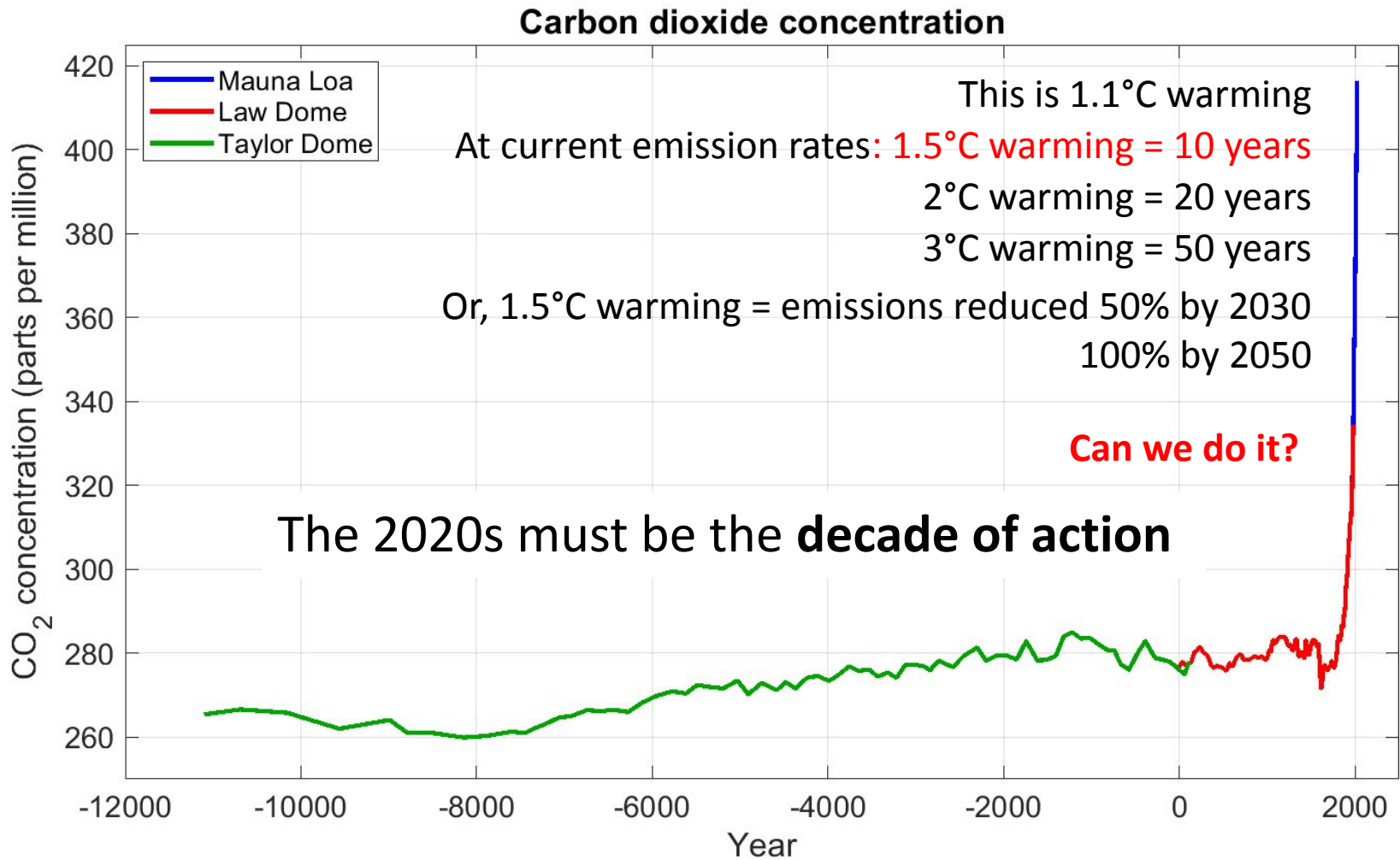


DATA: Gravity Recovery and Climate Experiment (GRACE/GRACE-FO)  
SOURCE: <https://climate.nasa.gov/vital-signs/land-ice/> (NASA JPL)  
REFERENCE: Wiese et al. (2015, 2019)

GRAPHIC: Zachary Labe (@ZLabe)

**Exchange rate: 360Gt ice = 1mm SLR**

# Where to from here?





[Credit: Peter John Maridable | Unsplash]

“ Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.

# What is at stake?

- Everything
- “The climate system” is what gives us
  - Every mouthful of food
  - Every sip of water
  - All of our livelihoods and our lives
- We are collectively pulling the rug out from beneath ourselves...



[Credit: [Shari Gearheard](#) | NSIDC]

“There’s no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.”

# Sea Level Rise

Human activities affect all the major climate system components, with some responding over decades and others over centuries

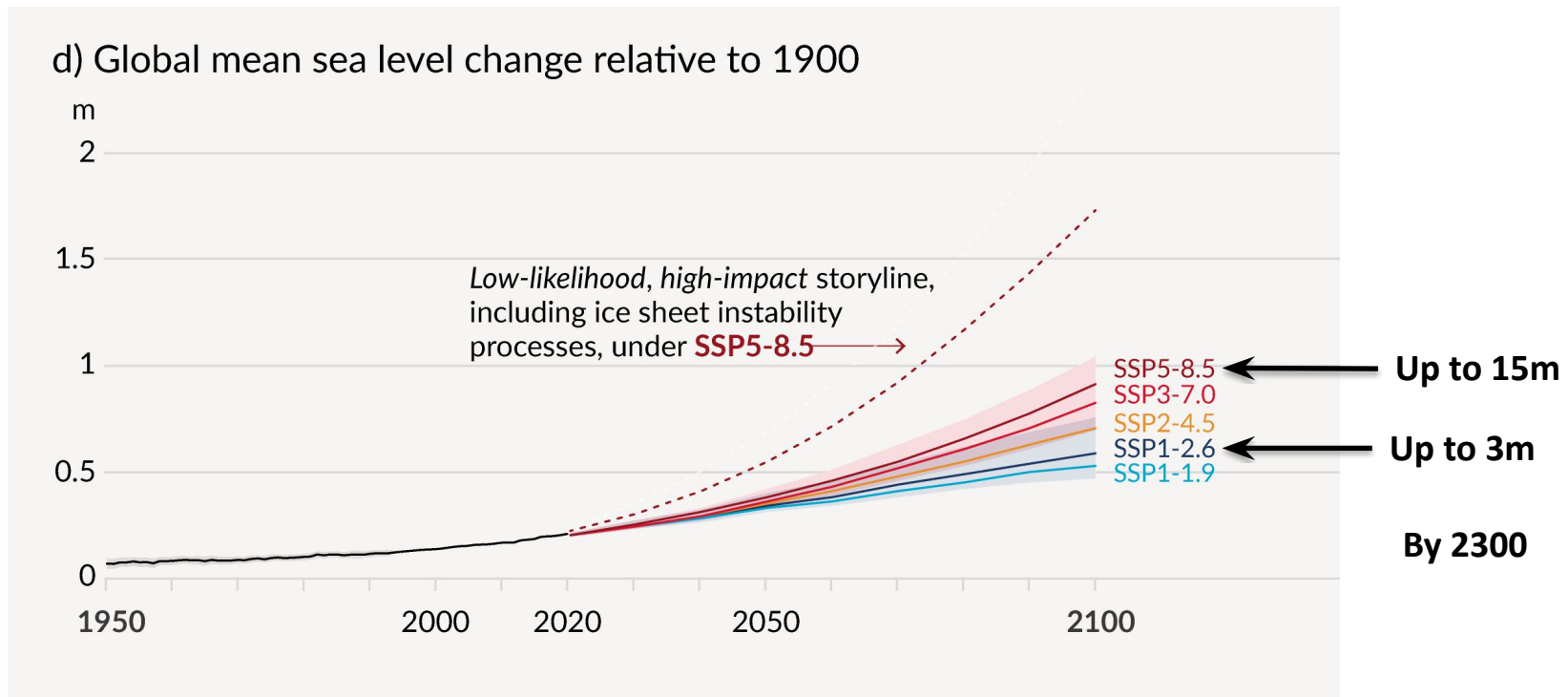
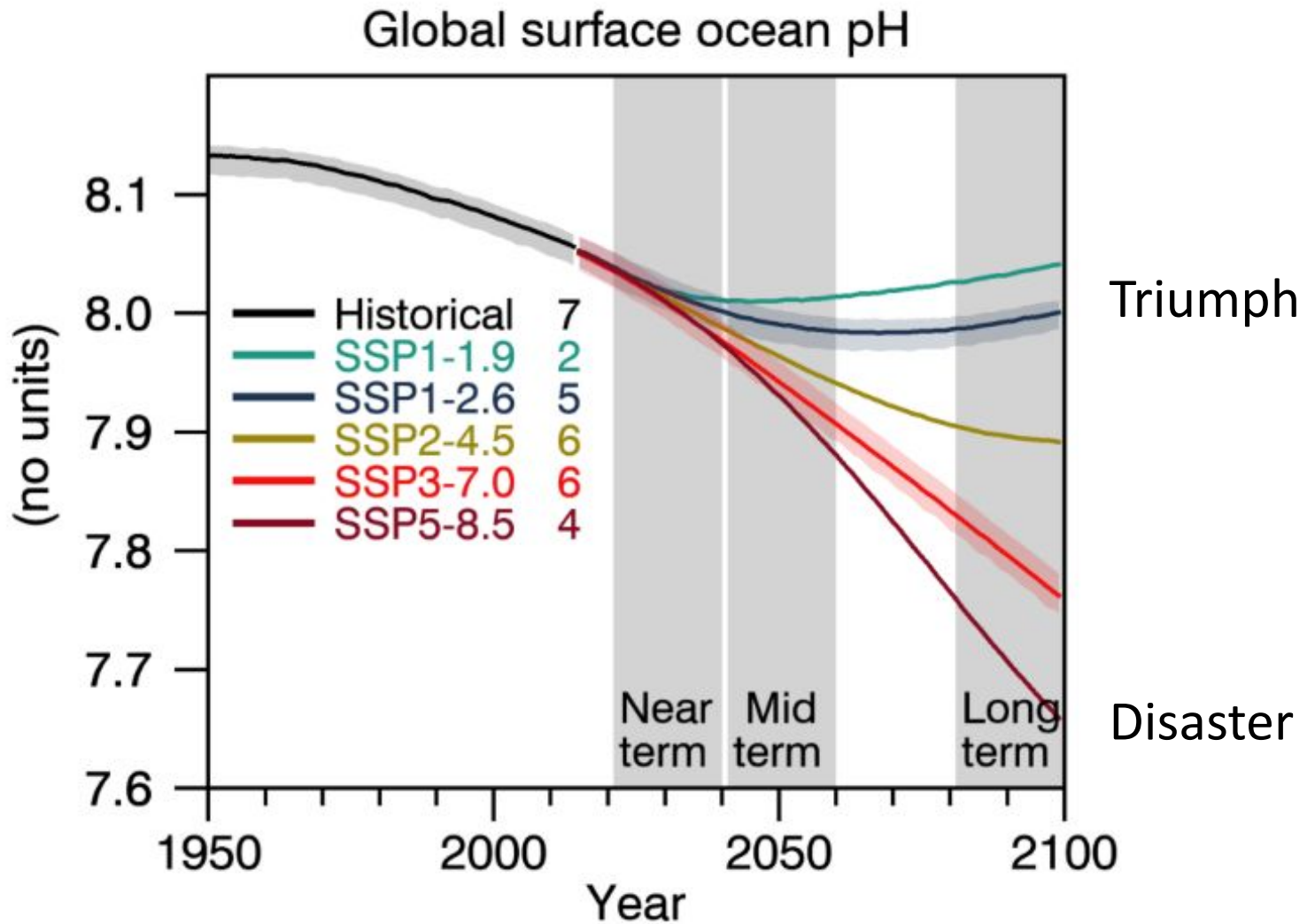


Figure SPM.8

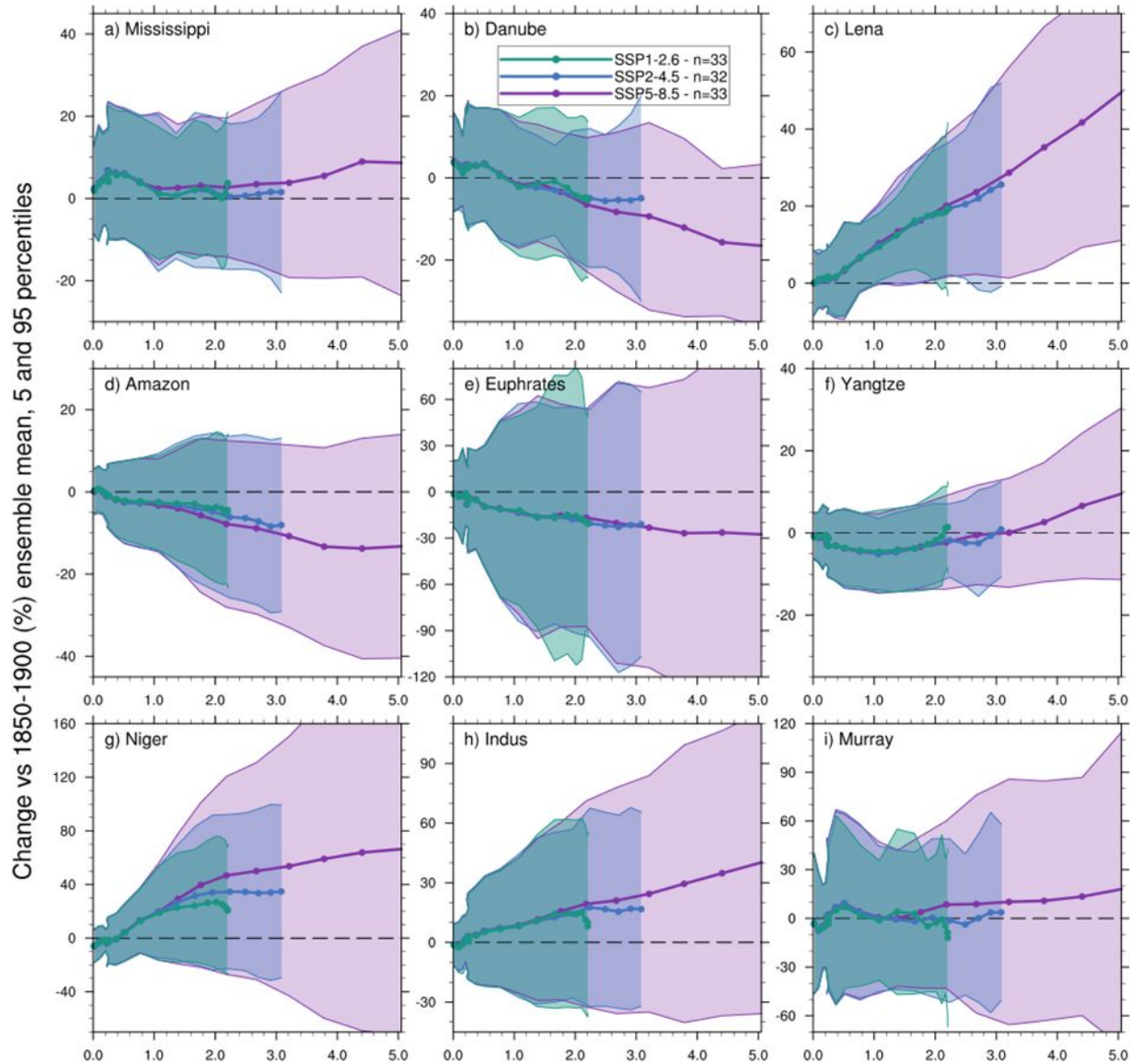


# Ocean Acidification



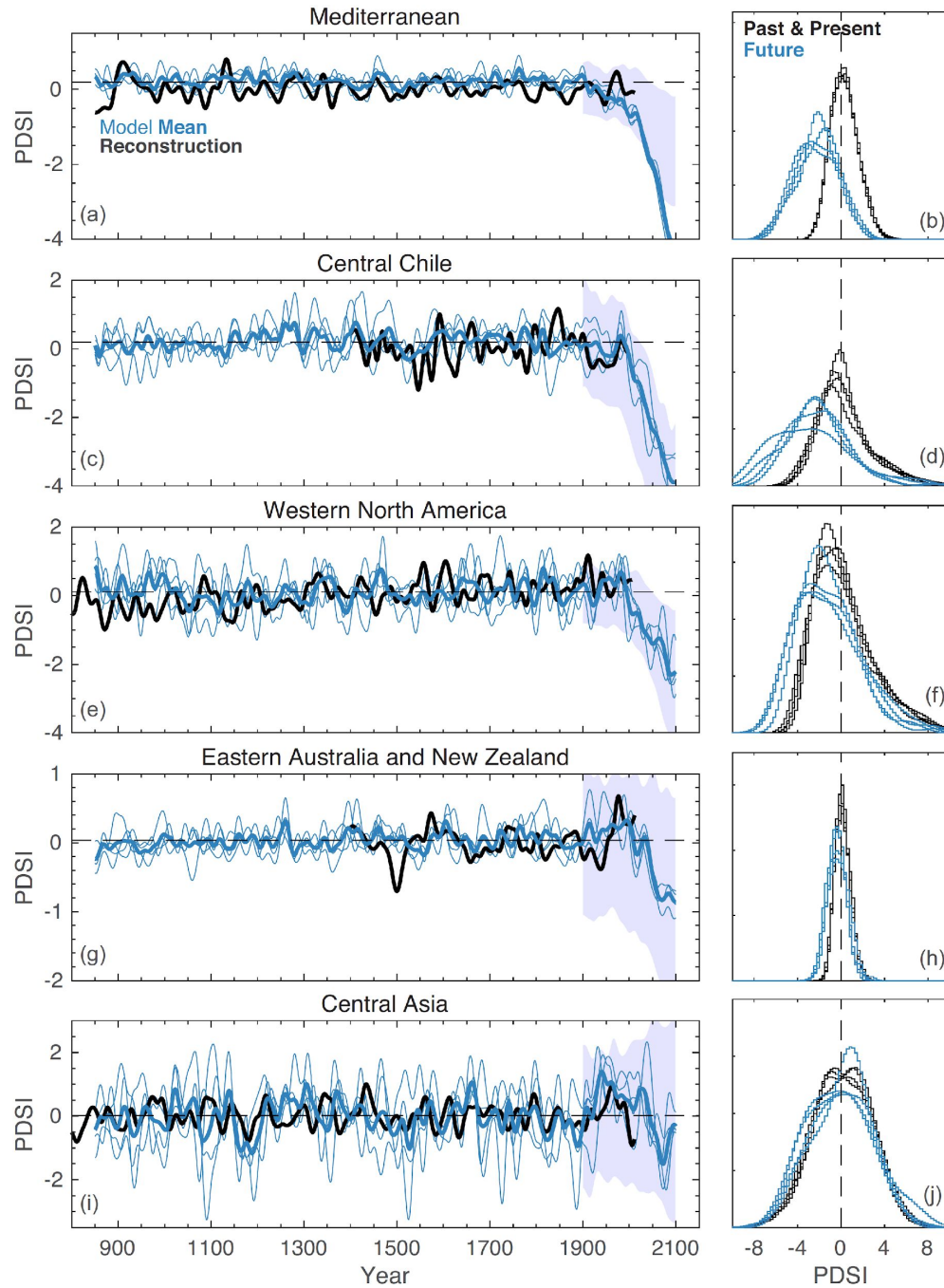
# River flow and warming

Rate of change in basin-scale runoff mean



Warming above 1850-1900, from 1901 to 2100

# Mega-drought



# Locally

## Projected percentage change in mean annual runoff

2086–2099 relative to 1986–2005 from hydrological modelling informed by six CMIP5 GCMs for

RCP2.6

RCP4.5

RCP6.0

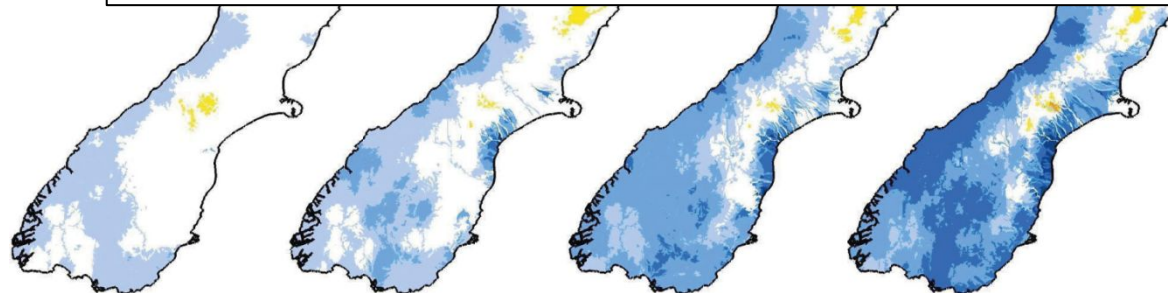
RCP8.5

2 x Hot Days  
Few frosts

Average  
50cm s

3-4 x Hot Days  
No frosts  
20% more rain  
>1m sea level rise

What's happening internationally?  
What about our offshore markets?  
Displacement, migration? Population?




+1.8°C

+2.4°C

+3.0°C

+4.0°C

# Locally...

An aerial photograph showing a two-lane asphalt road built on a steep, eroded cliffside. The cliff face is dark brown and shows significant vertical erosion. The ocean is to the left, with waves crashing against the base of the cliff. The road has white dashed lines and a solid white edge line. The surrounding area is green with grass and some trees.

30cm more, next 40 years  
[had 20cm in last 100 years]  
Between 50-150cm by 2100  
Depends on overall warming

# Actions: Adaptation

- Retreat from the coast
  - Easy to say, difficult and costly to do □ start early
- Retreat from flood plains
  - Improve drainage, don't build bigger stop banks
  - Protective measures may be sensible, sometimes
- Change land use to suit the climate
  - No pip or stone fruit?
  - Hotter-climate grapes?
- Help communities become more resilient
  - A sense of “community”

# Mitigation – reducing emissions

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.

## Latest IPCC

- Emissions – For a 5C
- We are dr
- There are



the power  
missions...

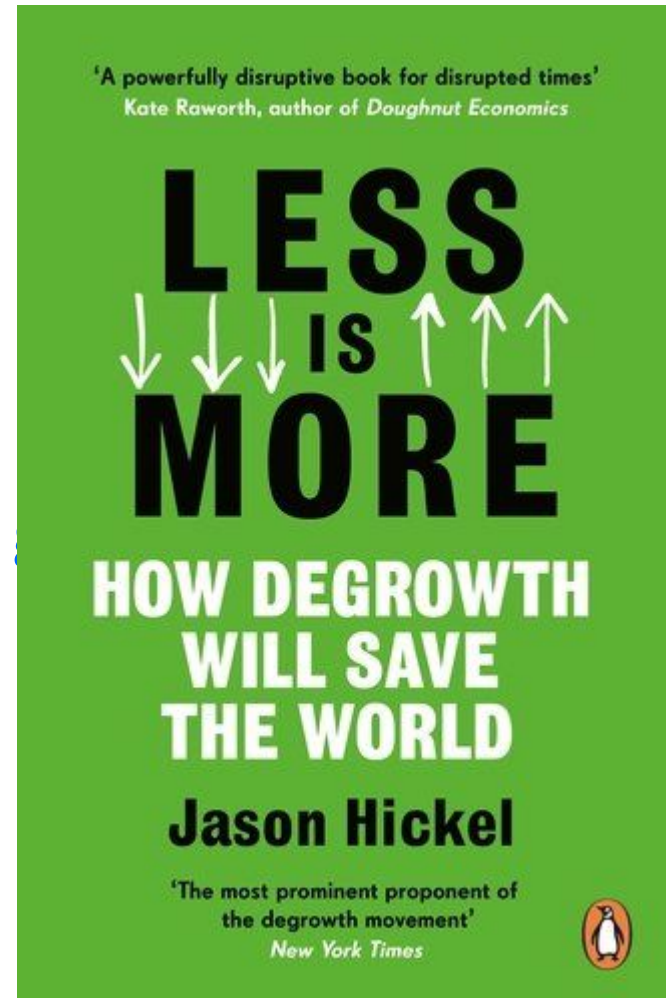
# Personal action & agency





# How did we get here?

- Growth
  - Especially economic growth
- And how we stop it
  - Economic
  - Also resource use, population, land use...
- The answer? Degrowth...



# Summary

## Climate Science 101

@KA\_Nicholas

1. It's Warming<sup>1</sup>
2. It's US<sup>2</sup>
3. We're Sure<sup>3</sup>
4. It's Bad<sup>4</sup>
5. We Can Fix It<sup>5</sup>

1. IPCC AR5 WG1, "Warming of the climate system is unequivocal..."
2. "Extremely likely (95%) human influence has been the dominant cause of observed warming since mid 20th c." IPCC WGR4, 2013.
3. 97% to 100% scientists concurred (Oreskes et al., 2004); c. 37. Anderson et al., 2011.
4. Widespread impacts on water, food, ecosystems (IPCC WGR4, 2007).
5. See [KimNicholas.com/we-can-fix-it-world-wide.html](http://KimNicholas.com/we-can-fix-it-world-wide.html)

Kimberly Nicholas -

<https://www.kimnicholas.com/activism.html>