

Climate change: *past, present, future*

Nick Golledge
Victoria University of Wellington



Wilhelmina Bay, Antarctic
Peninsula, 2008

Sixth Assessment Report

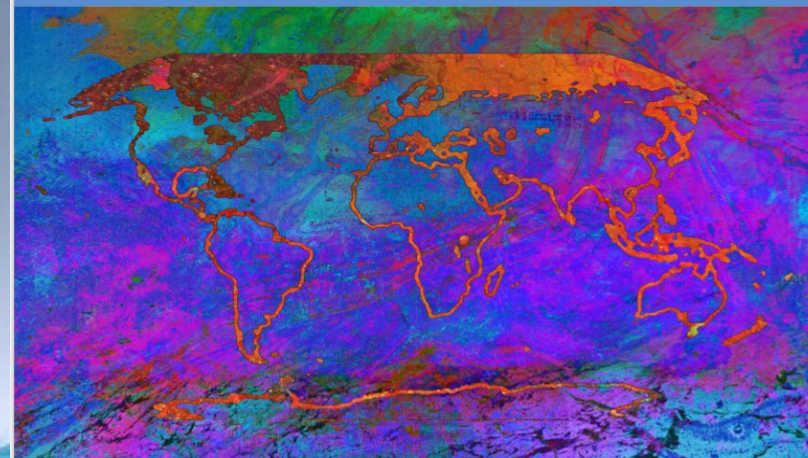
The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

LEARN MORE

Climate Change 2021

The Physical Science Basis

Summary for Policymakers

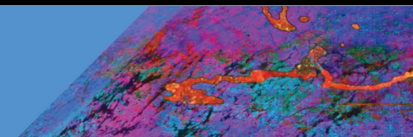


WGI

Working Group I contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change



***First lead author meeting for
AR6, Guangzhou, China,
2018.***



BY THE NUMBERS

Author Team

234 authors from **65** countries

28% women, **72%** men

30% new to the IPCC

Review Process

14,000 scientific publications
assessed

78,000+ review comments

46 countries commented on Final
Government Distribution

Chapter 9:

- c. **10000** review comments
- 3 CLA, 15 LA, 74 CA, 3 RE, 5 CS

LAM 1 June 2018 Guangzhou

LAM 2 January 2019 Vancouver

LAM 3 August 2019 Toulouse

IPCC Sixth Assessment Report (AR6) August 2021

- We are now **1.1°C warmer** than in 1850-1900
- Global surface warming has **accelerated** since 1970
- Recent rate of warming is **without precedent in at least 2000 yrs**
- Each of the last 4 decades has been warmer than any previous decade since 1850

Current CO₂ concentrations have not been experienced for at least 2 million years

IPCC Sixth Assessment Report (AR6) August 2021

- The rate of sea level rise was **faster over the last century** than at any time in at least the **last 3000 years**
- Summer Arctic sea ice cover has **decreased by about 40%** since 1979, and is at its lowest level since at least 1850
- The retreat of glaciers since 1950 is **unprecedented in >2000 yrs**

Current CO₂ concentrations have not been experienced for at least 2 million years



[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.

ipcc
INTERGOVERNMENTAL PANEL ON climate change

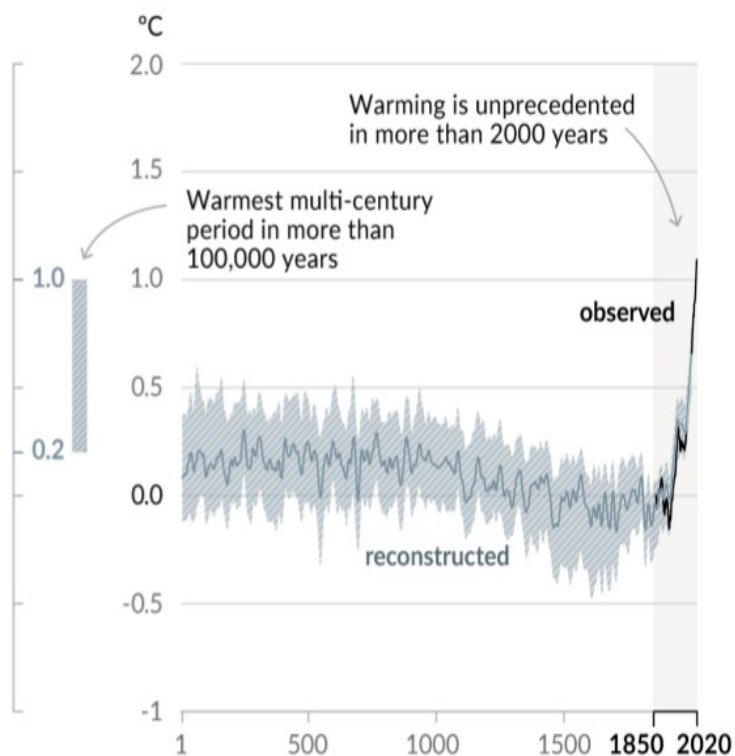


Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

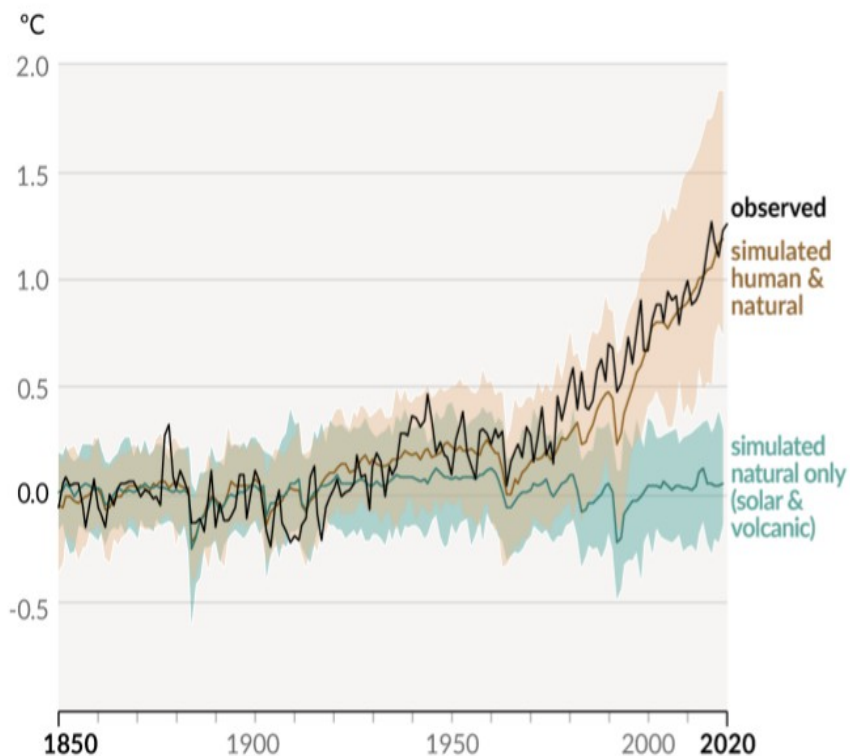
Figure SPM.1

Changes in global surface temperature relative to 1850-1900

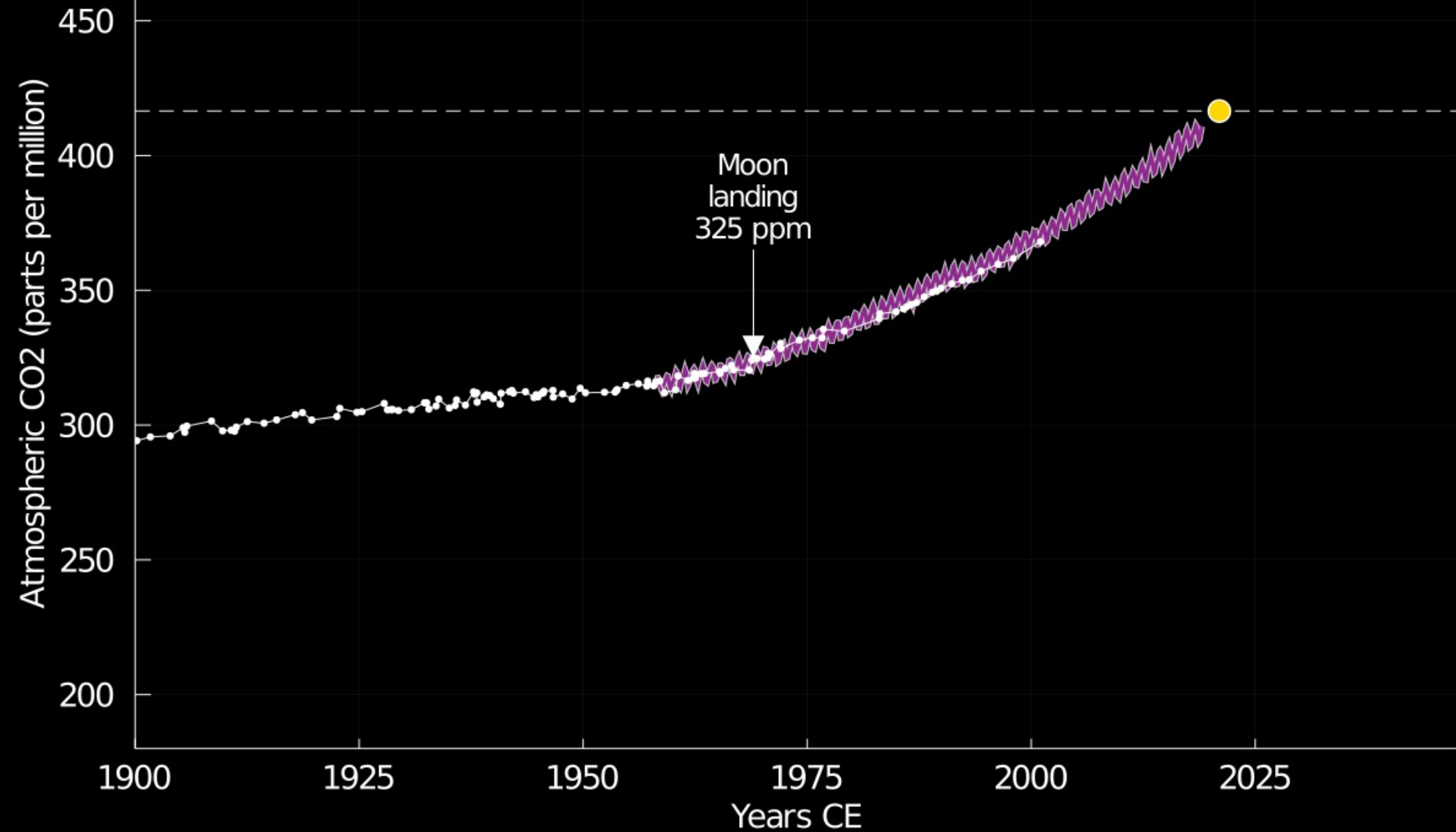
a) Change in global surface temperature (decadal average) as **reconstructed** (1-2000) and **observed** (1850-2020)



b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)



The last c.100 years



Observed CO₂: NASA, NOAA

Ice core CO₂: Bereiter et al, 2015, GRL, composite of 12 studies

The last c.1000 years

Atmospheric CO₂ (parts per million)

450
400
350
300
250
200

1000

1250

1500

1750

2000

Years CE

First Maori
settlers in NZ
283 ppm

French
revolution
282 ppm

Moon
landing
325 ppm

Observed CO₂: NASA, NOAA

Ice core CO₂: Bereiter et al, 2015, GRL, composite of 12 studies



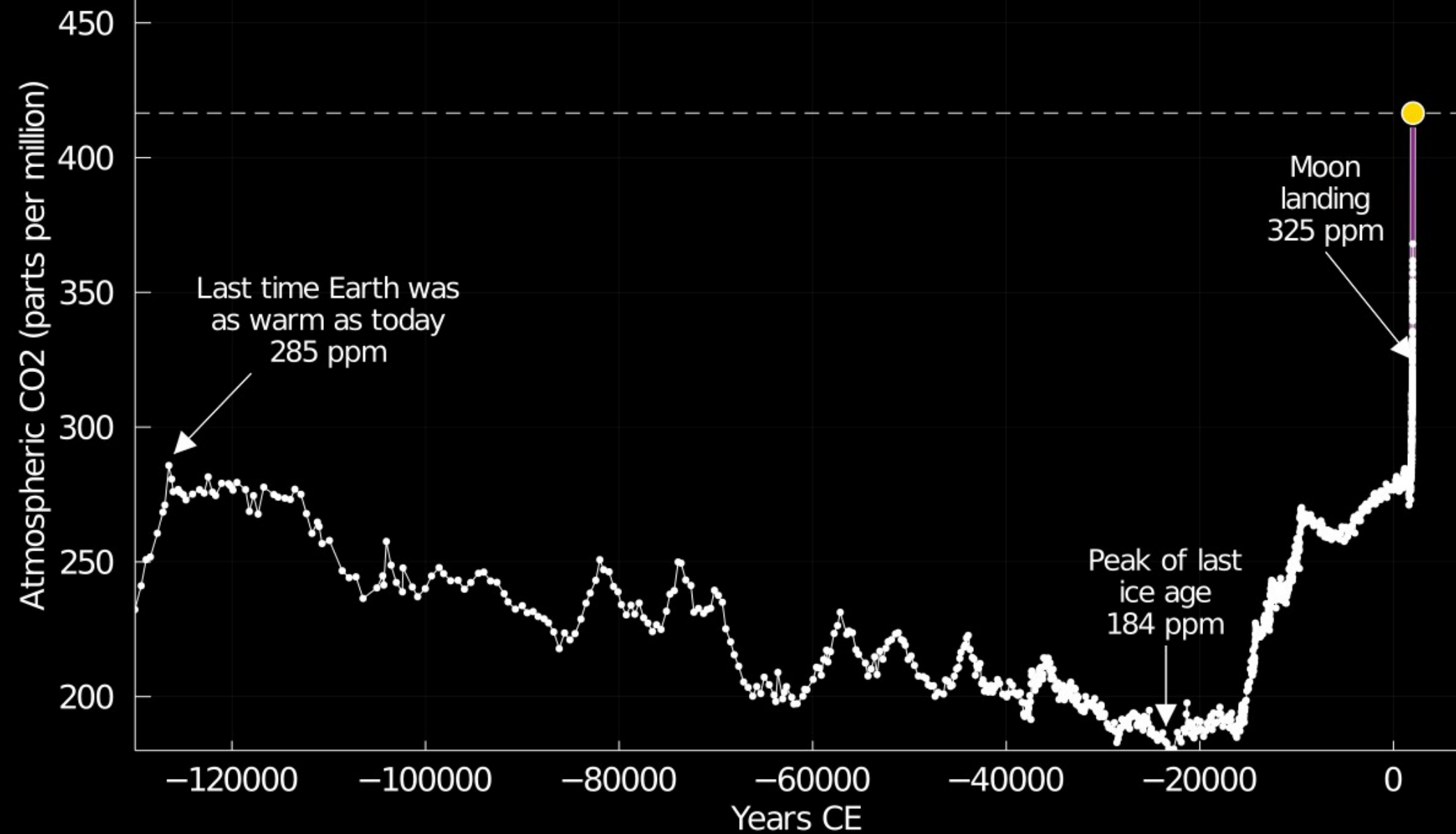
The last c.10000 years



Observed CO₂: NASA, NOAA

Ice core CO₂: Bereiter et al, 2015, GRL, composite of 12 studies

The last c.100000 years



Observed CO₂: NASA, NOAA

Ice core CO₂: Bereiter et al, 2015, GRL, composite of 12 studies

The last c.1000000 years

Atmospheric CO₂ (parts per million)

450
400
350
300
250
200

-800000

-600000

-400000

-200000

0

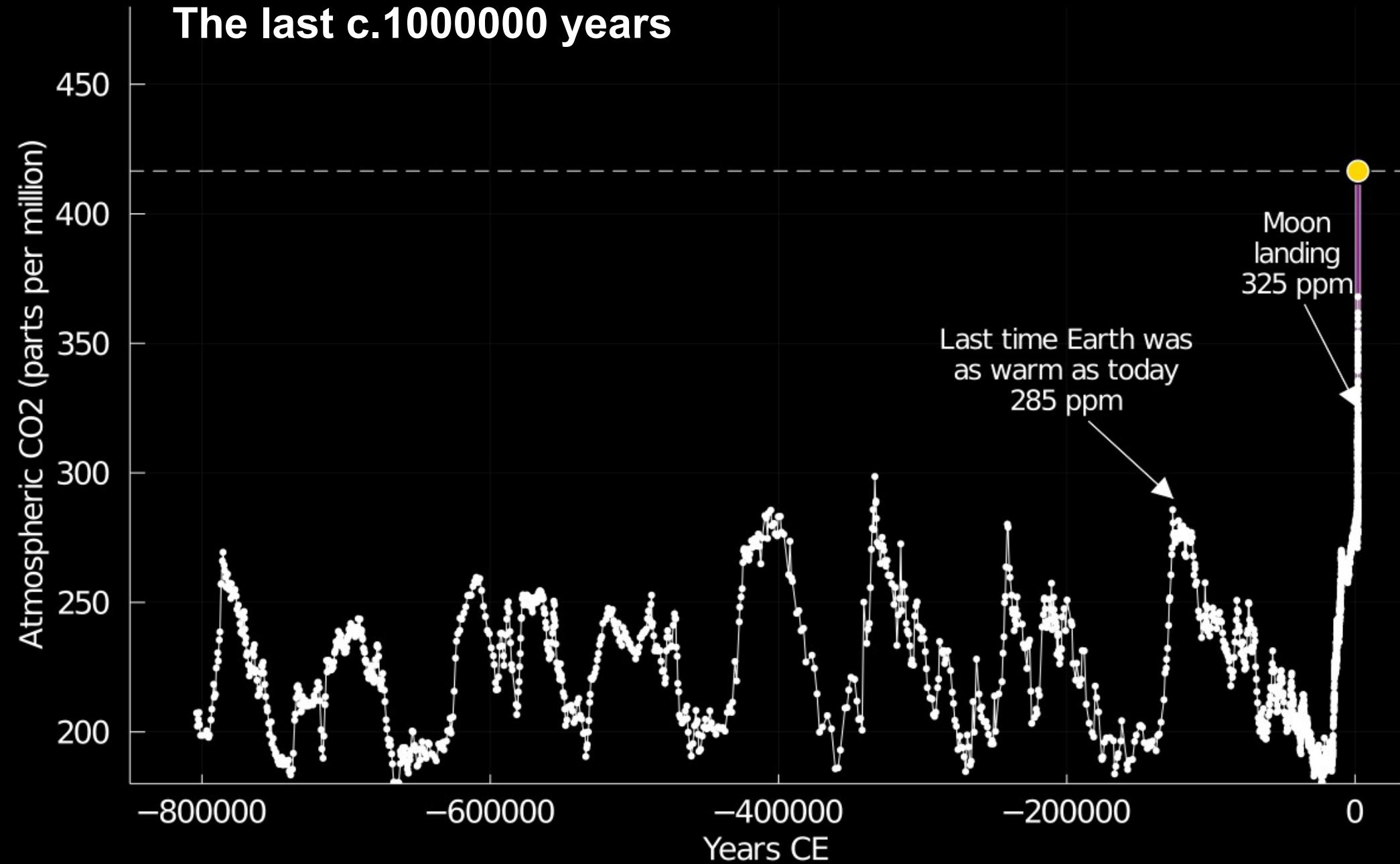
Years CE

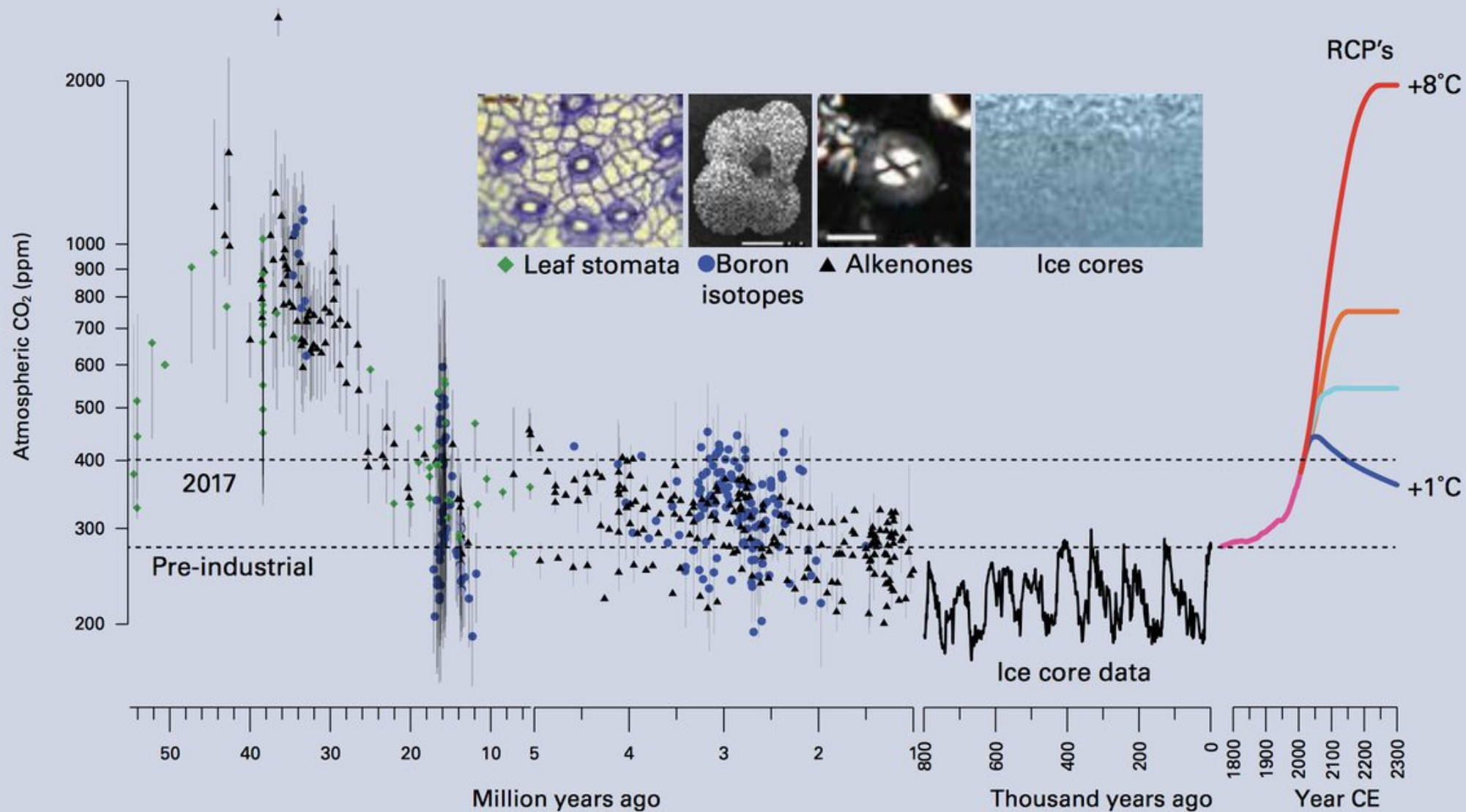
Last time Earth was
as warm as today
285 ppm

Moon
landing
325 ppm

Observed CO₂: NASA, NOAA

Ice core CO₂: Bereiter et al, 2015, GRL, composite of 12 studies



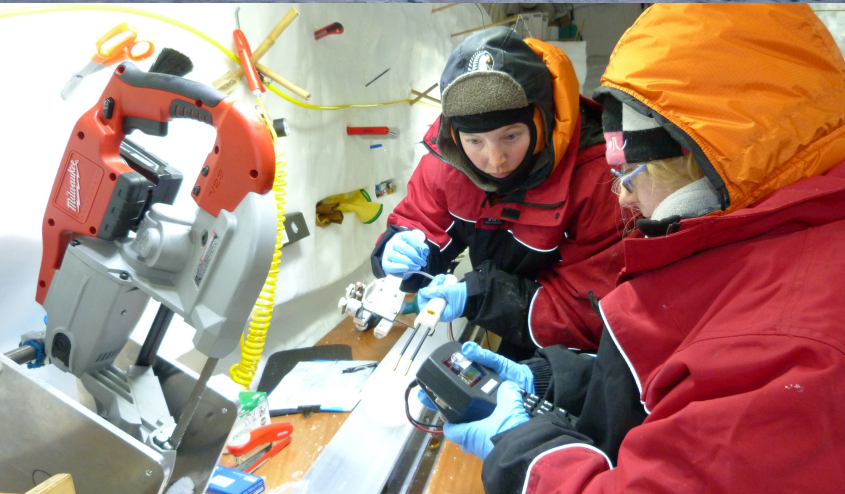


CE – Common Era

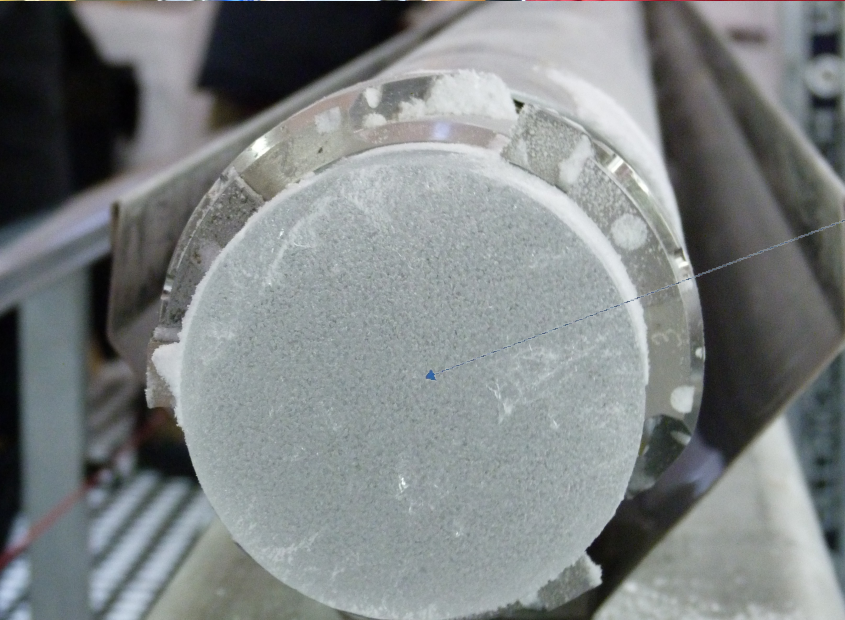
Images:
Nancy Bertler,
GNS Science



764 m ice
core from
West
Antarctica,
>70,000 yrs



Air
bubbles



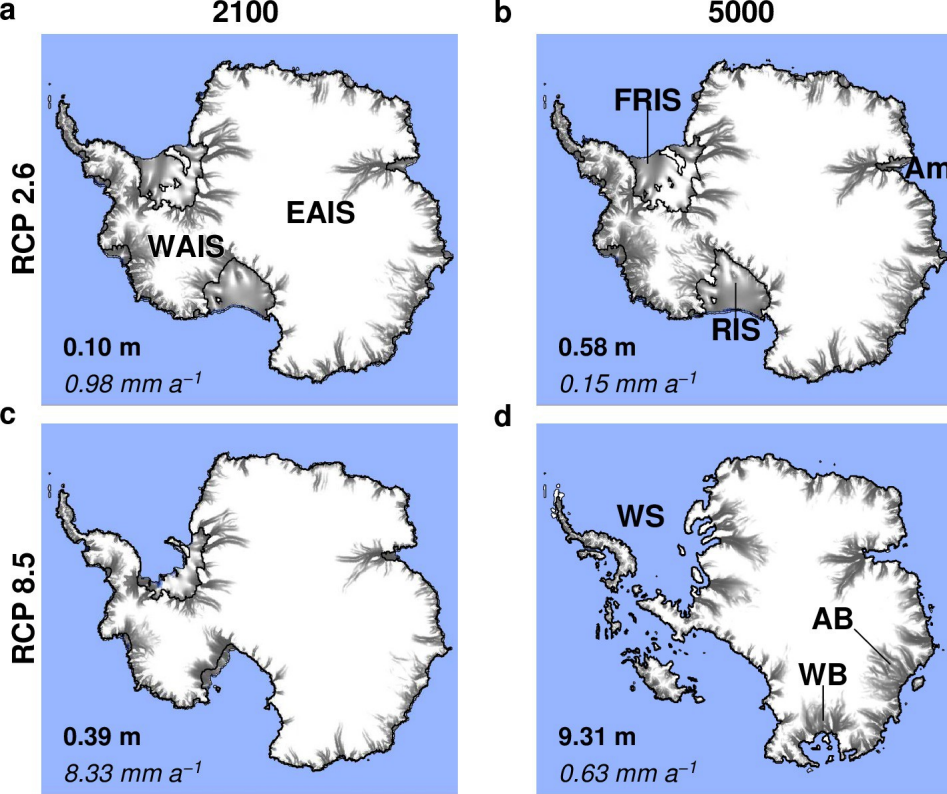
Ok, that's great about the past, but what about the future?



Ice radar survey,
Ross Ice Shelf, 2010

Ice velocity GNSS survey,
Skelton Glacier, 2011





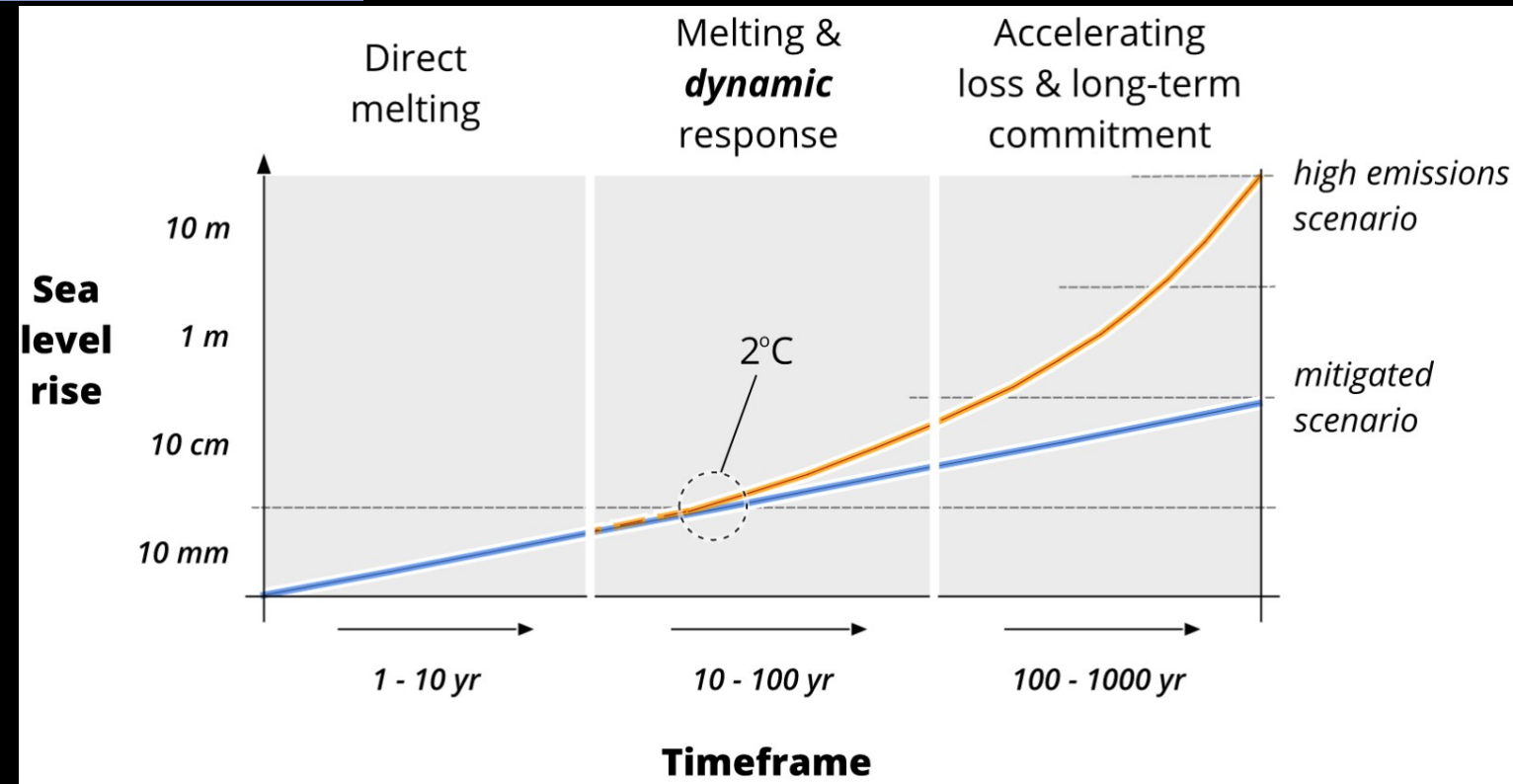
Antarctica has the potential to contribute **65 m** to sea level if it all melts.

Even partial melting could be catastrophic.

Key uncertainty is *how quickly* ice sheet melt will occur...

Golledge et al., 2015, Nature

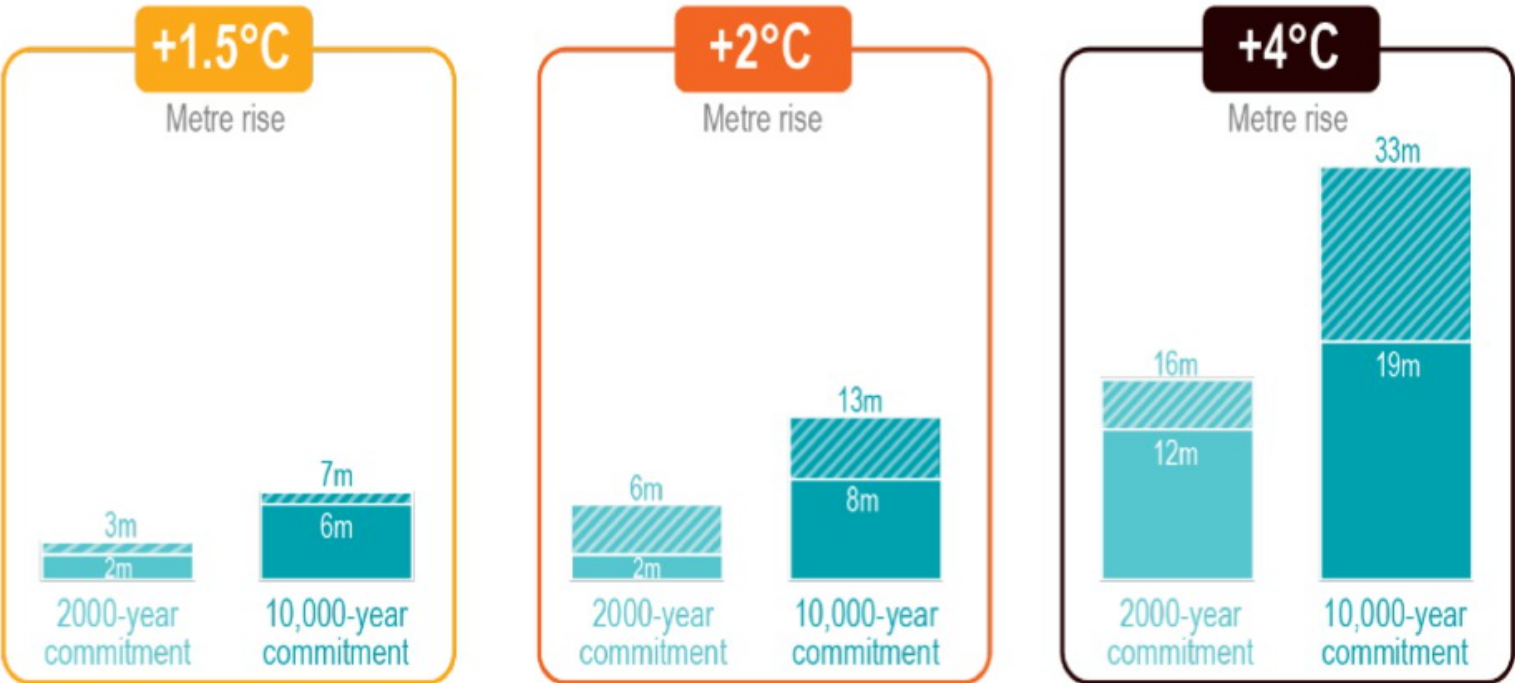
Models help us explore future possibilities.



Long-term consequences: Sea level rise

Today, sea level has already increased by 20 cm and will increase an additional 30 cm to 1 m or more by 2100, depending on future emissions.

Sea level reacts very slowly to global warming so, once started, the rise continues for thousands of years.



<http://www.searise.nz>

About

We combine projections of sea level rise (from ice sheet melt, glacier melt, thermal expansion of the ocean) with measurements of **vertical land motion**.

This allows us to produce location-specific estimates of sea level impacts.

VICTORIA
UNIVERSITY OF WELLINGTON
TE WHARE WĀNANGA
O TE ŪPOKO O TE IKA A MĀUI



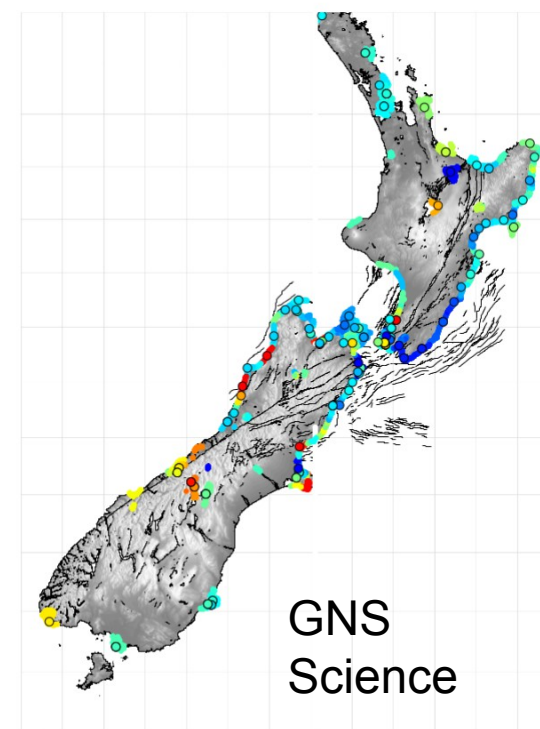
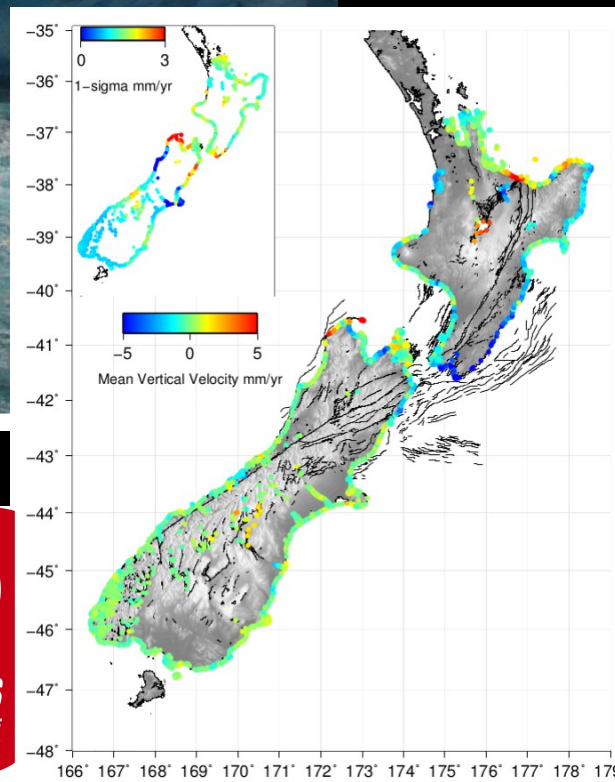
Antarctic Research Centre
Te Pūtahi Rangahau i te Kōpakatanga ki te Tonga



NIWA
Taihoro Nukurangi



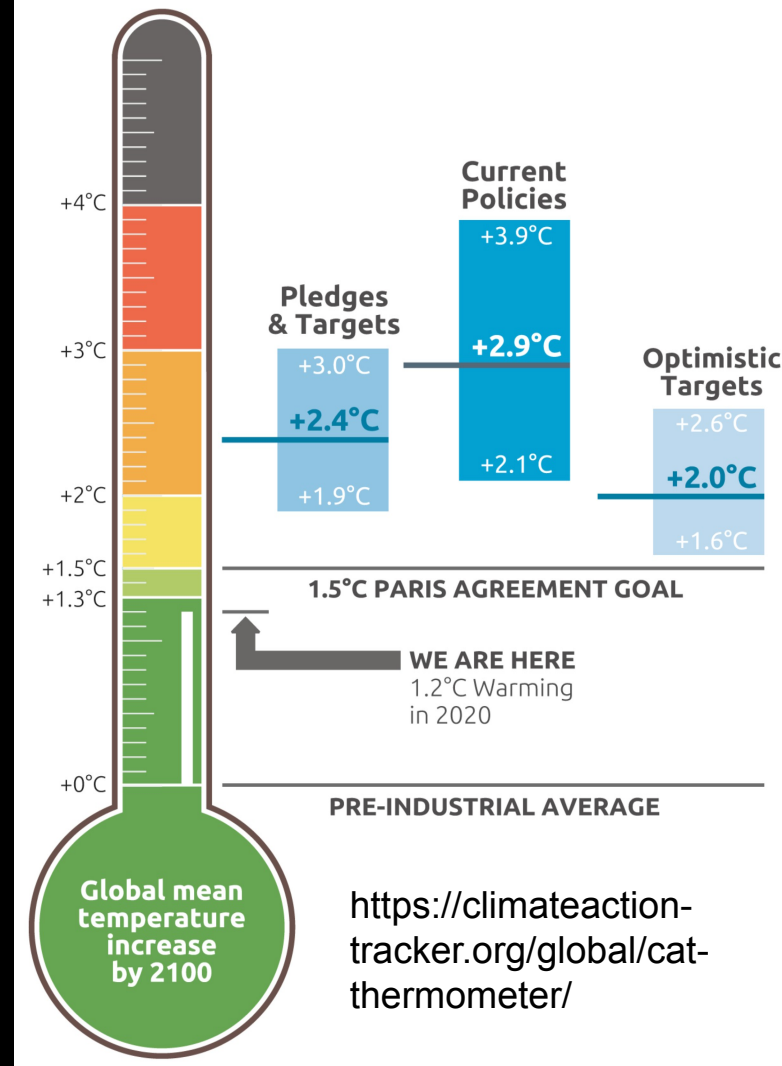
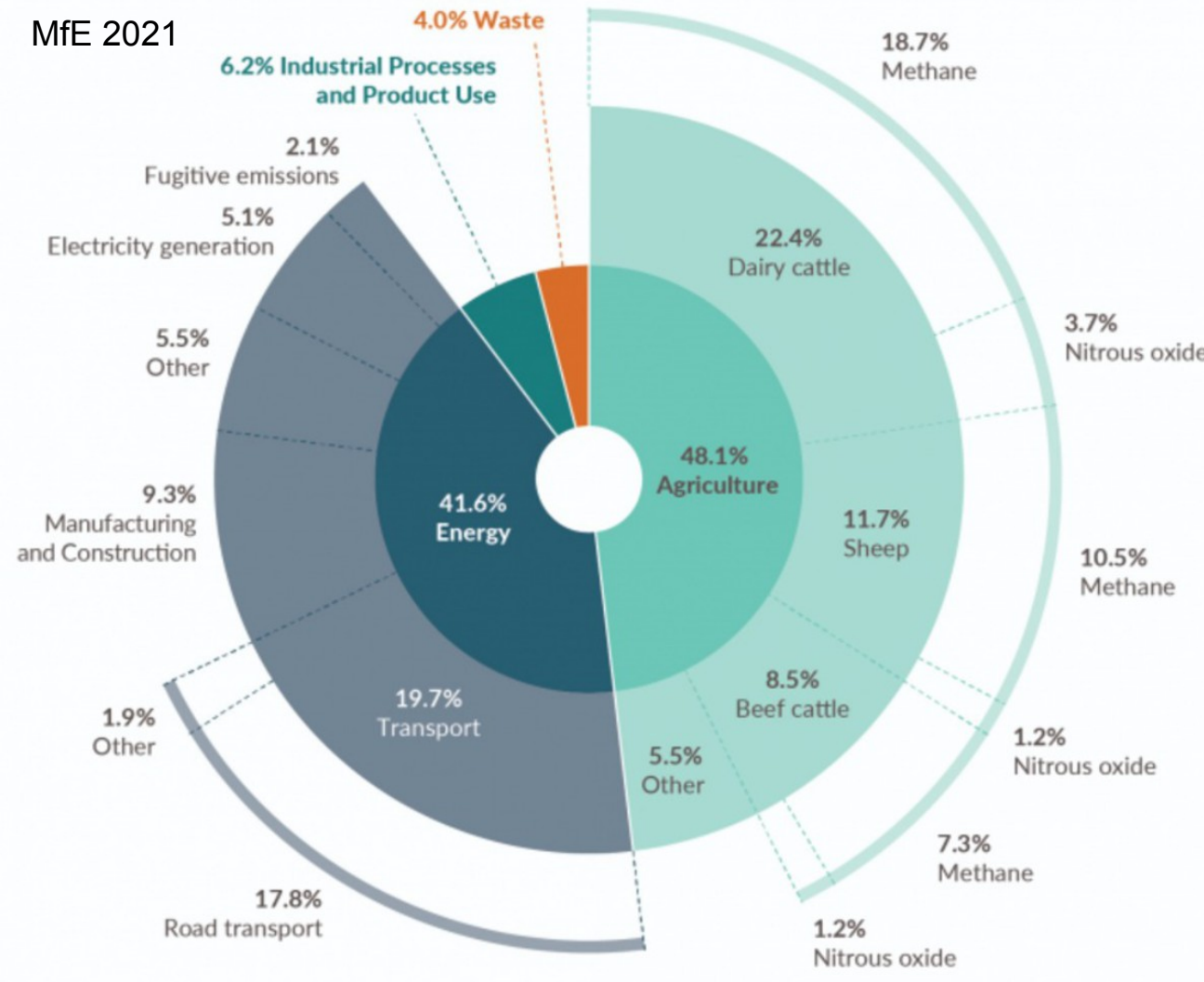
**GNS
SCIENCE**
TE PŪ AO



New Zealand's greenhouse gas inventory

Global target

MfE 2021



“One of the frustrations is the realisation that climate change is not something that can be left to politicians to deal with on our behalf. The urgency is simply too great. The responsibility has been implicitly devolved to the individual, without any prior consent”.

Thank you!

Aotearoa New Zealand 7-station series

Monthly temperature anomalies (relative to 1981-2010)

Refs: See Mullan (2012); doi.org/10.2307/26169723

-1 to -2 stdev *below normal* >+3 stdev *extraordinarily above normal*
-2 to -3 stdev *well below normal* +2 to 3 stdev *well above normal*
<-3 stdev *extraordinarily below normal* +1 to 2 stdev *above normal*
-1 to +1 stdev *normal*

Temperature anomaly (°C)

