What Does Arctic Science Say About Climate Justice?

Pam Pearson, Director, ICCI

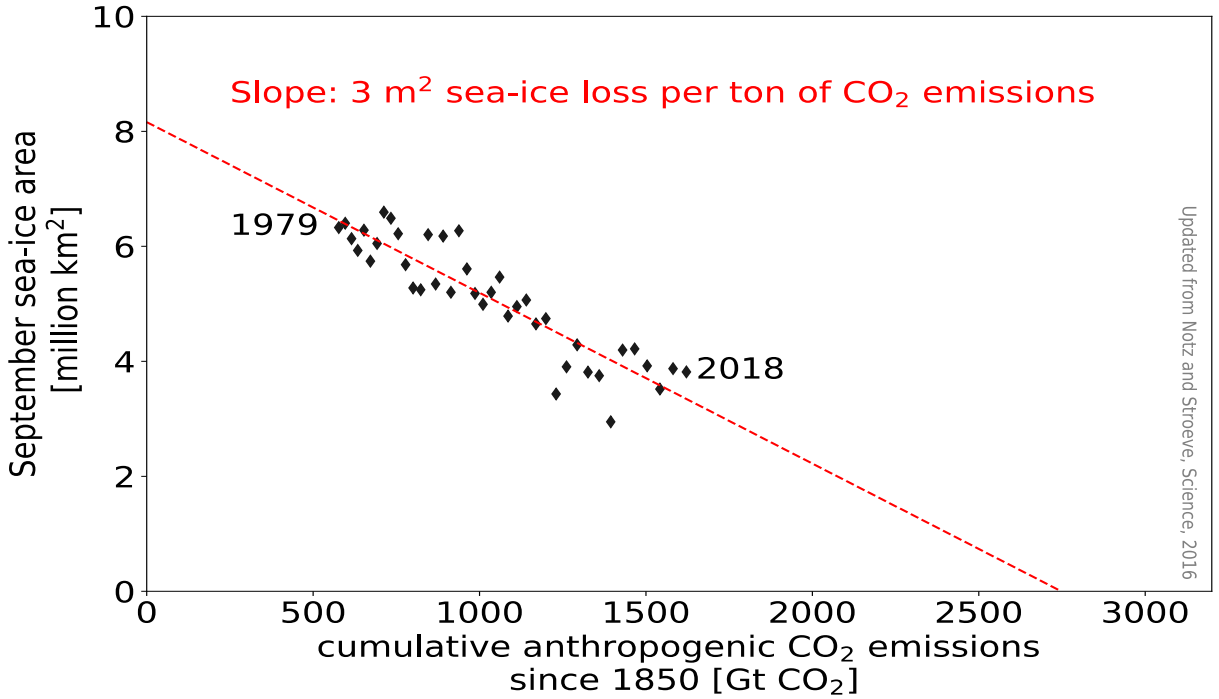
Arctic Sea Ice

Key policy-relevant messages from Arctic sea ice

- Arctic summer and multi-year sea ice loss inevitable, even with very low emissions (SSP1), likely before 2050

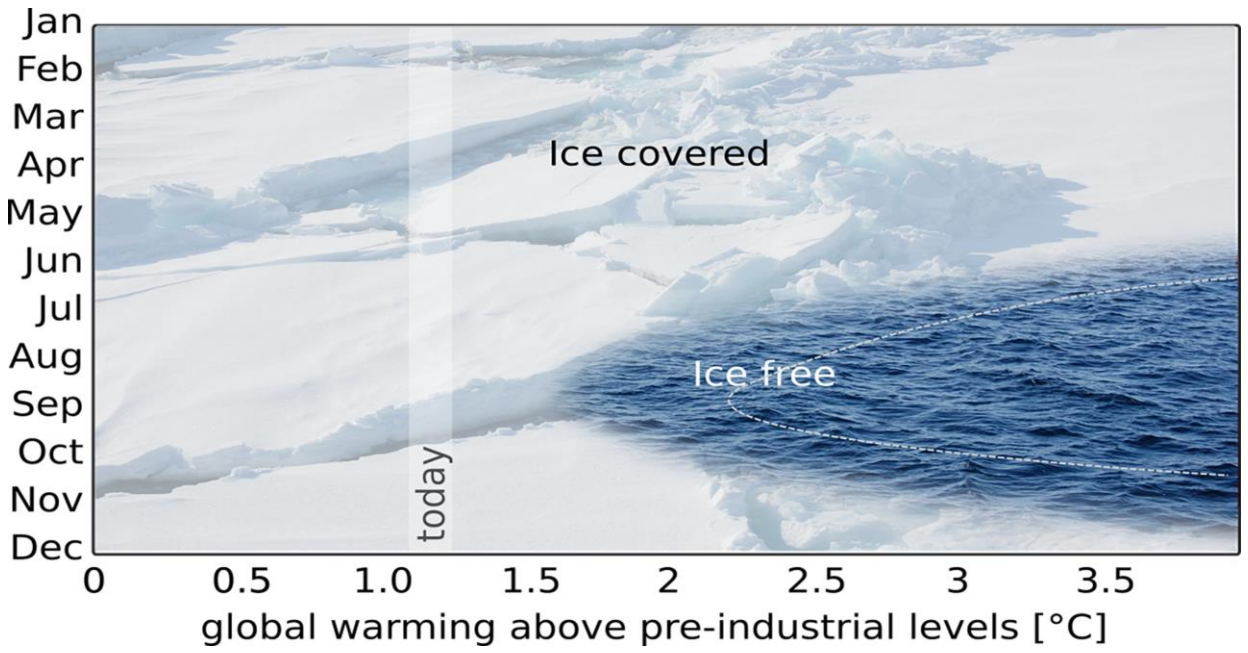
2022: Decades-centuries to recover – depending on peak temperature

Decreasing Sea Ice with Rising CO2…



Notz and Stroeve, *Science*, 2016

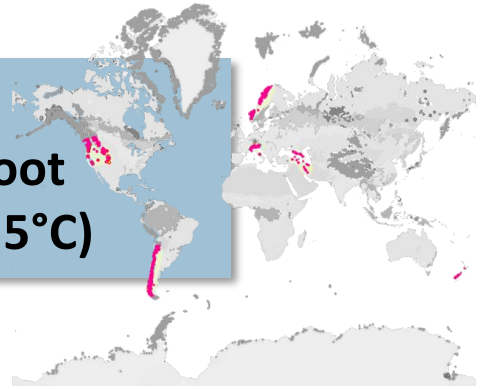
….and Temperature:

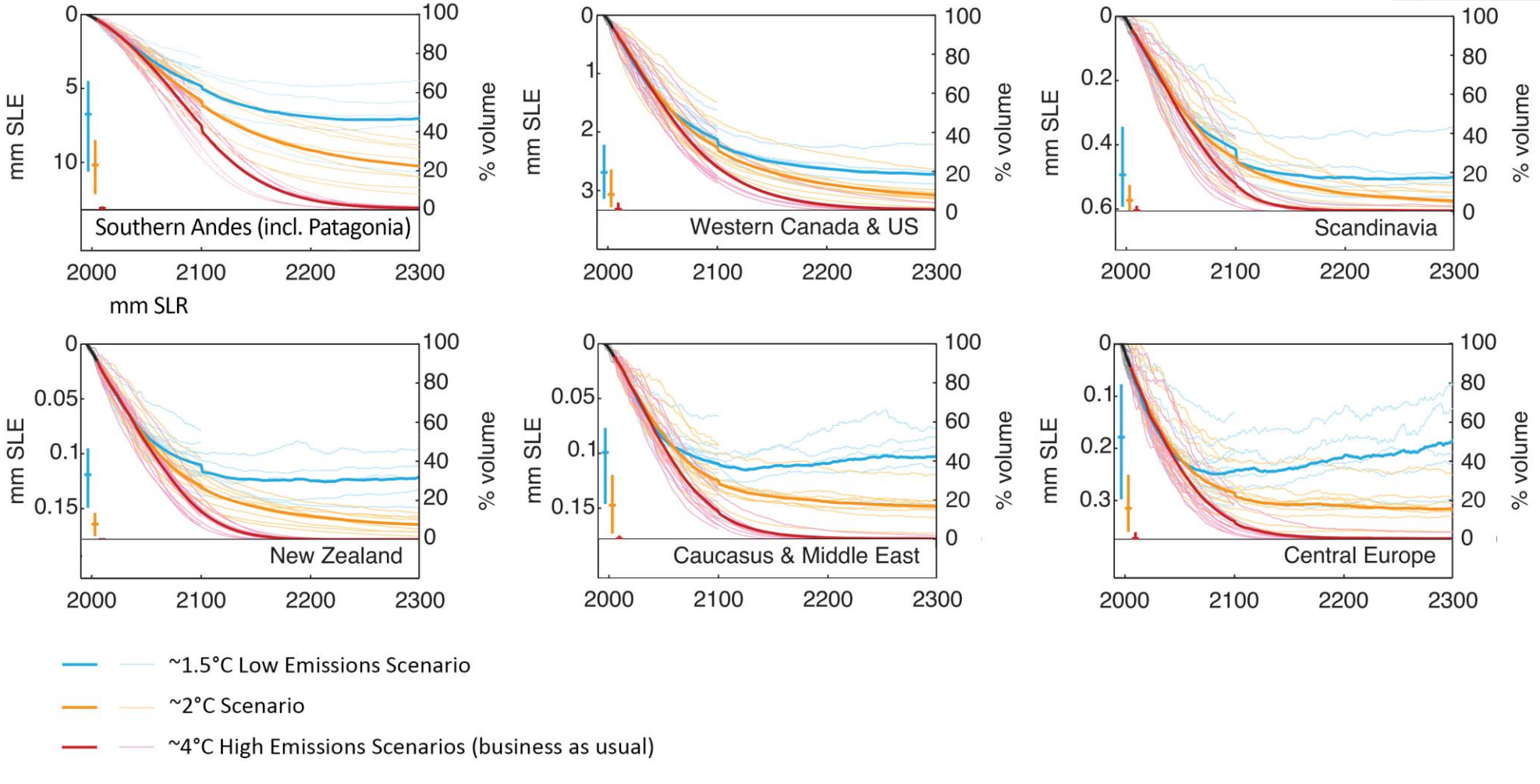


Notz and Stroeve, 2018

Mid-Latitude Glaciers

Substantial Remnants at 1.5°C,
Nearly All Lost with Even 2°C Overshoot
Many Centuries to Recover (even at 1.5°C)



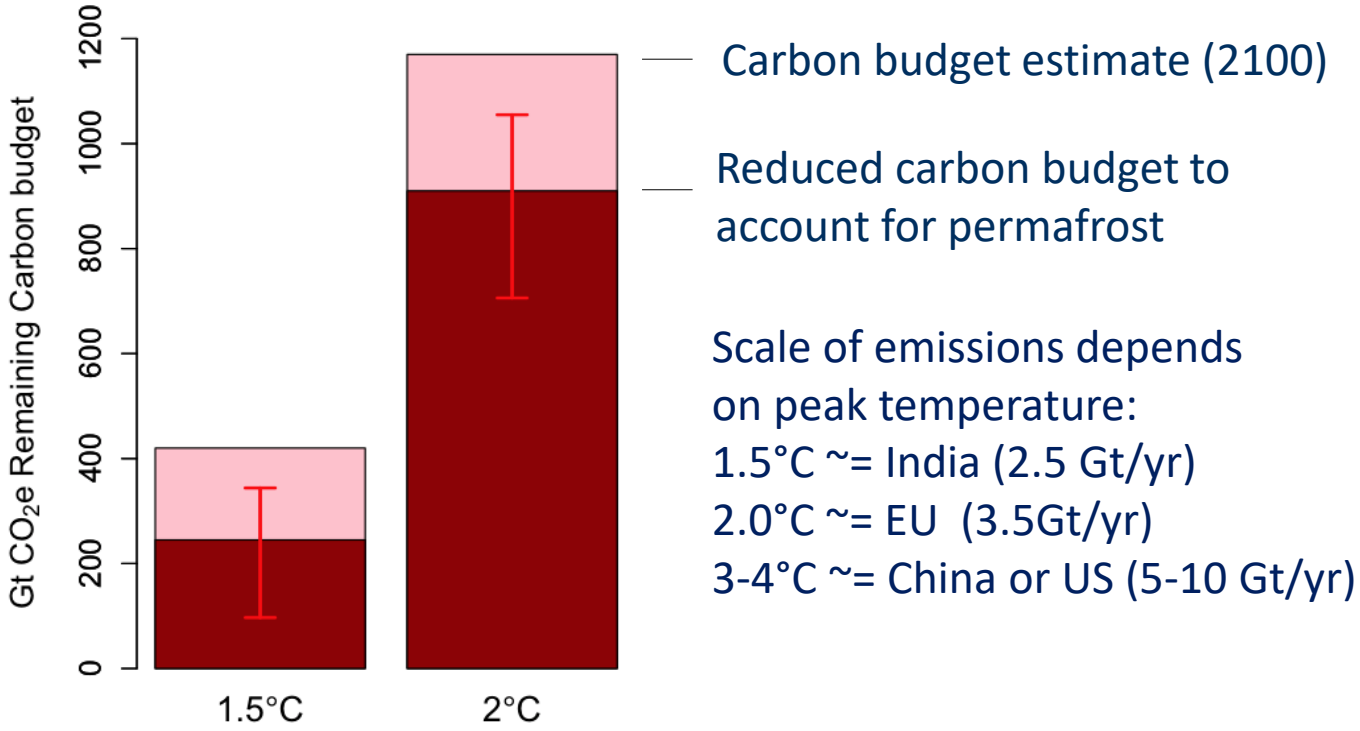


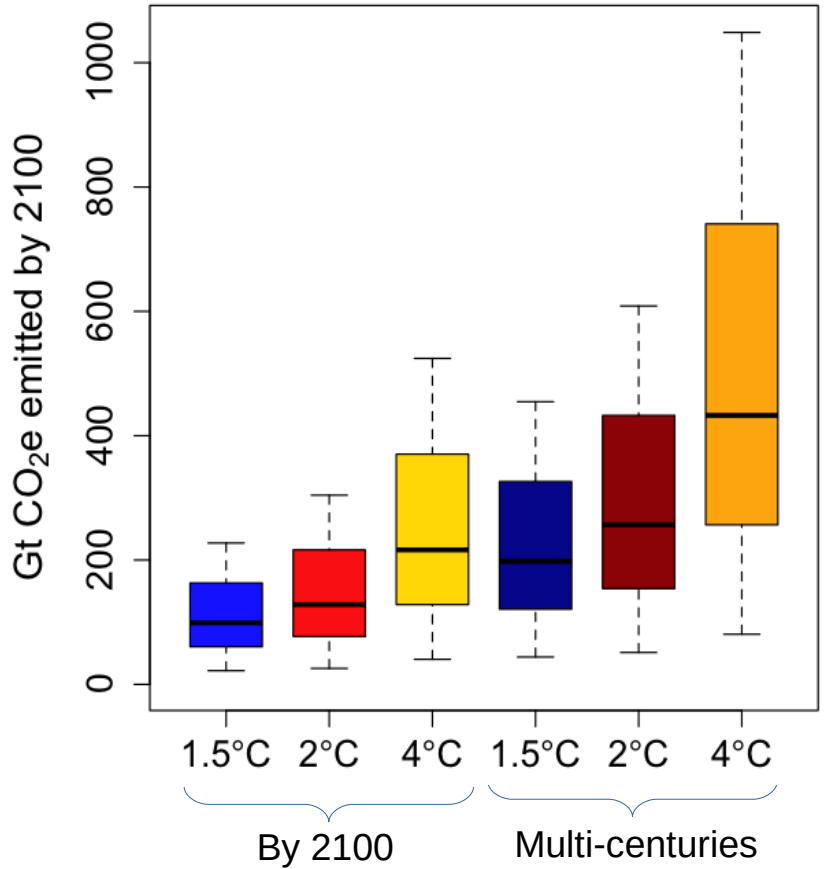
Figures based on Marzeion et al (2012)

Permafrost Thaw

2022: first observed increase methane; fires increasing thaw

- Size of emissions depends on peak temperature
- Emissions continue for centuries after initial thaw





Data sources: IPCC SR15, Gasser et al (2018), Turetsky et al (2019)

Greenland "zombie ice": Box et al, Aug. 2022

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-022-01441-2

Check for updates

OPEN

Greenland ice sheet climate disequilibrium and committed sea-level rise

Jason E. Box[1]✉, Alun Hubbard[2,3], David B. Bahr[4], William T. Colgan[1], Xavier Fettweis[5], Kenneth D. Mankoff[1], Adrien Wehrlé[6], Brice Noël[7], Michiel R. van den Broeke[7], Bert Wouters[7,8], Anders A. Bjørk[9] and Robert S. Fausto[1]

Ice loss from the Greenland ice sheet is one of the largest sources of contemporary sea-level rise (SLR). While process-based models place timescales on Greenland's deglaciation, their confidence is obscured by model shortcomings including imprecise atmospheric and oceanic couplings. Here, we present a complementary approach resolving ice sheet disequilibrium with climate constrained by satellite-derived bare-ice extent, tidewater sector ice flow discharge and surface mass balance data. We find that Greenland ice imbalance with the recent (2000–2019) climate commits at least 274 ± 68 mm SLR from $59 \pm 15 \times 10^3$ km^2 ice retreat, equivalent to $3.3 \pm 0.9\%$ volume loss, regardless of twenty-first-century climate pathways. This is a result of increasing mass turnover from precipitation, ice flow discharge and meltwater run-off. The high-melt year of 2012 applied in perpetuity yields an ice loss commitment of 782 ± 135 mm SLR, serving as an ominous prognosis for Greenland's trajectory through a twenty-first century of warming.

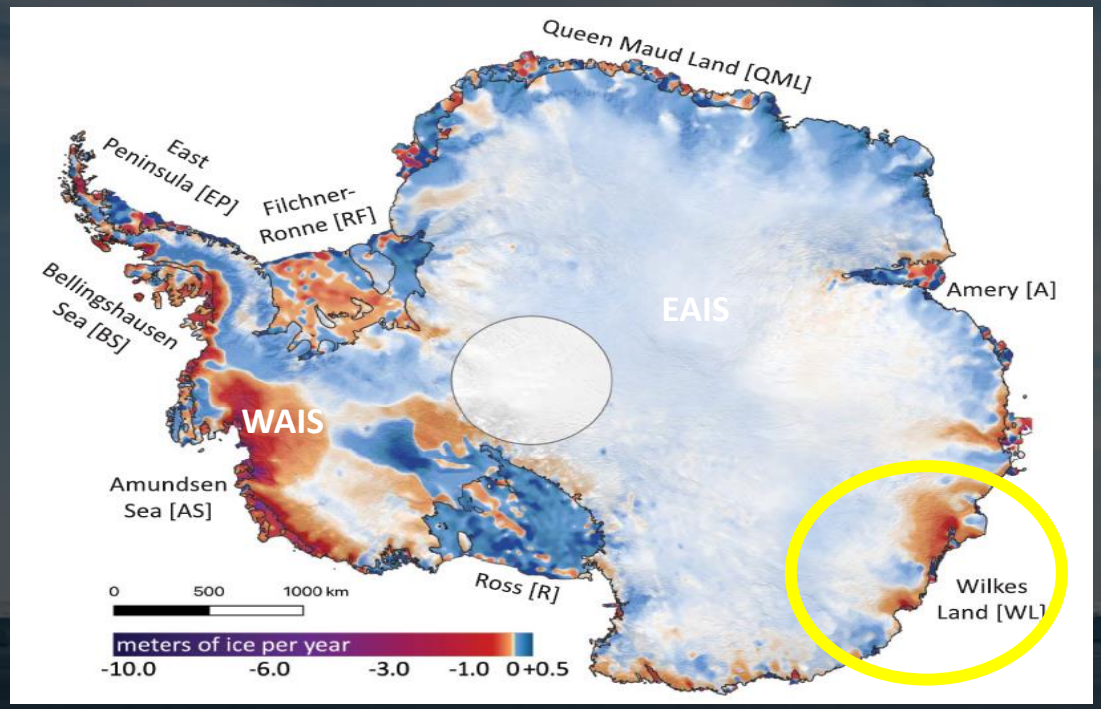
East Antarctica vulnerable >1.8°C: Stokes et al, Aug.2022

Review

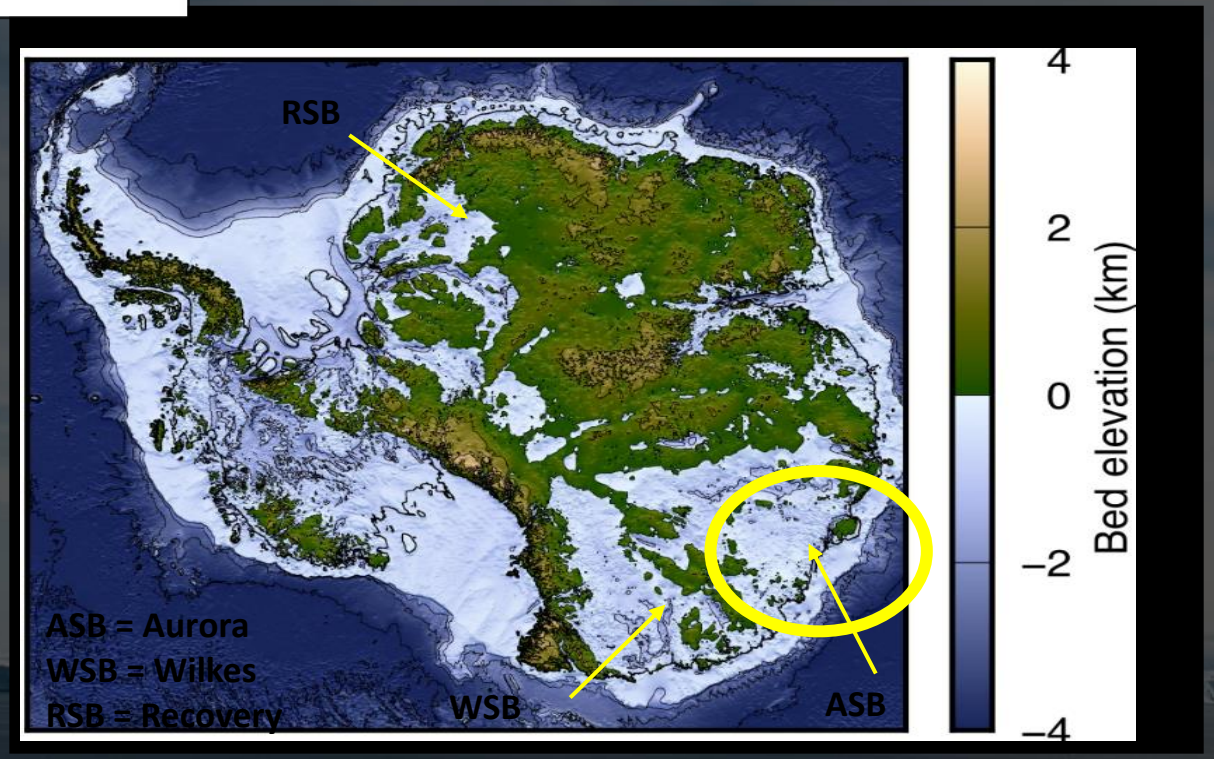
Response of the East Antarctic Ice Sheet to past and future climate change

https://doi.org/10.1038/s41586-022-04946-0
Received: 16 April 2021
Accepted: 7 June 2022

Chris R. Stokes[1✉], Nerilie J. Abram[2,3], Michael J. Bentley[1], Tamsin L. Edwards[4], Matthew H. England[5,6], Annie Foppert[7], Stewart S. R. Jamieson[1], Richard S. Jones[8,9], Matt A. King[10,11], Jan T. M. Lenaerts[12], Brooke Medley[13], Bertie W. J. Miles[1], Guy J. G. Paxman[14], Catherine Ritz[15], Tina van de Flierdt[16] & Pippa L. Whitehouse[1]



Smith et al. (2020: Science)

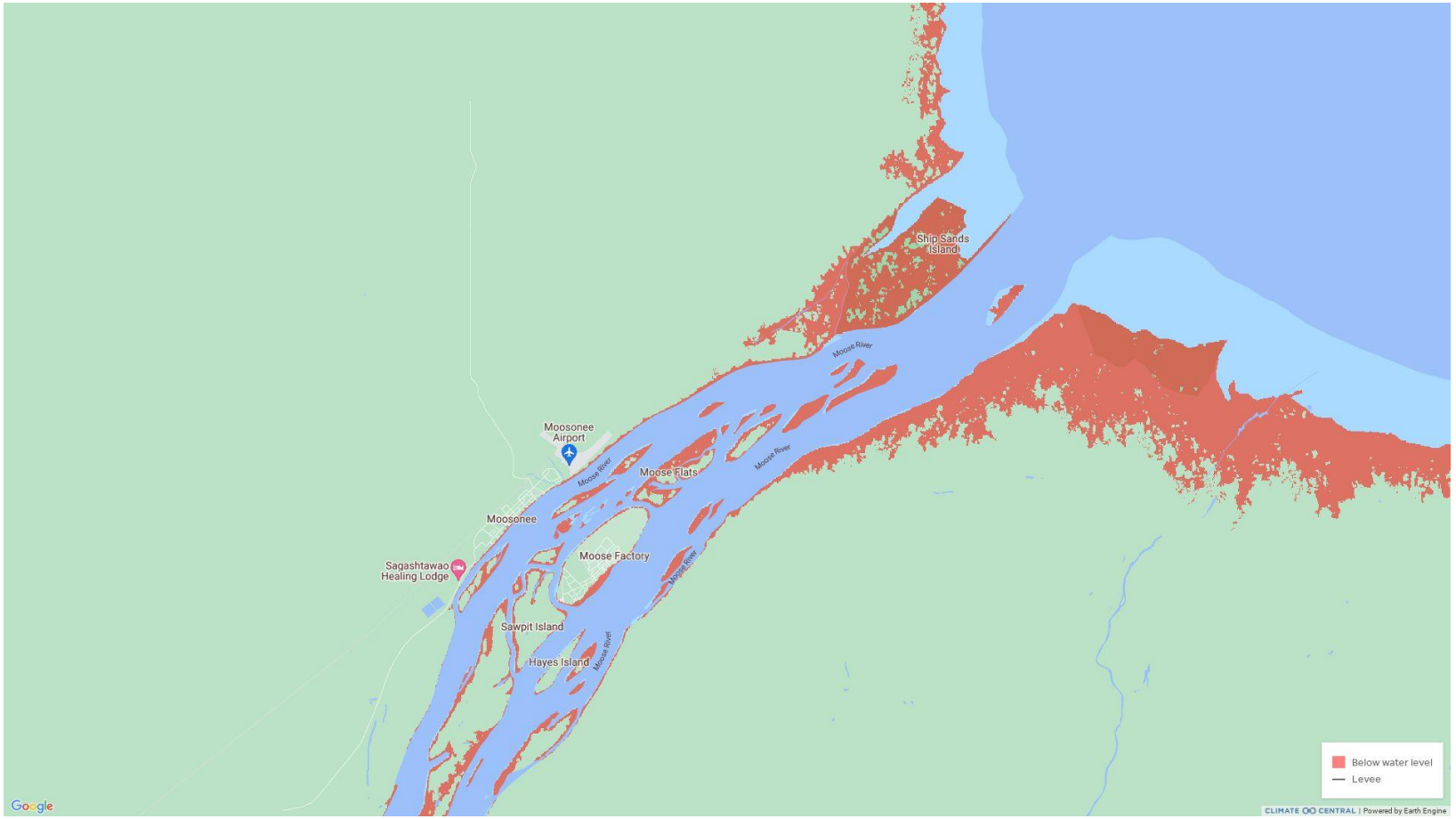


Stokes et al. (2022), modified from Morlighem et al. (2020: Nat. Geosci.)

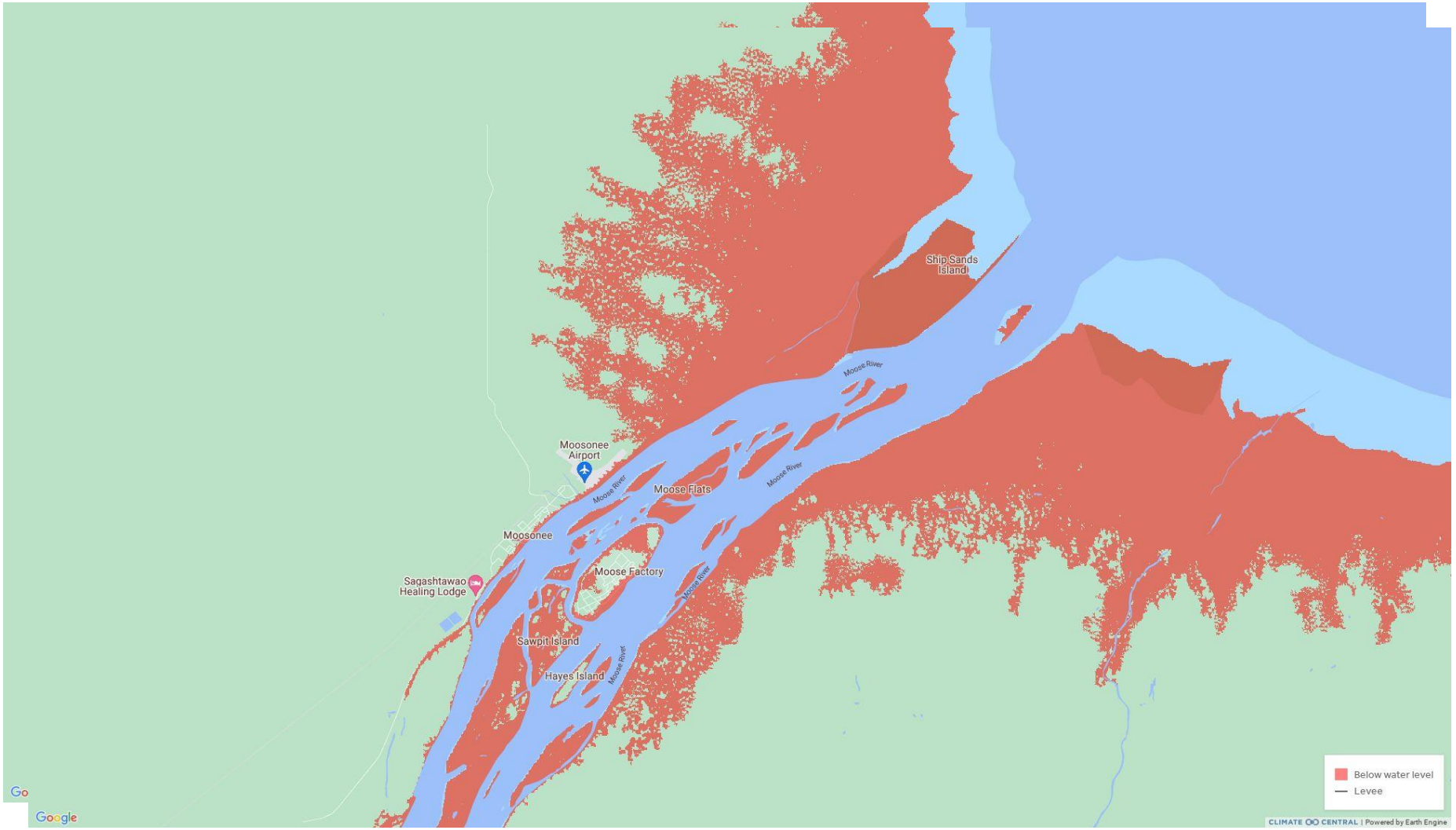
Ice Sheets and Sea-level Rise:

Paleoclimate records and models converging on committed SLR

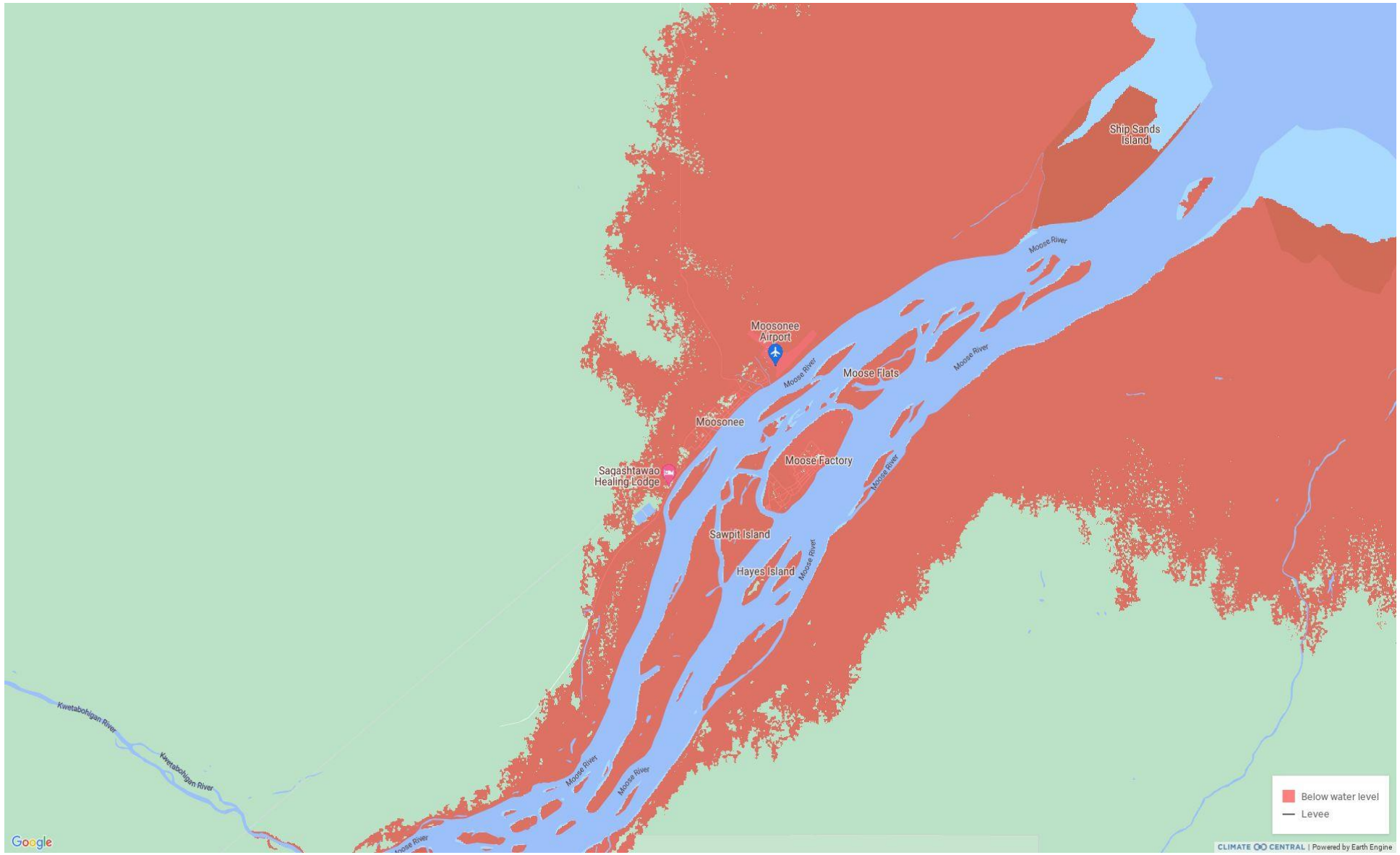
Moosonee - 3m SLR



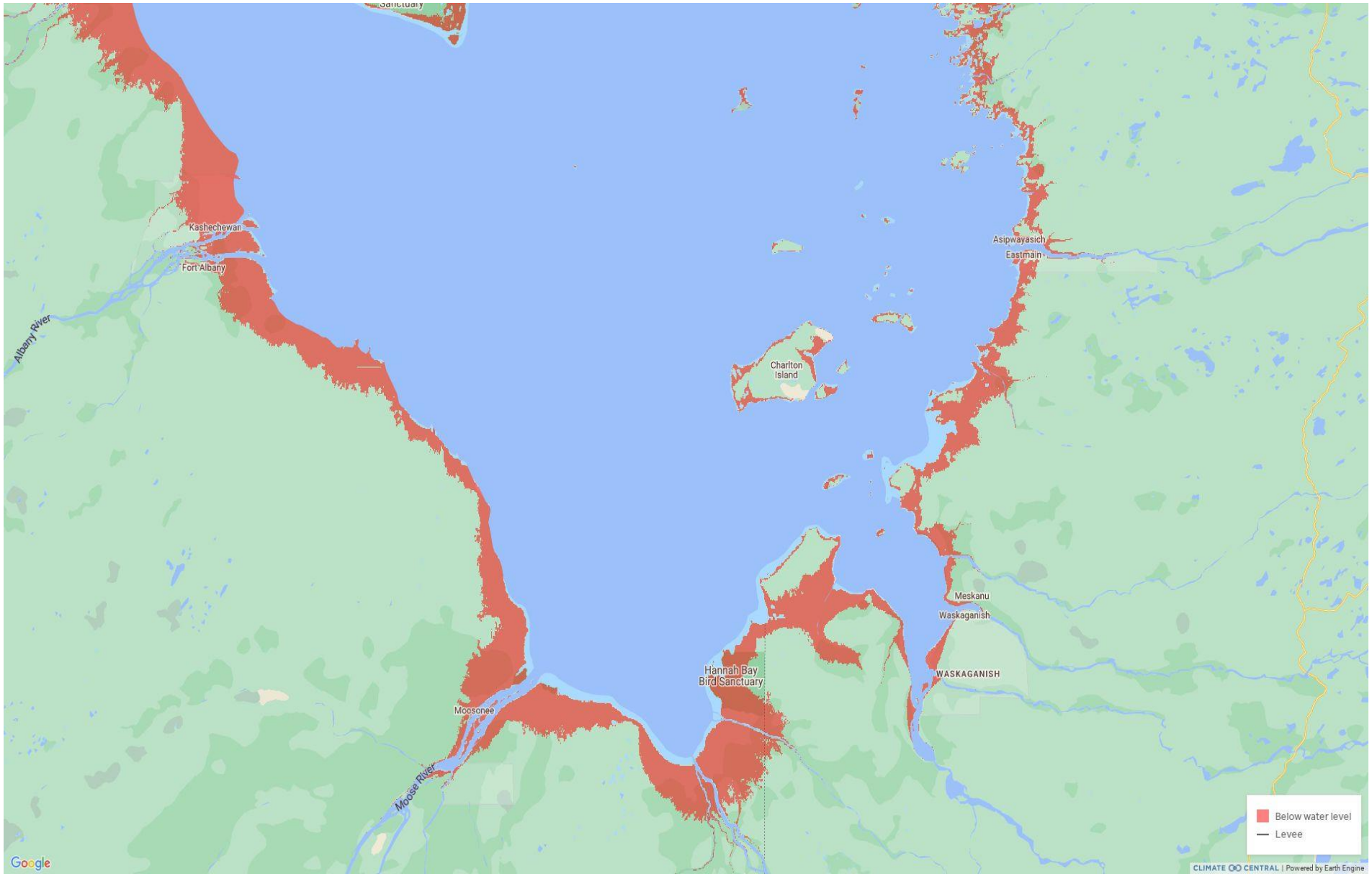
Moosonee: 6m SLR



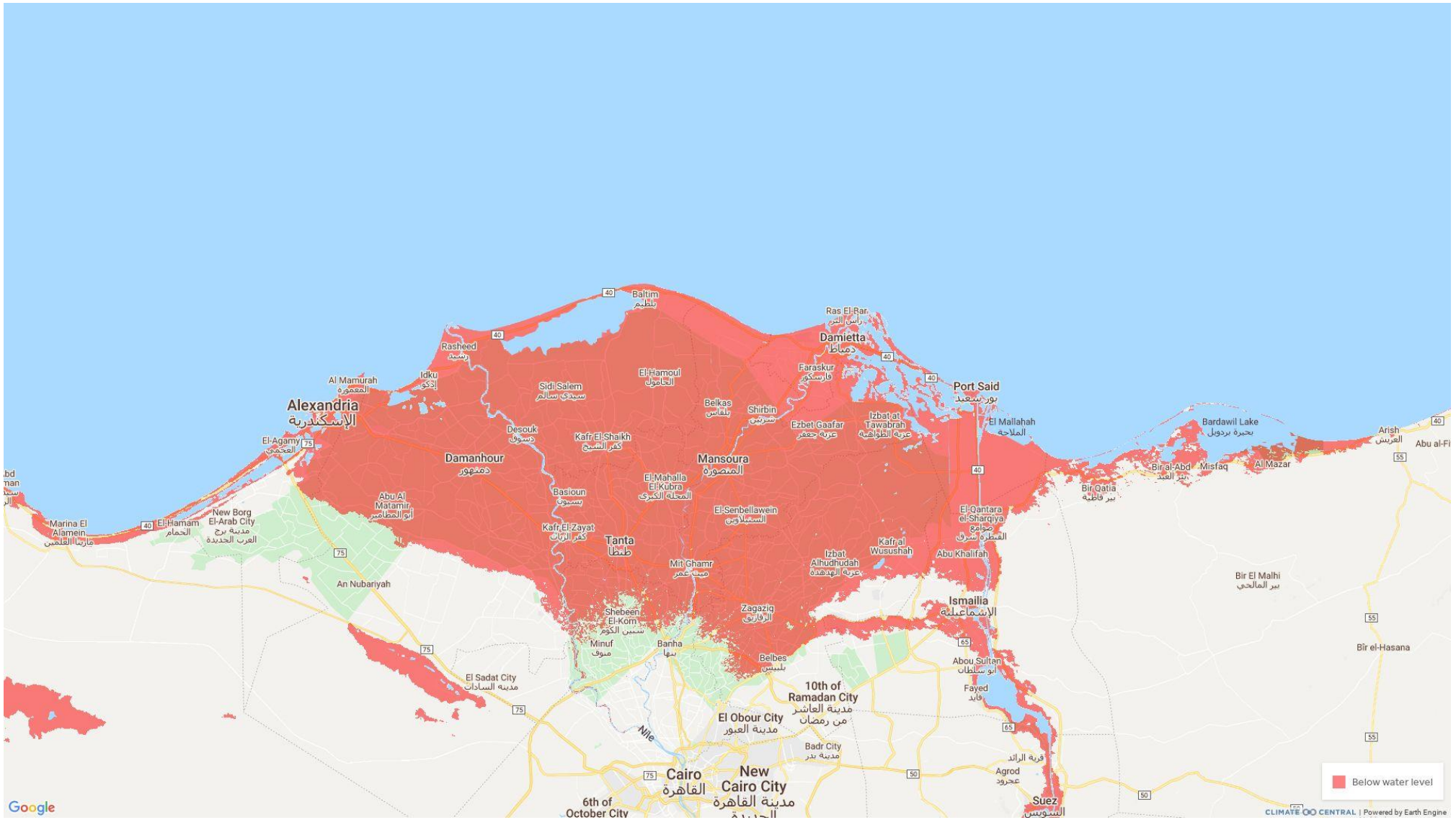
Moosonee: 10m SLR



Moosonee: 10m SLR



Nile Delta: 10m SLR

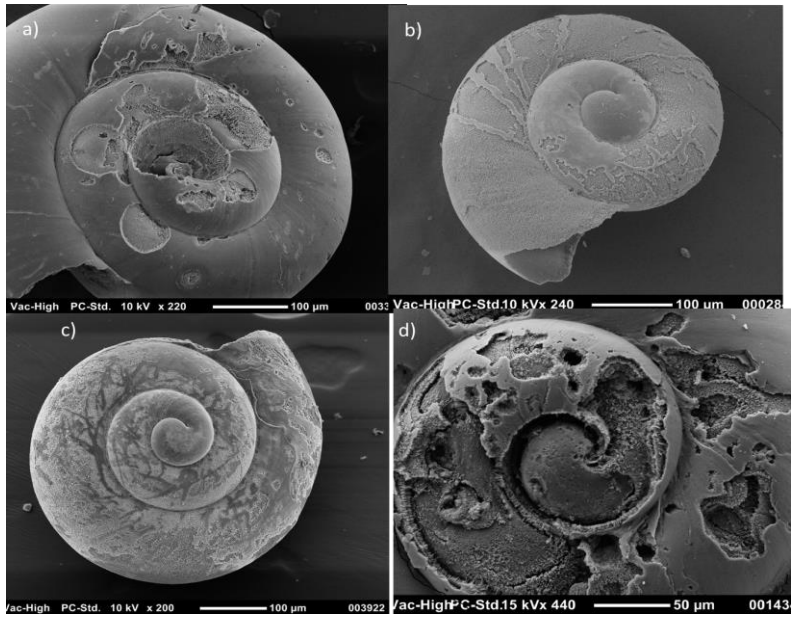


Polar Ocean Acidification

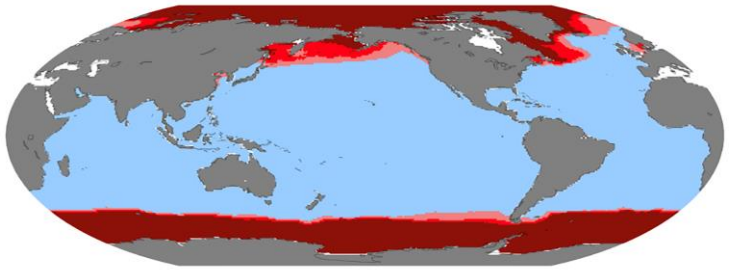
2022: Observations: faster than previously forecast; sea ice loss speeds

- Permanence on human timescales (50k-70k years)
- Population crash (snow crabs): multiple stressors

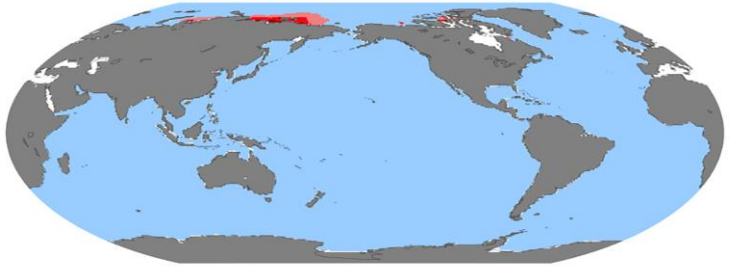
Shell Damage from Acidification:
Damage observed *today* in polar oceans



Ocean Acidification: CO2 → Carbonic acid
SRM Allows Continued Rise

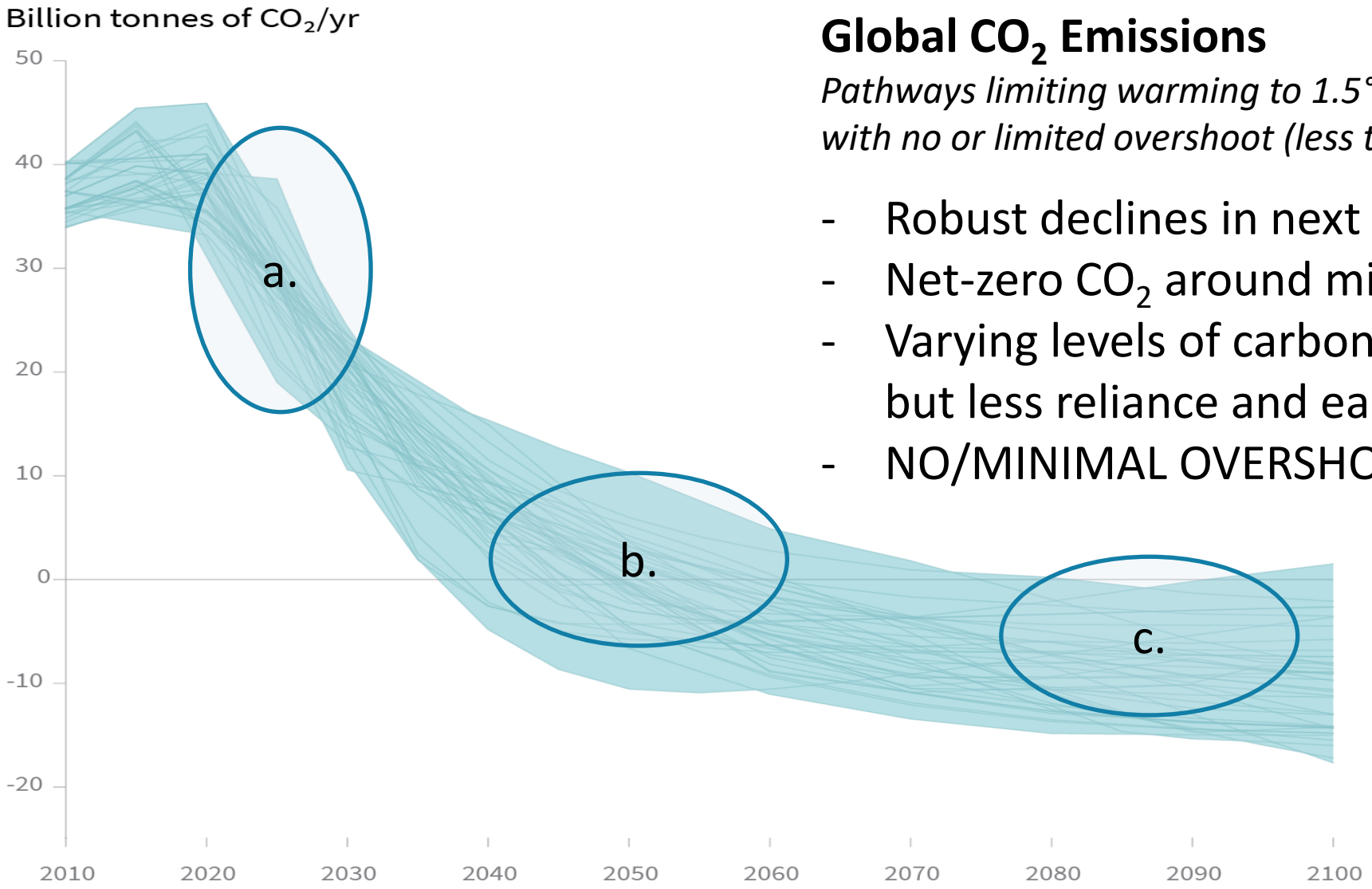


High emissions world (3-4°C)
year 2100; CO2 above 650



Low emissions world (1.5°C)
year 2100; CO2 ≈450

Cryosphere Science Means Firm 1.5°C Limit:



Global CO_2 Emissions

Pathways limiting warming to 1.5°C and 450ppm with no or limited overshoot (less than 0.1°C):

- Robust declines in next decade (50%)
- Net-zero CO_2 around mid-century
- Varying levels of carbon-dioxide removal (CDR), but less reliance and earlier (<2060)
- NO/MINIMAL OVERSHOOT

Source: IPCC SR15 SPM 3.A