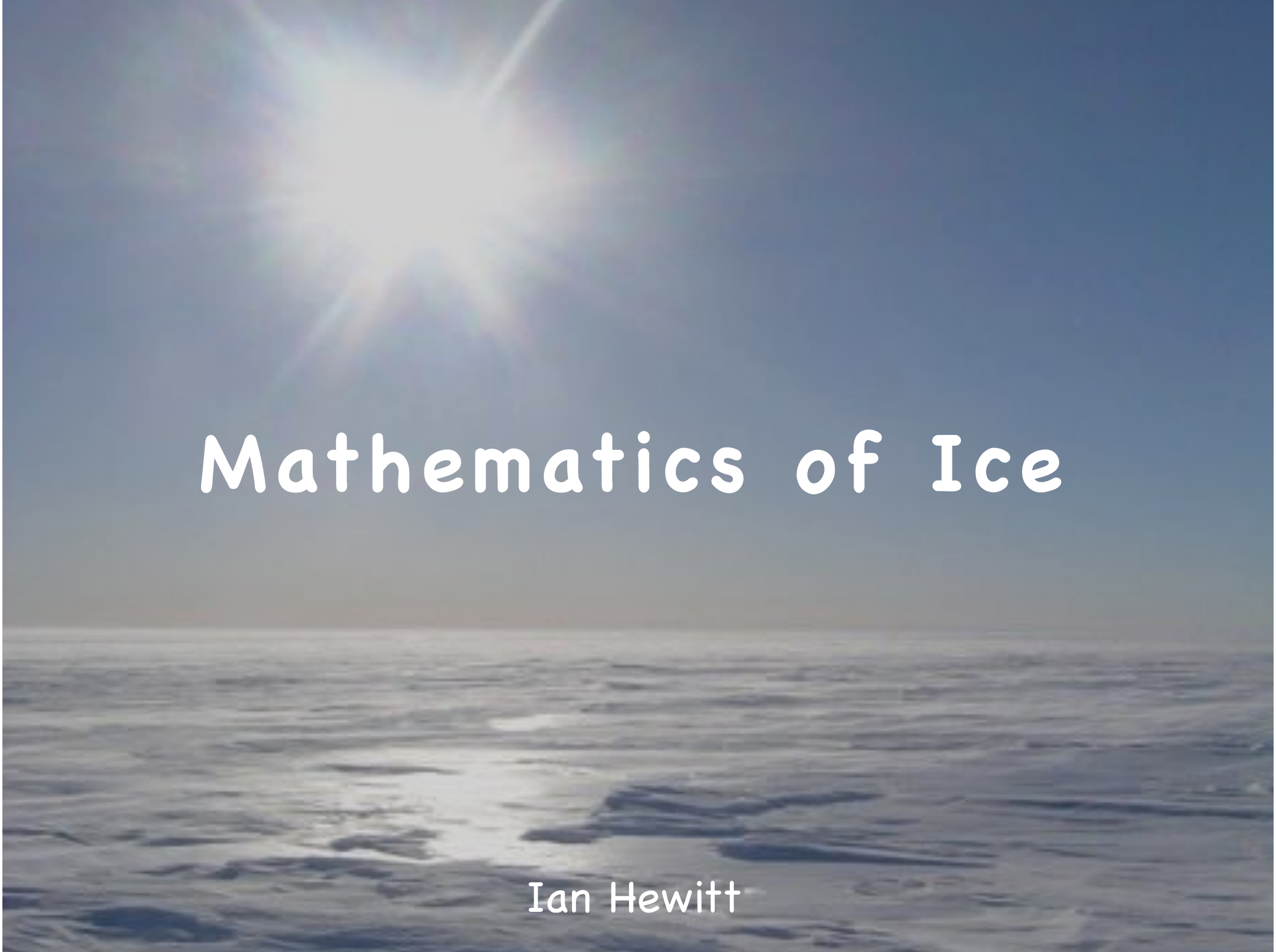
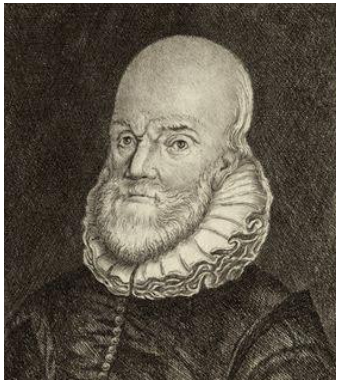


Mathematics of Ice

Ian Hewitt

Trinity Maths Fellows



Thomas Allen (1564-1571)

John Hammersley (1961-1985)

Chris Prior (1976-2013)

Simon Salamon (1984-2001)

Bernd Kircheim (2002-2012)

Ian Hewitt (2013-)

Steve Shkoller (2013-2014)

Melanie Rupflin (2015-)

Trinity Maths Today

2 fellows

21 undergraduates (BA / MMath)

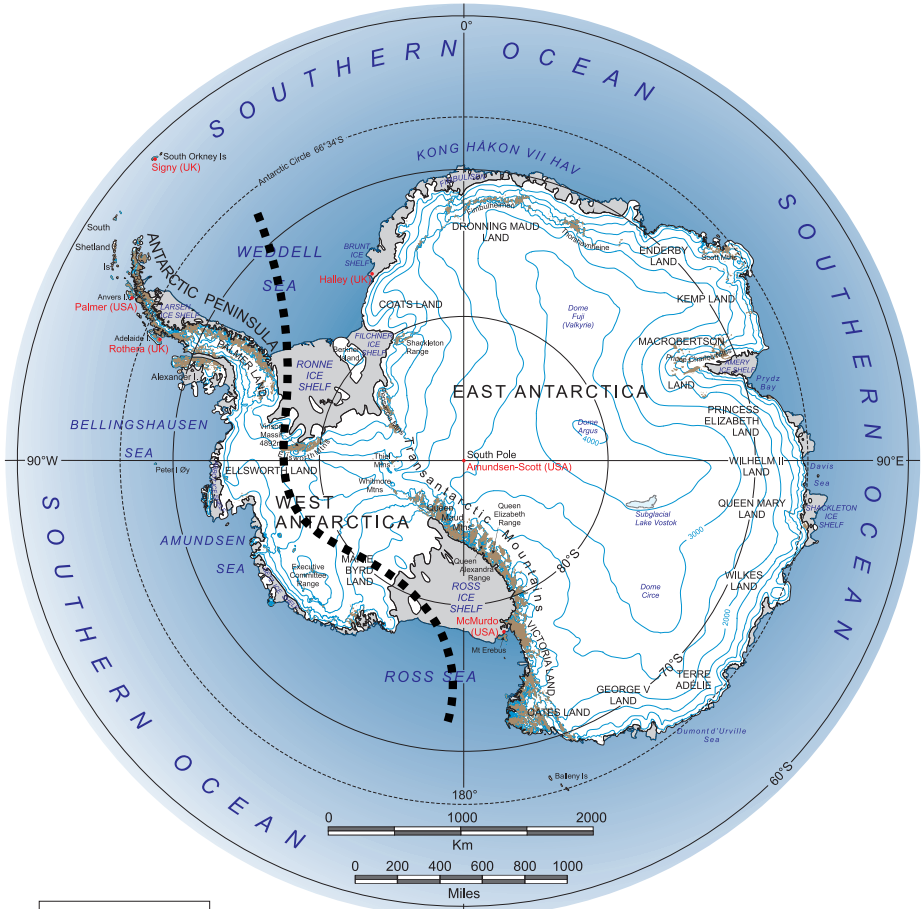
7 graduate students (MSc / DPhil)

new Mathematical Institute (2013)


current sea level rise
≈ 3.2 mm/y

Ice sheets

The Antarctic and Greenland ice sheets contain water equivalent to approximately 65 m sea level.



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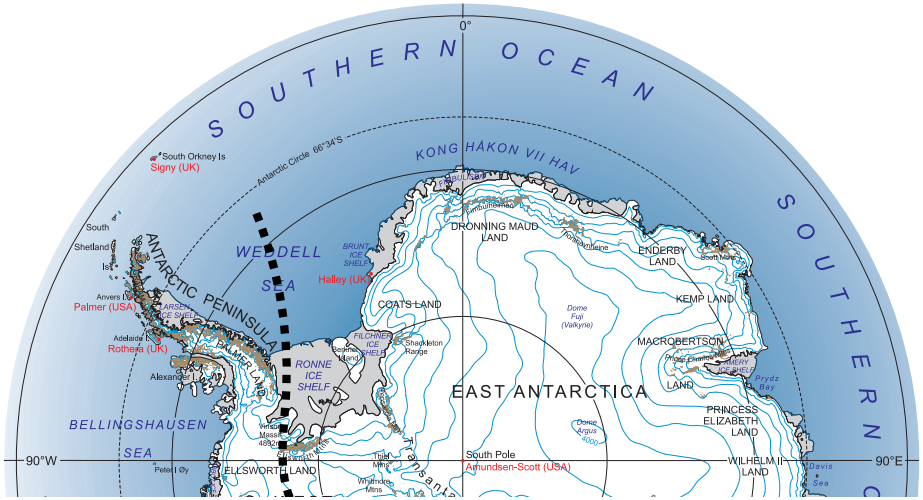
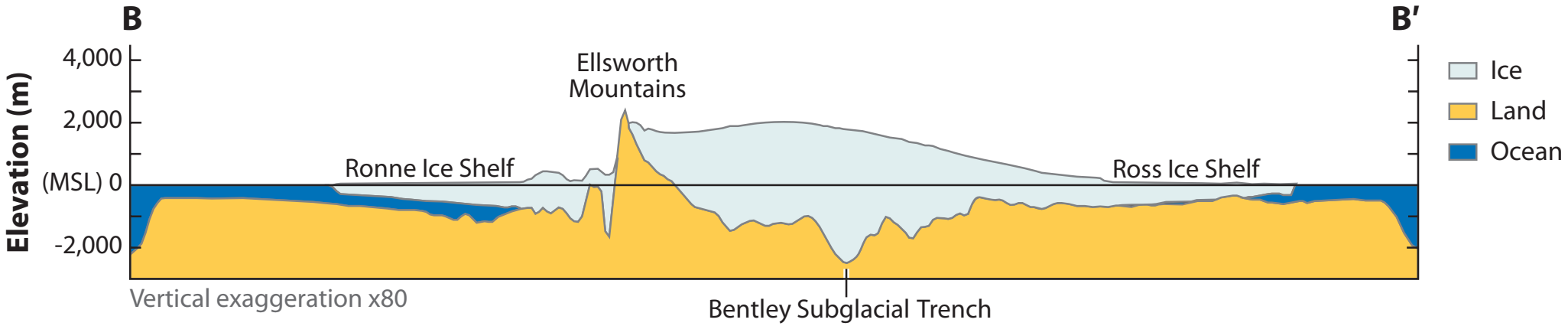
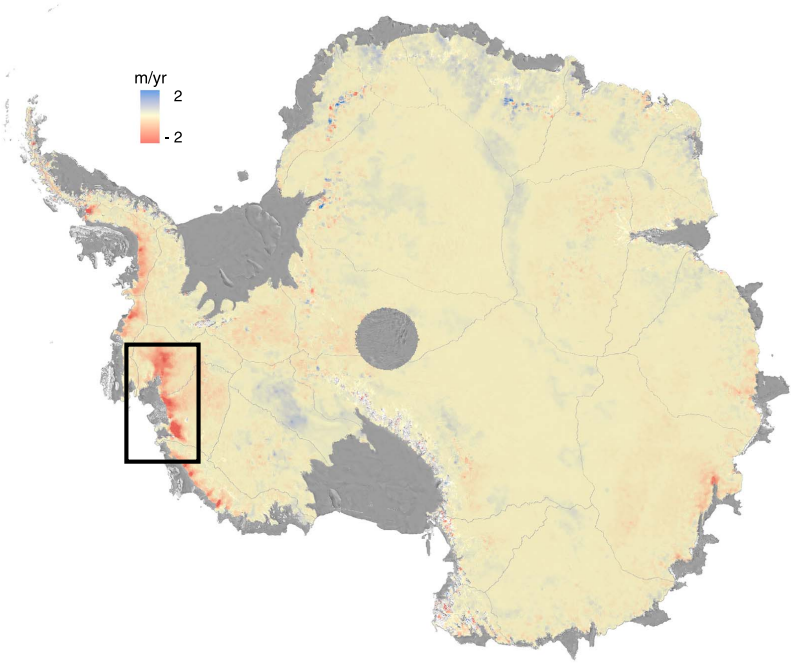




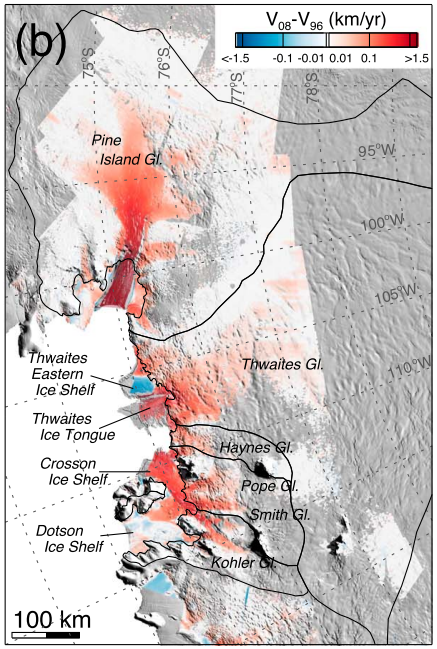
Schoof & Hewitt 2013

Ice sheet collapse?

Marginal ice has accelerated and thinned over the last decade



McMillan et al 2014



Mouginot et al 2014

Marine Ice Sheet Collapse Potentially Under Way for the Thwaites Glacier Basin, West Antarctica

Ian Joughin, Benjamin E. Smith, Brooke Medley

Collapse of the West Antarctic Ice Sheet after local destabilization of the Amundsen Basin

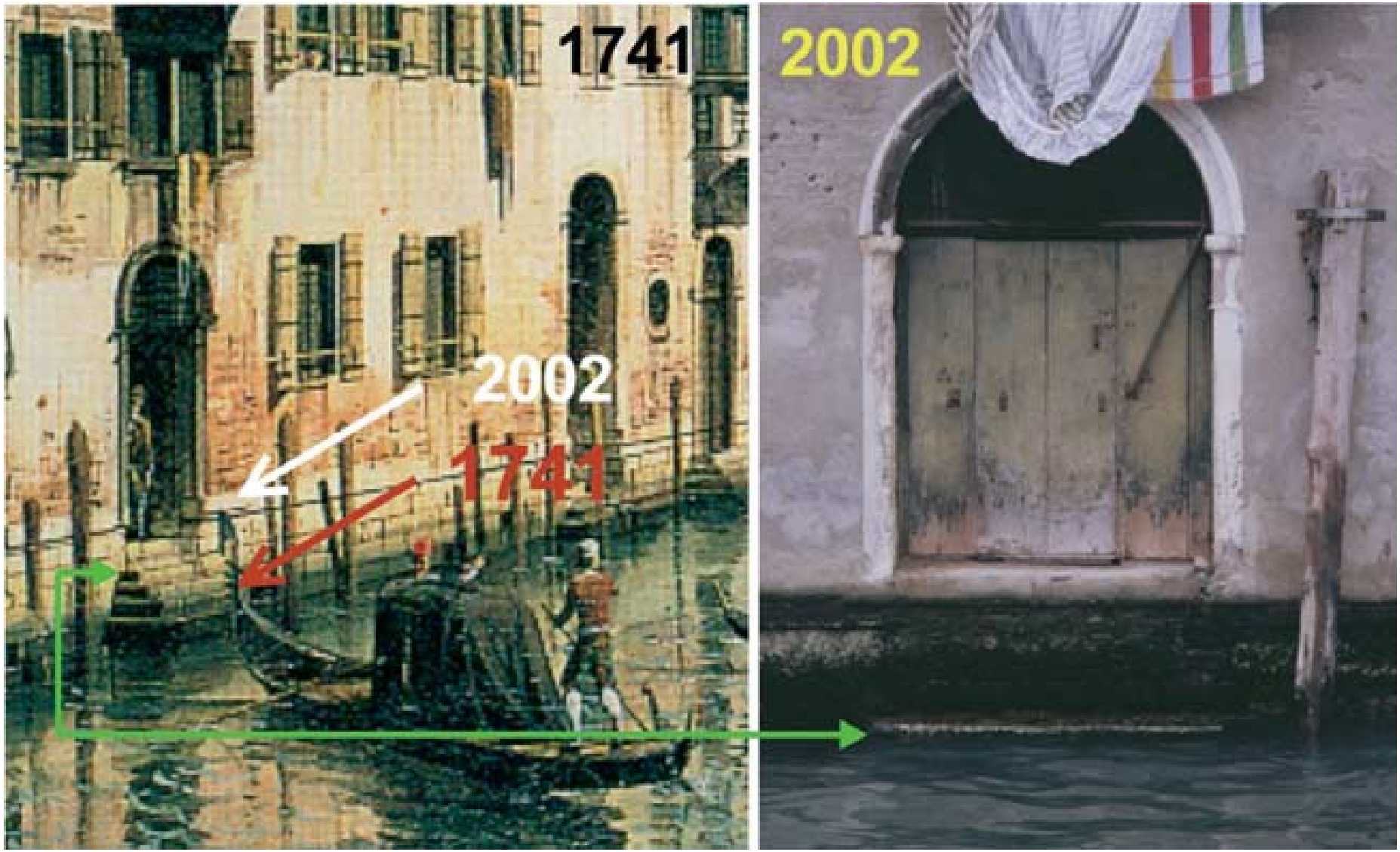
Johannes Feldmann[a,b] and Anders Levermann[a,b,1]

When and why does rapid sea level change occur?

Can we constrain how fast it might happen?

Sea level rise

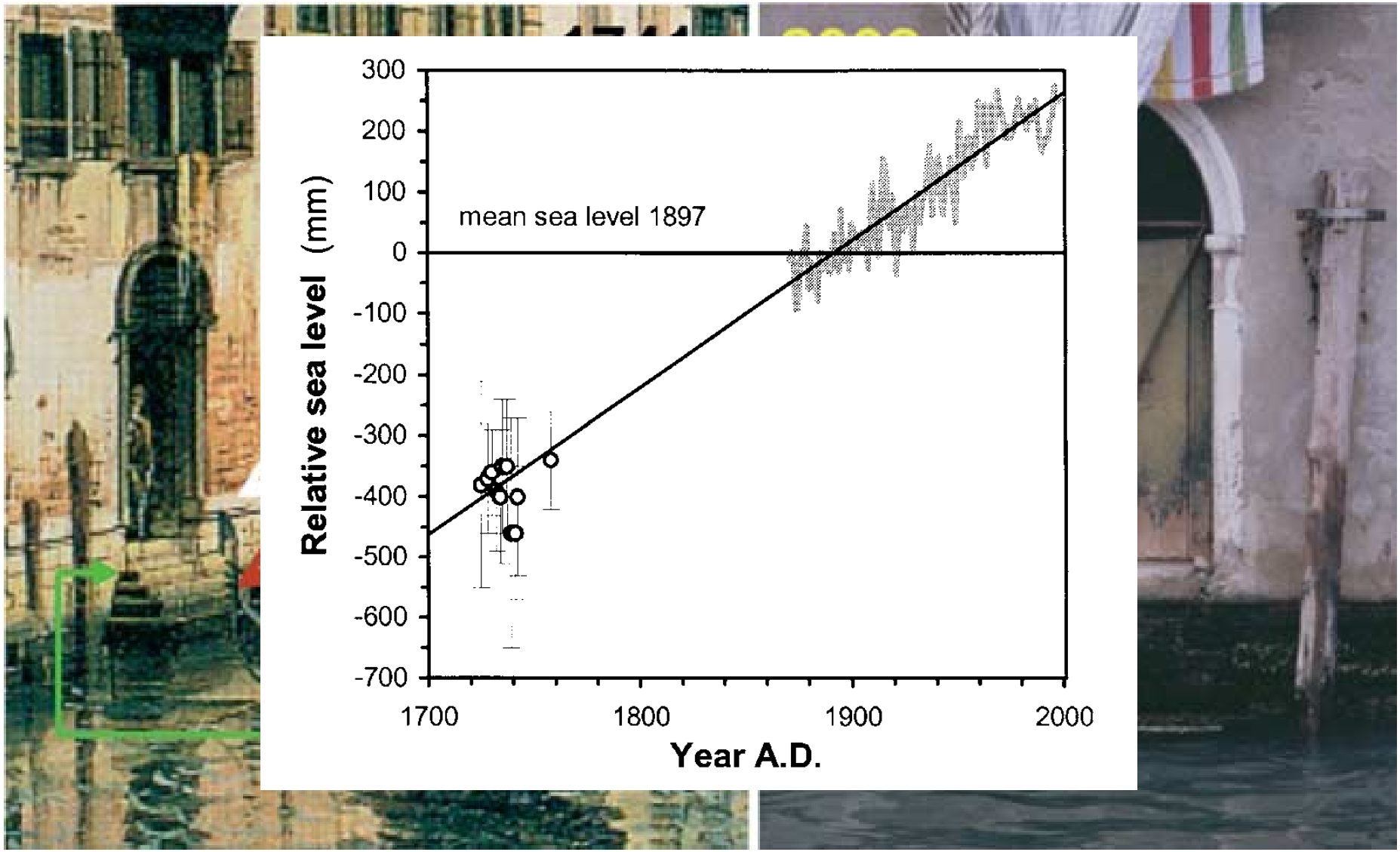
Venetian paintings by Canaletto & Bellotto



Camuffo & Sturaro 2003

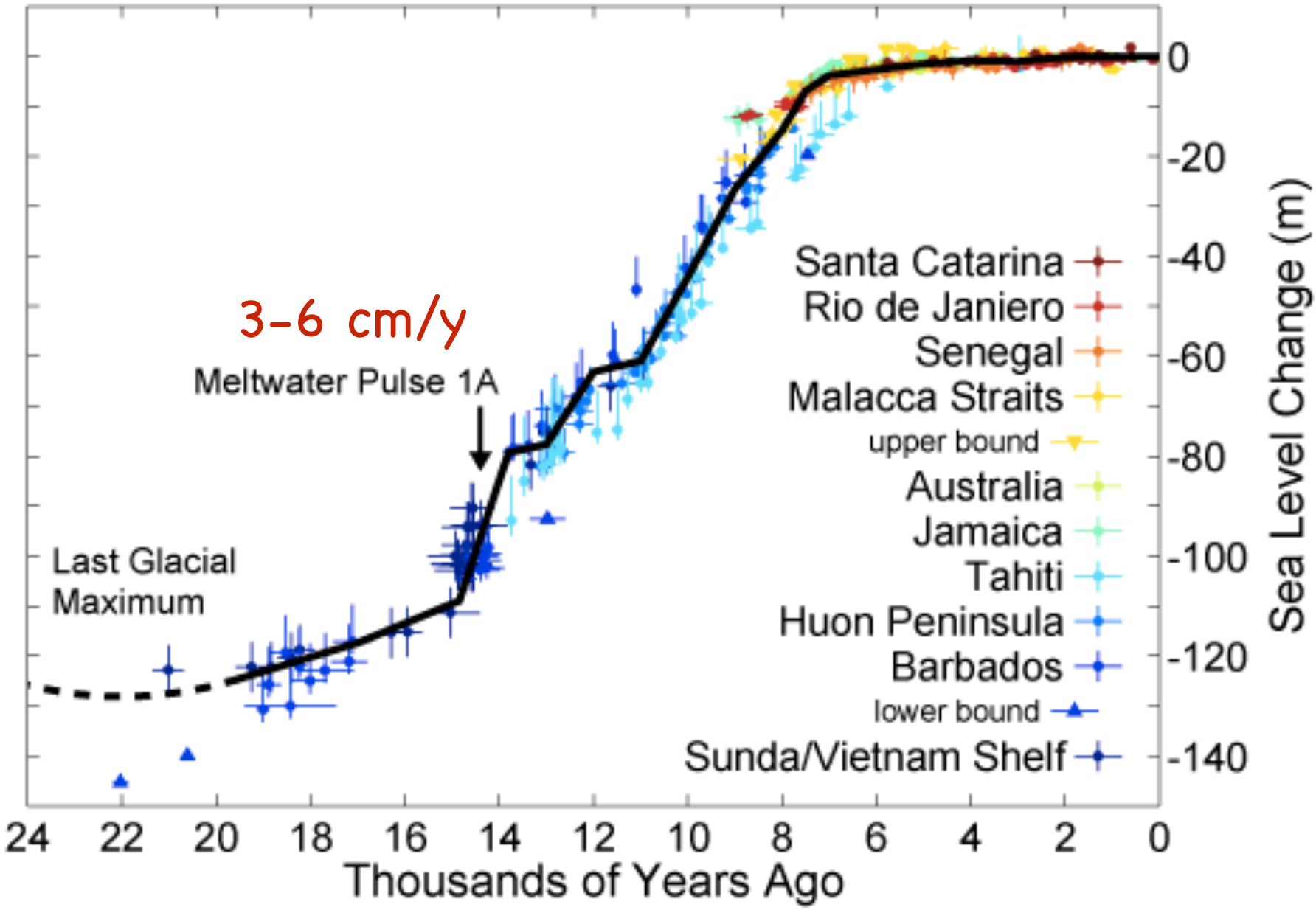
Sea level rise

Venetian paintings by Canaletto & Bellotto



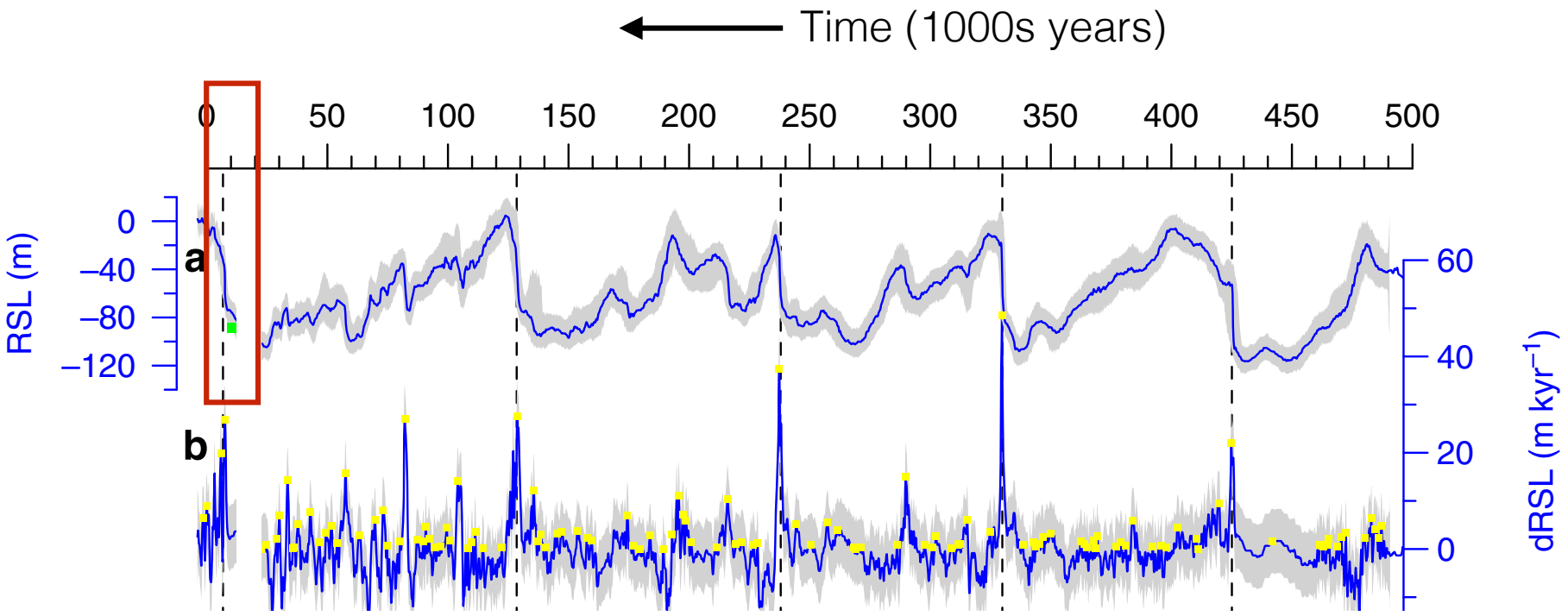
Camuffo & Sturaro 2003

Historical sea level



Historical sea level

The glacial period is punctuated by several periods of rapid sea level rise > 1 cm/y.

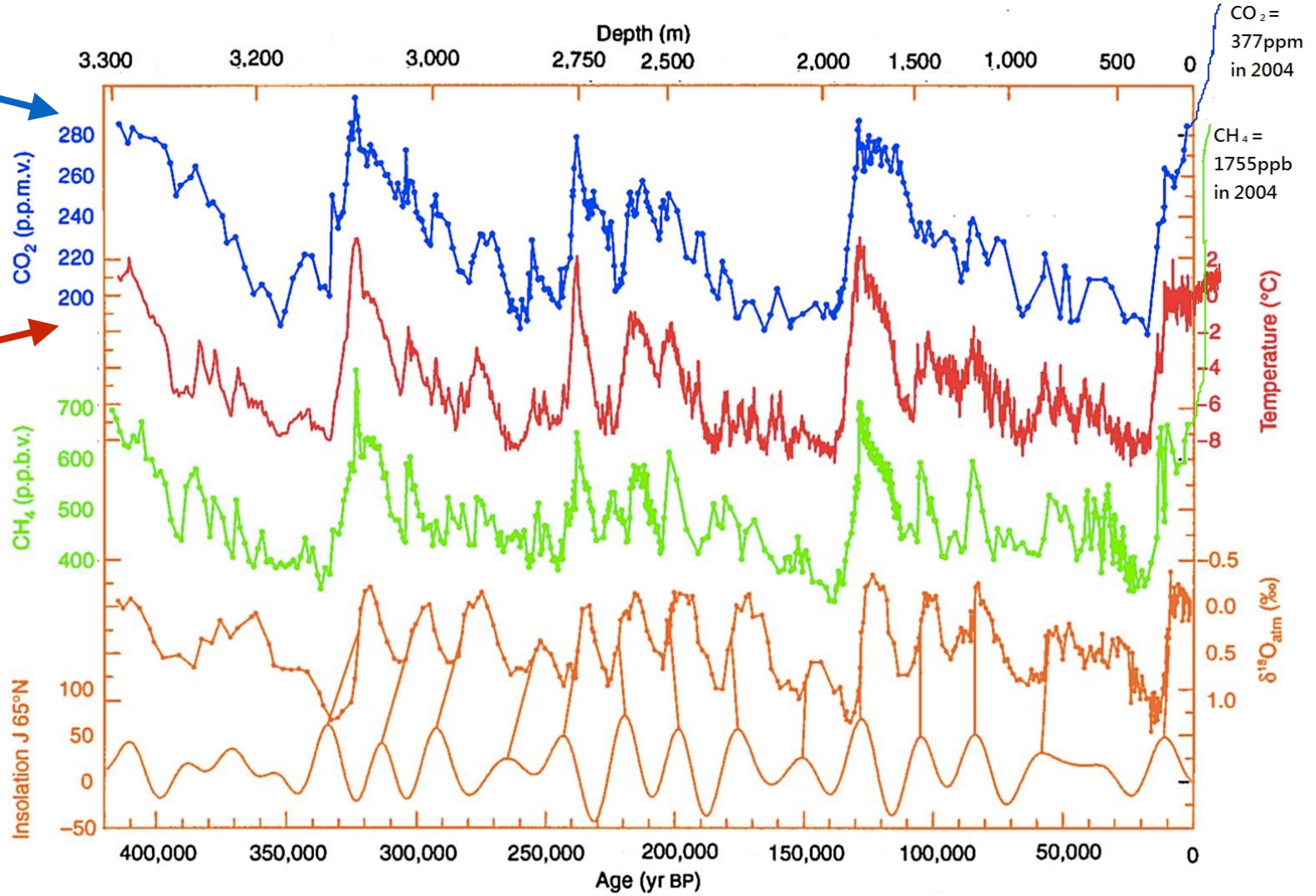


Grant et al 2014

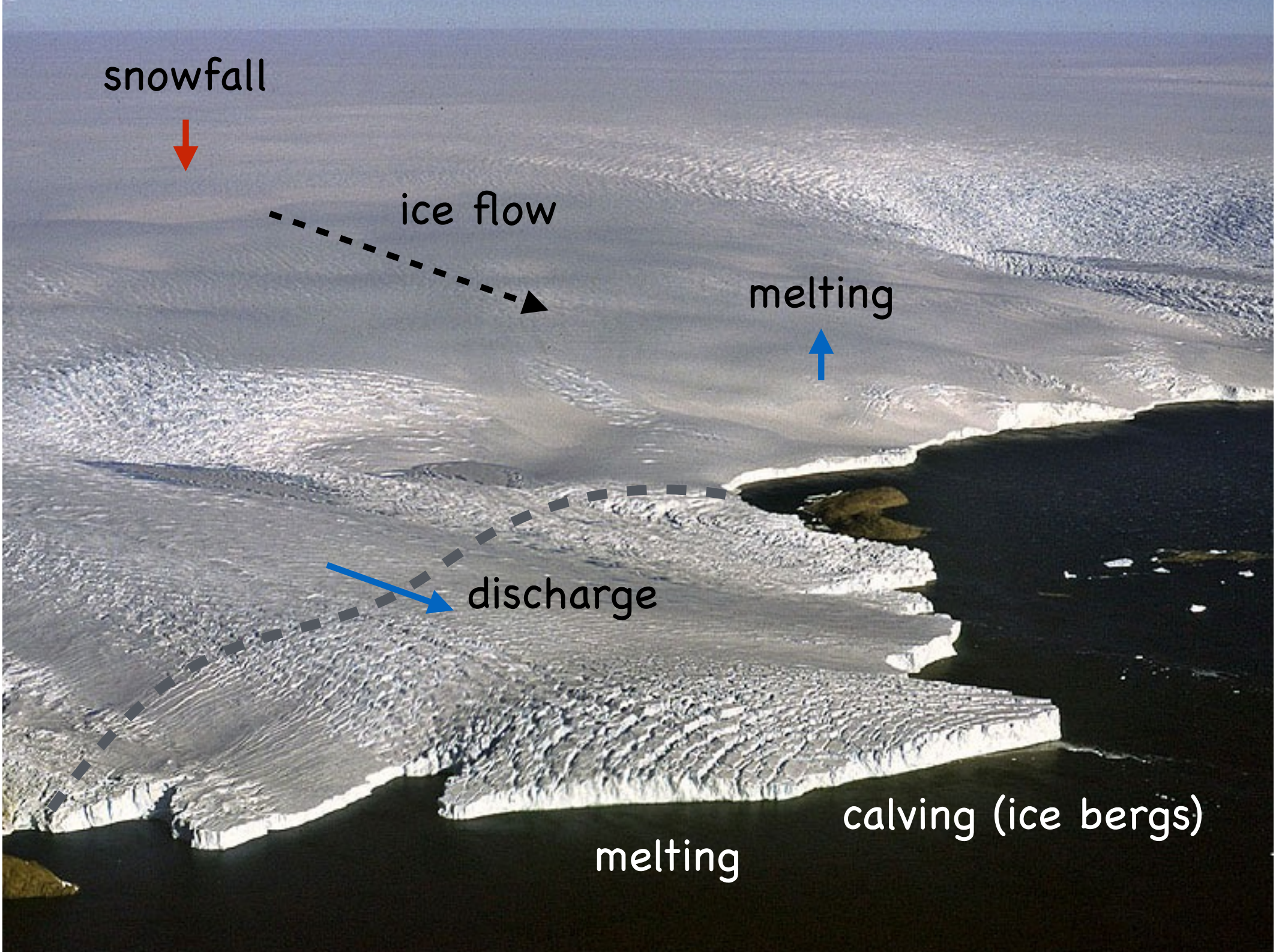
Antarctic ice core measurements

CO_2

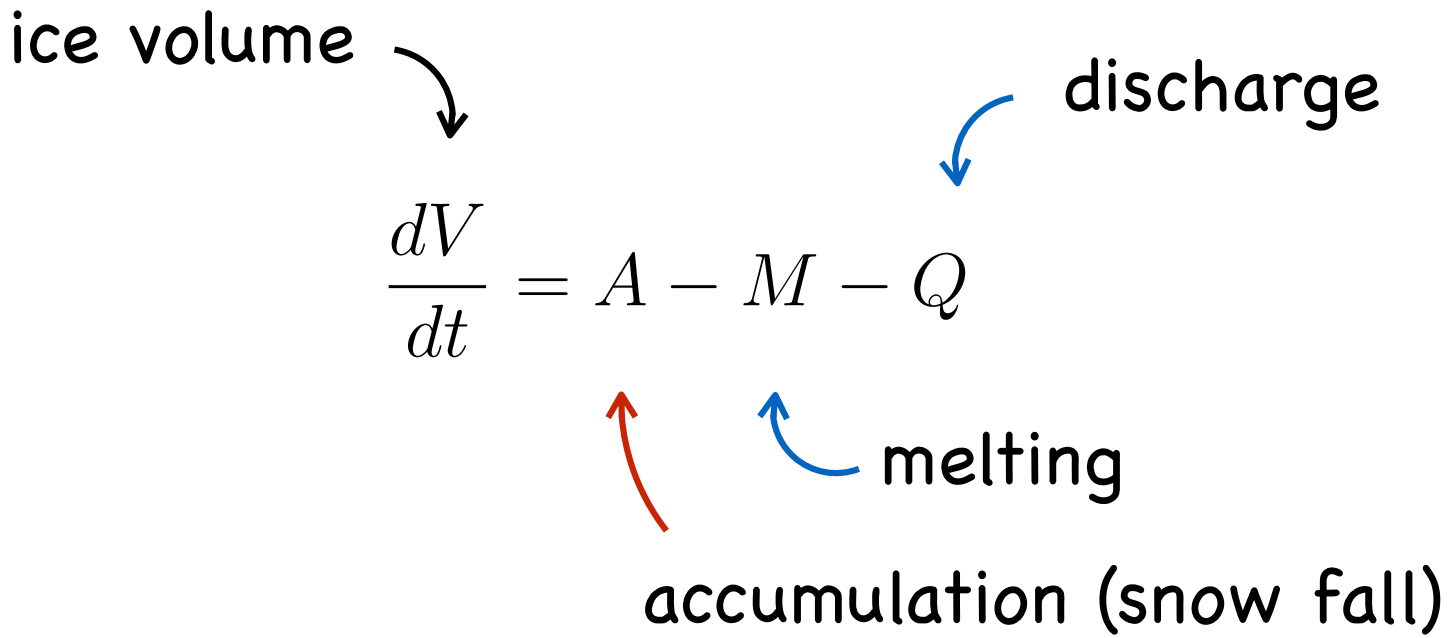
Temperature



Time (years) →


snowfall
ice flow
melting
discharge
melting
calving (ice bergs)

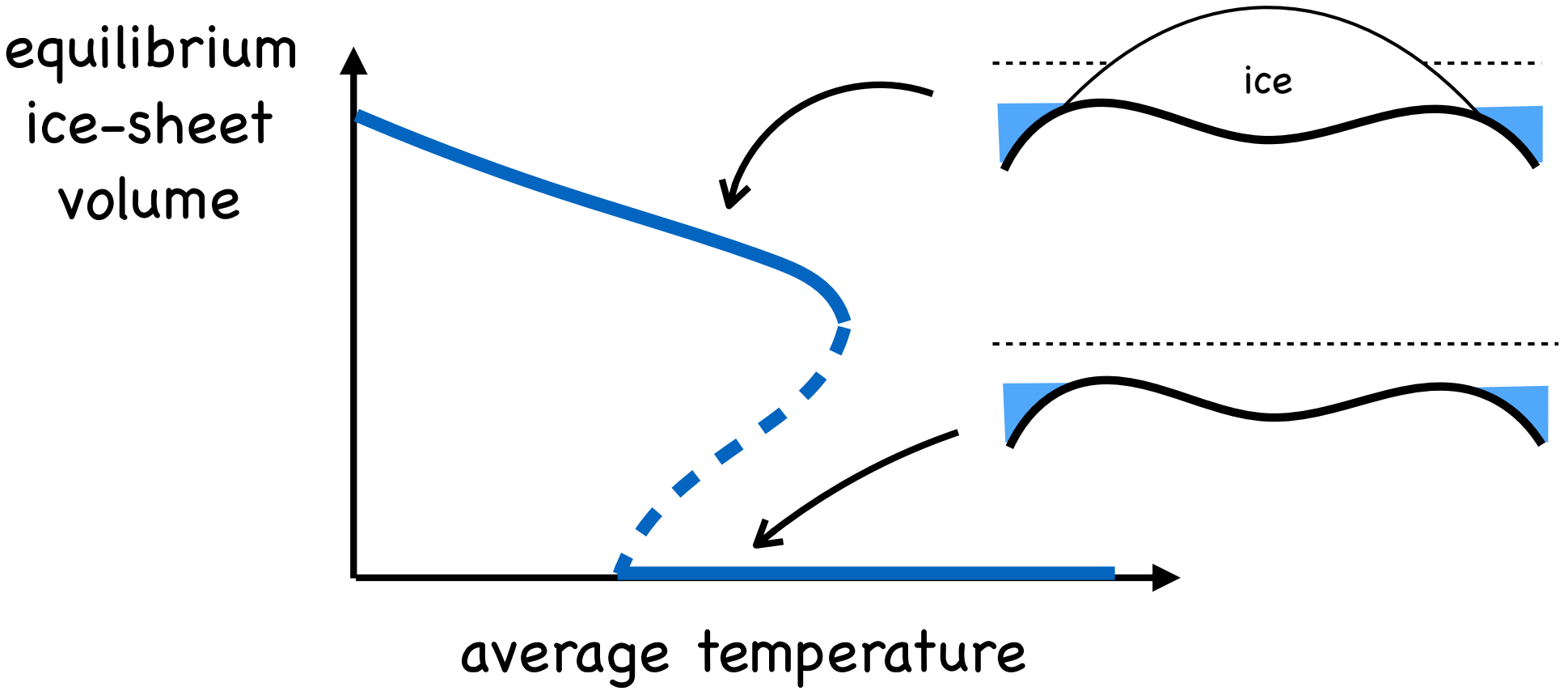
A mathematical model



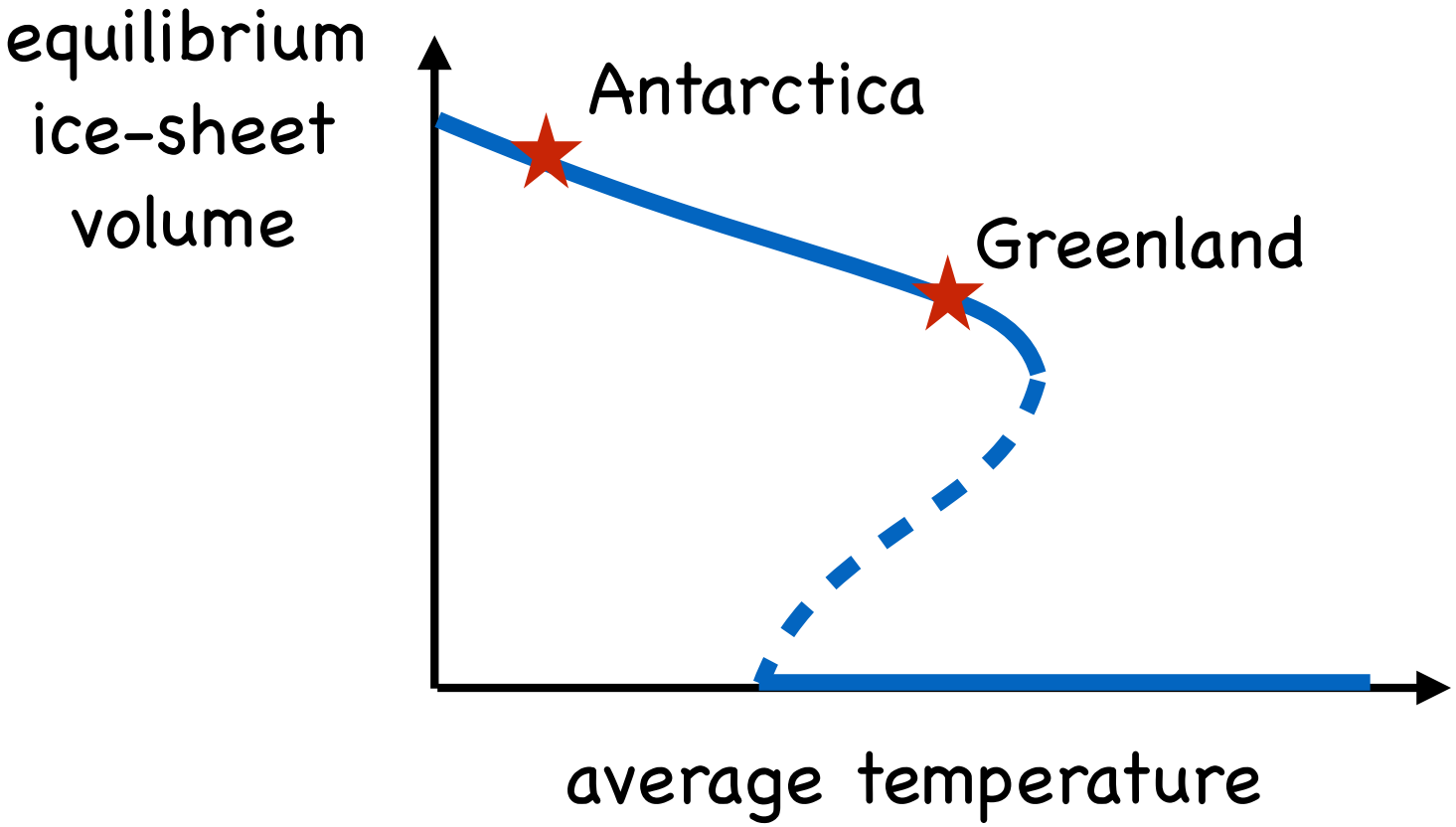
Extreme Ice Survey - Time-lapse camera
Columbia Glacier, Alaska

Ice-sheet elevation feedback - hysteresis

A higher ice surface leads to less melting

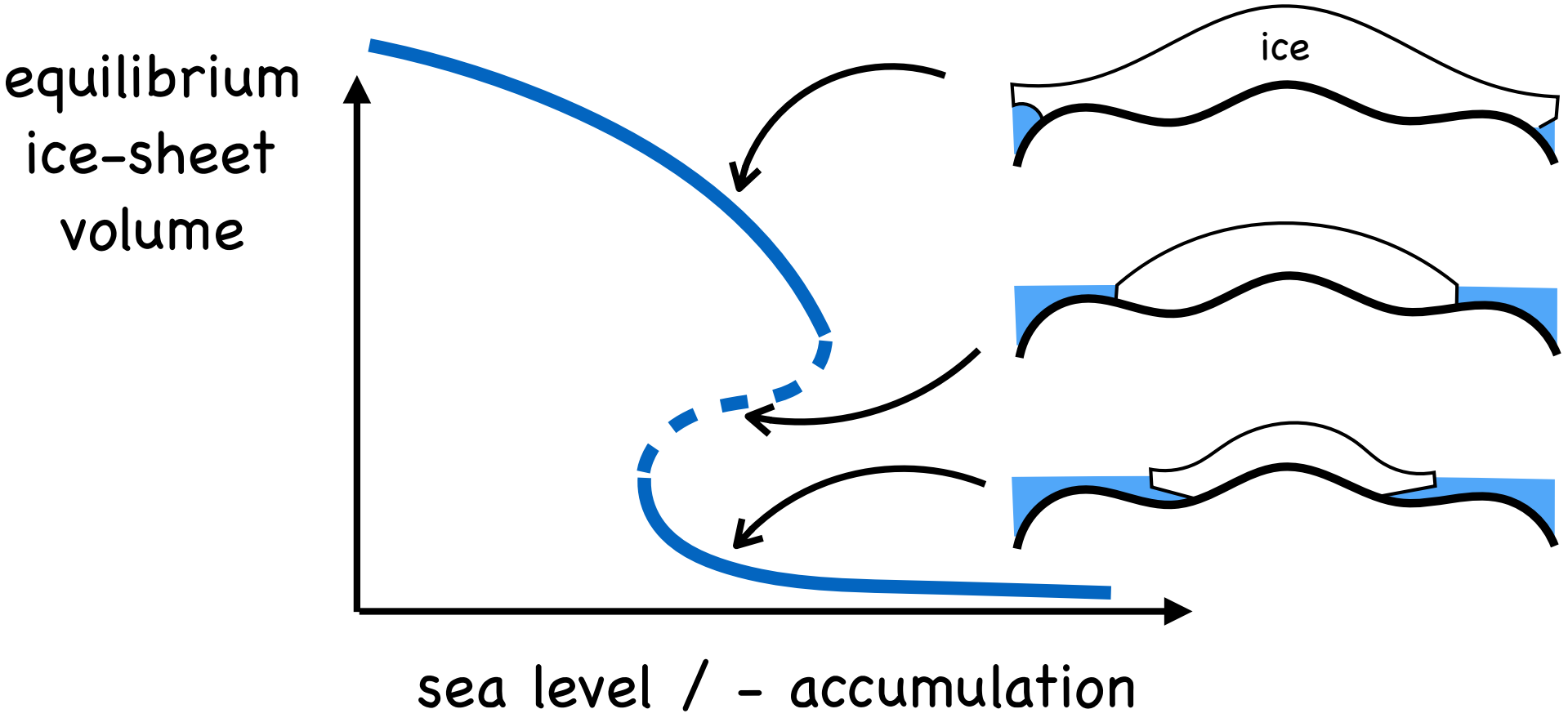


Ice-sheet elevation feedback - hysteresis

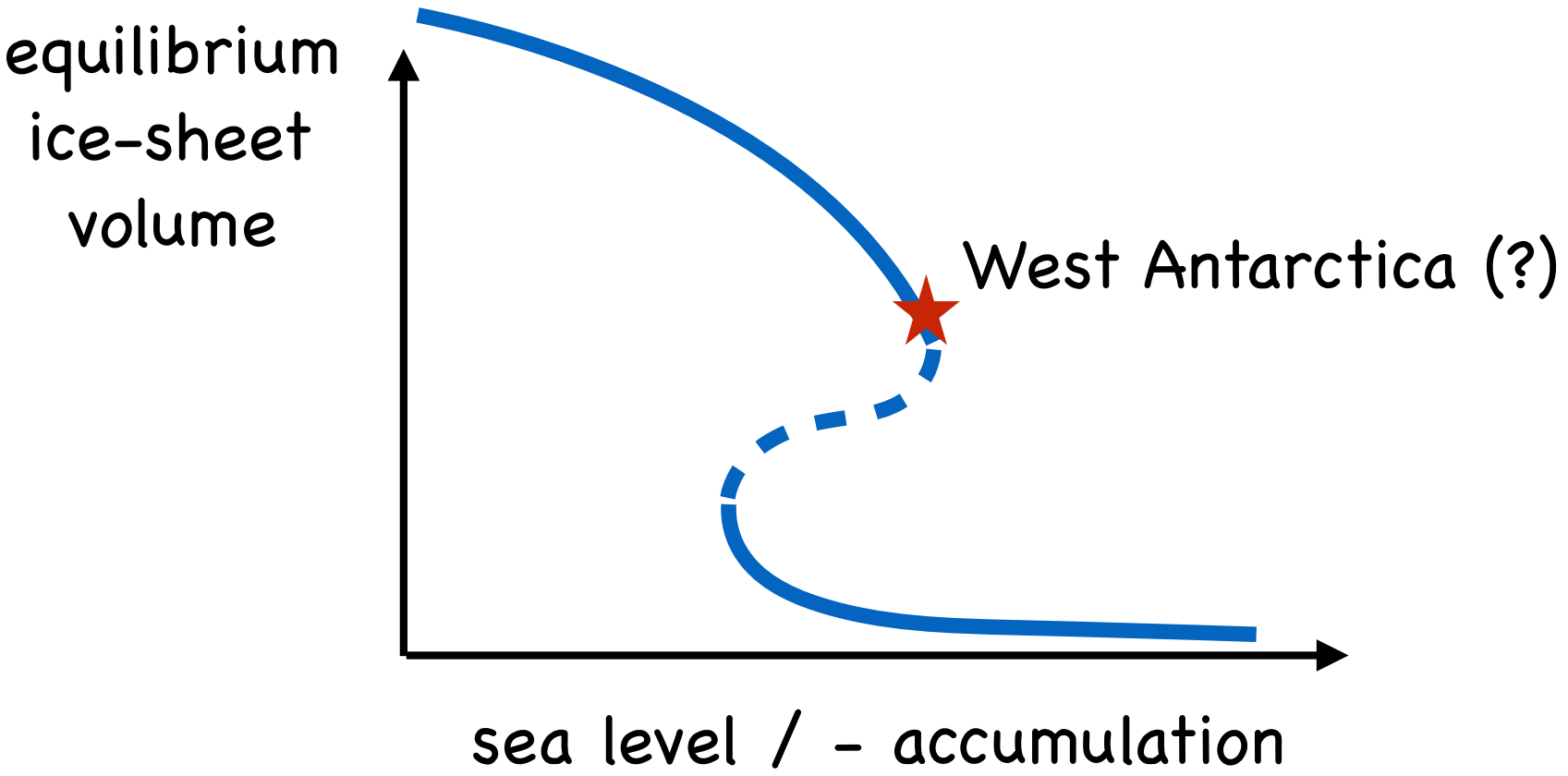


Marine ice sheet instability

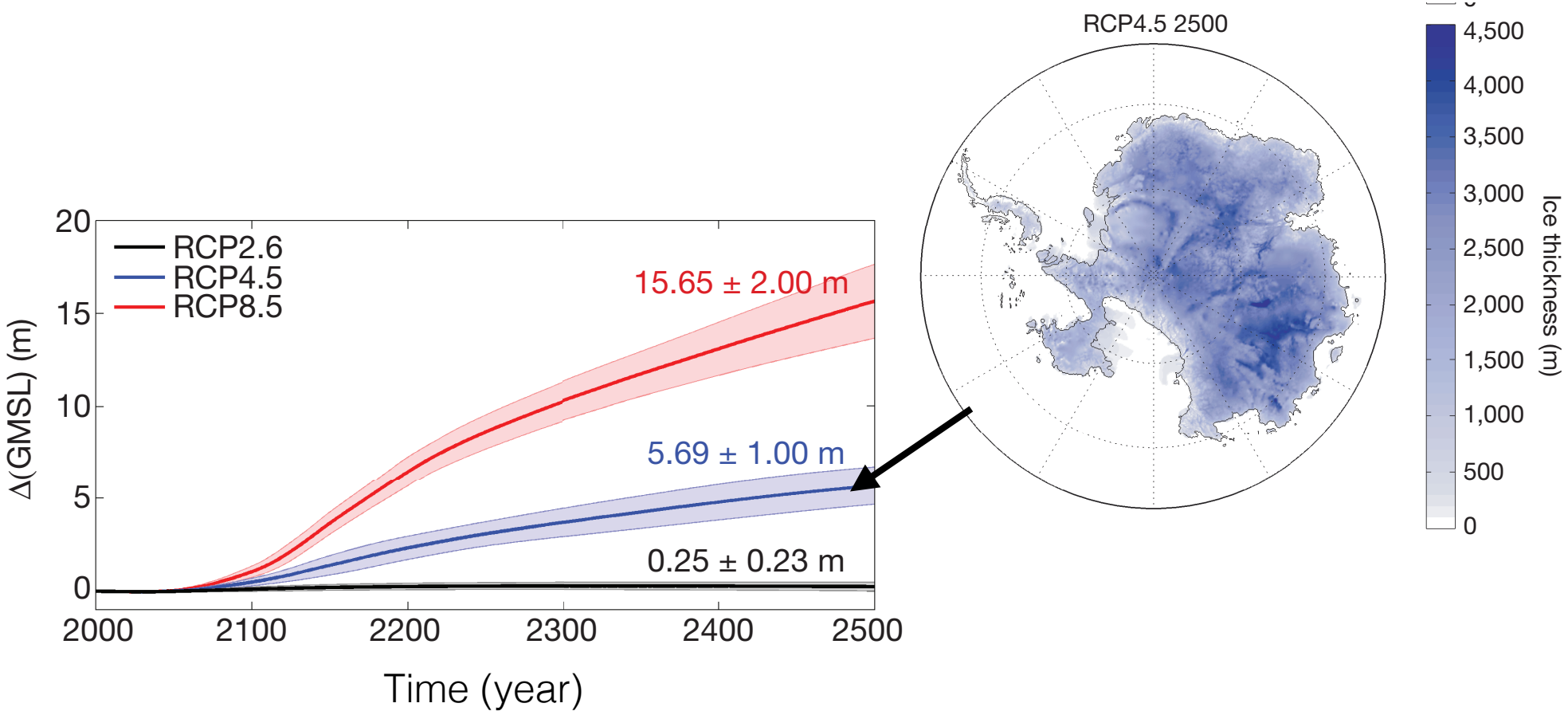
Deeper ocean at margin leads to larger ice flux



Marine ice sheet instability



Numerical models

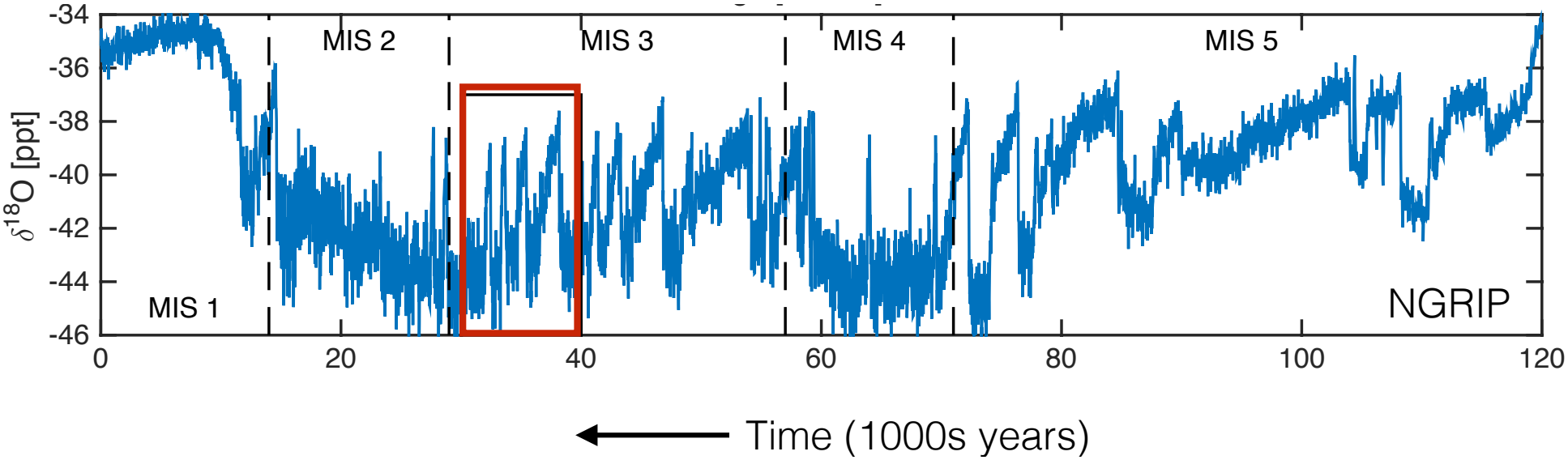


DeConto & Pollard 2016

What drives historic climate change?

Greenland ice core measurements

Oxygen isotopes are a proxy for past temperature.



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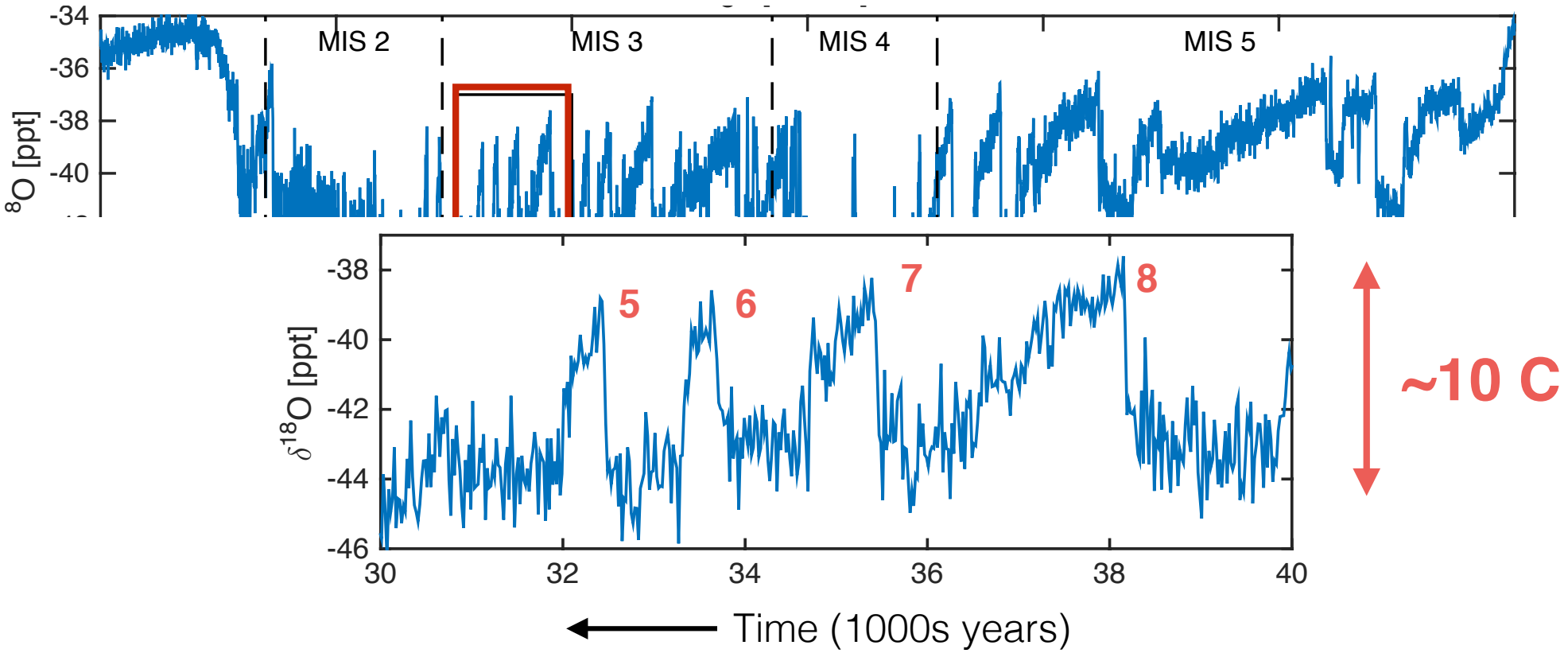
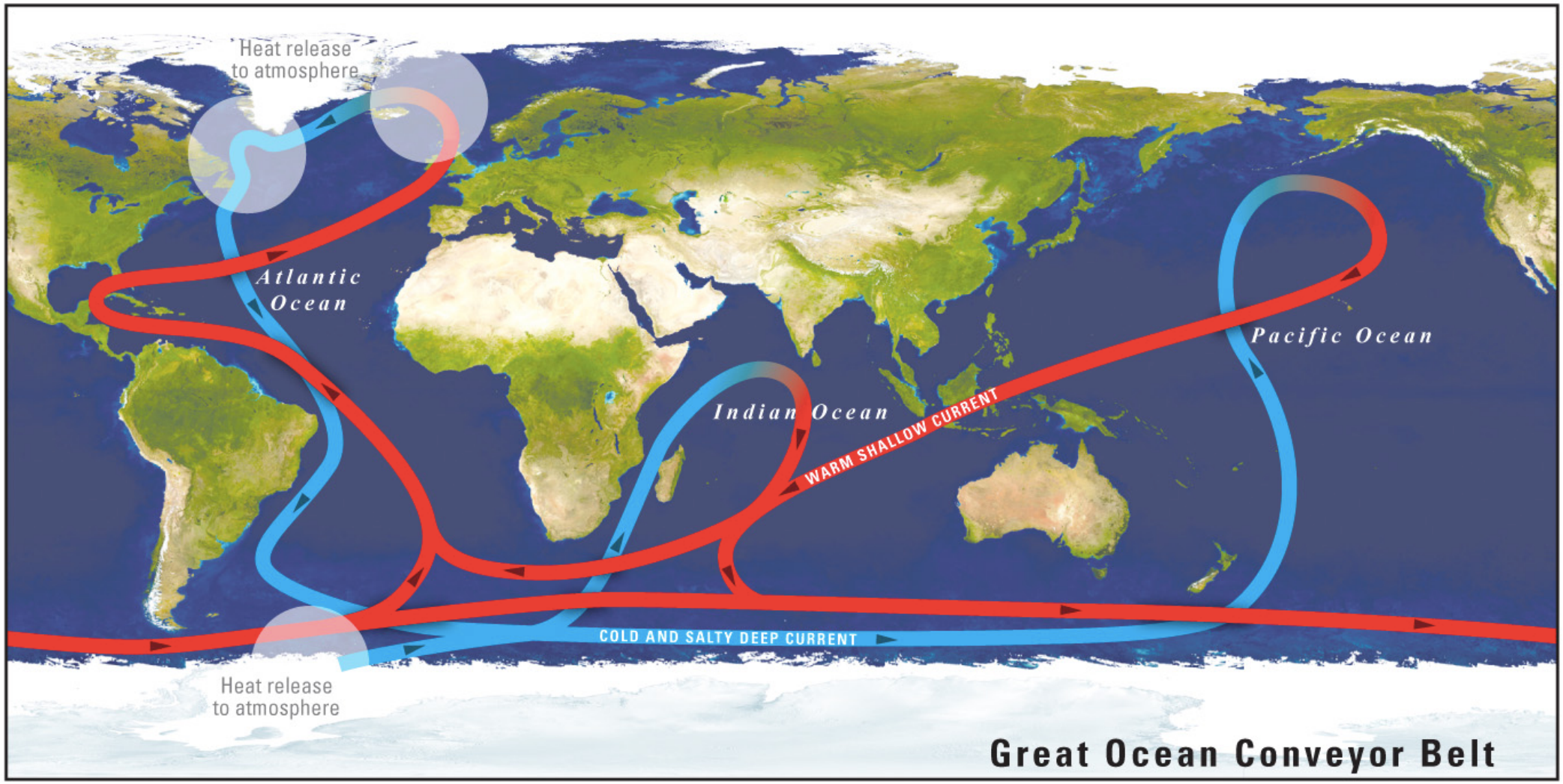


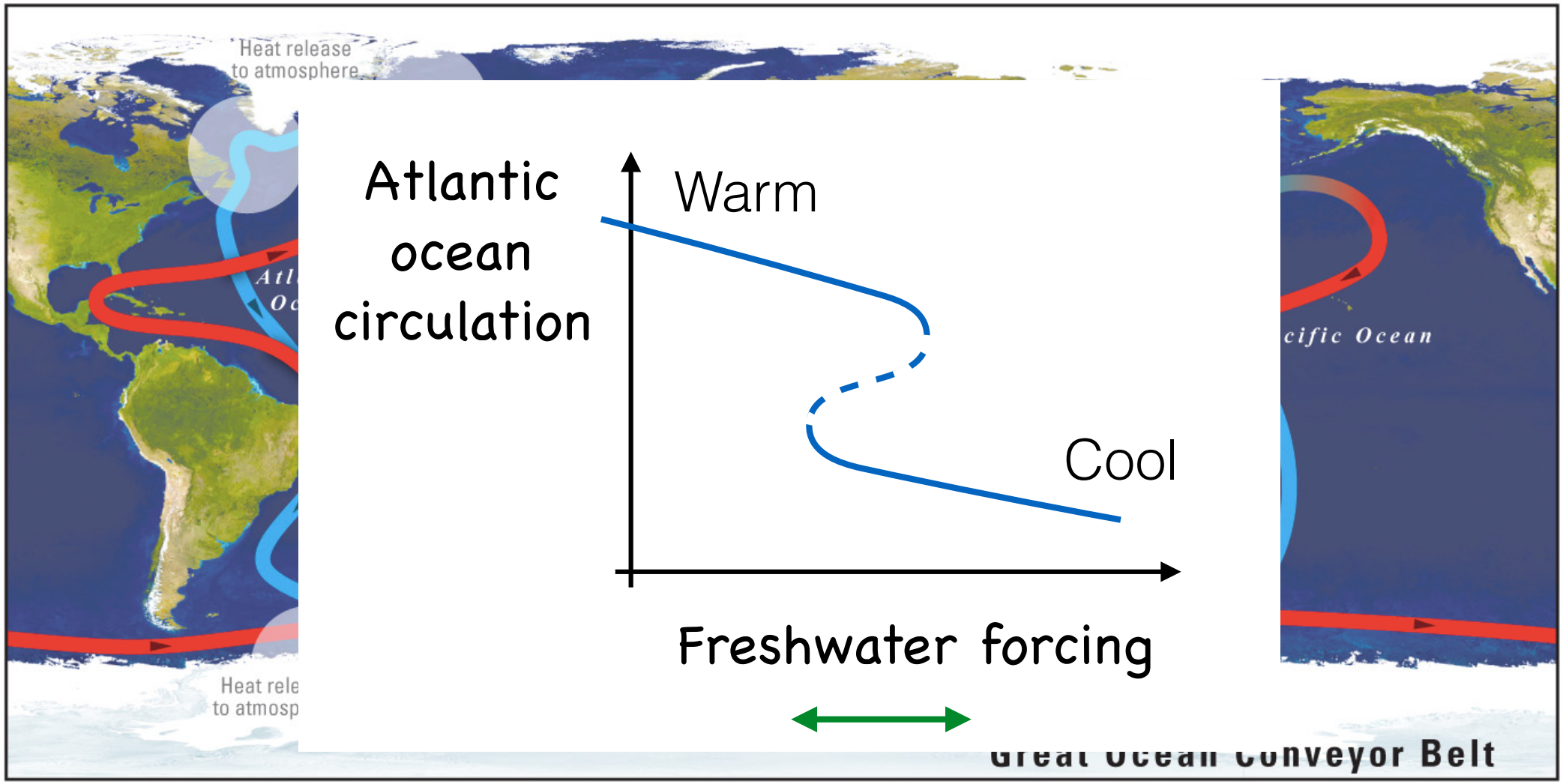
Dansgaard-Oeschger events: ≈ 10C warming in < 50 years

Ocean circulation



USGS

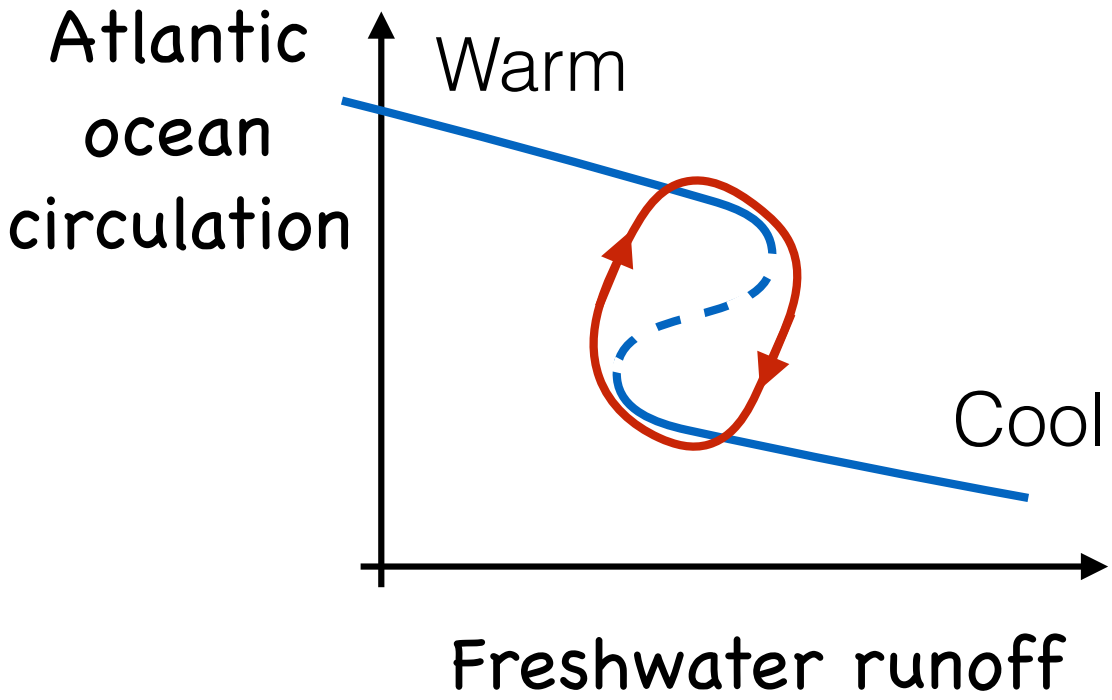
Ocean circulation



USGS

Relaxation oscillator

Runoff from NH ice sheets drives changes in circulation



in review, with Eric Wolff, Helen Johnson, Andrew Fowler, and others


thank you