

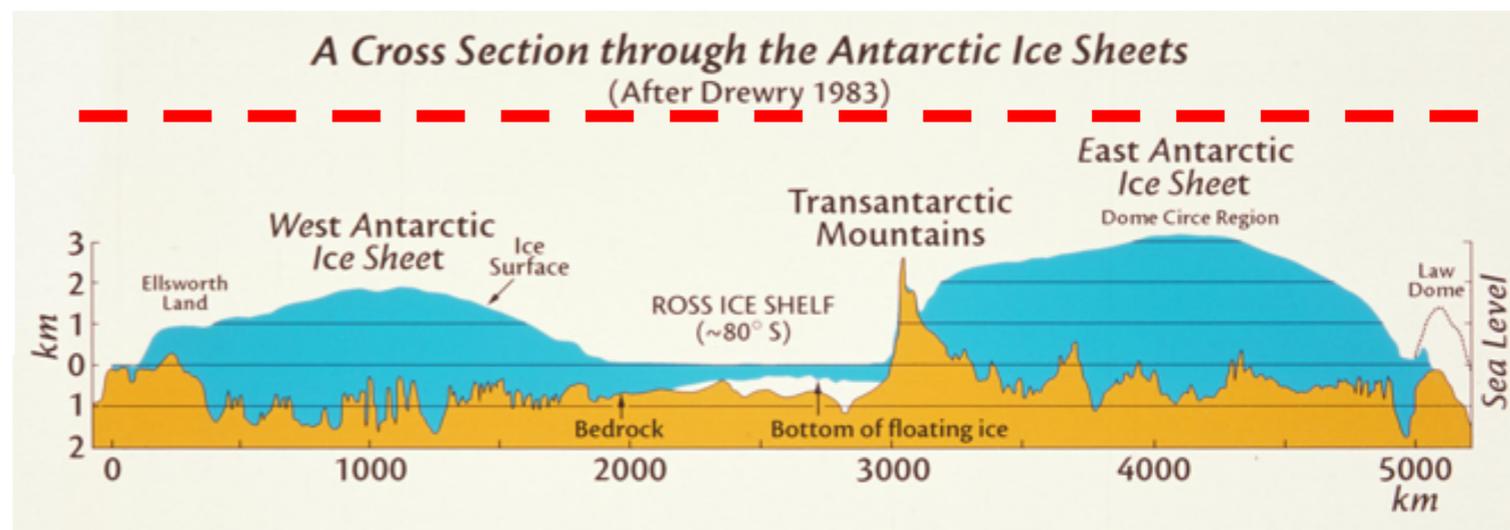
EARLY LAST INTERGLACIAL OCEAN WARMING DROVE SUBSTANTIAL ICE MASS LOSS FROM ANTARCTICA

CHRIS TURNEY, CHRIS FOGWILL, NICK GOLLEDGE, NICK MCKAY, ERIK
VAN SEBILLE, RICHARD JONES, ZOË THOMAS, DAVID ETHERIDGE,
ALAN COOPER, LAURA WEYRICH AND MANY OTHERS



UNSW
THE UNIVERSITY OF NEW SOUTH WALES

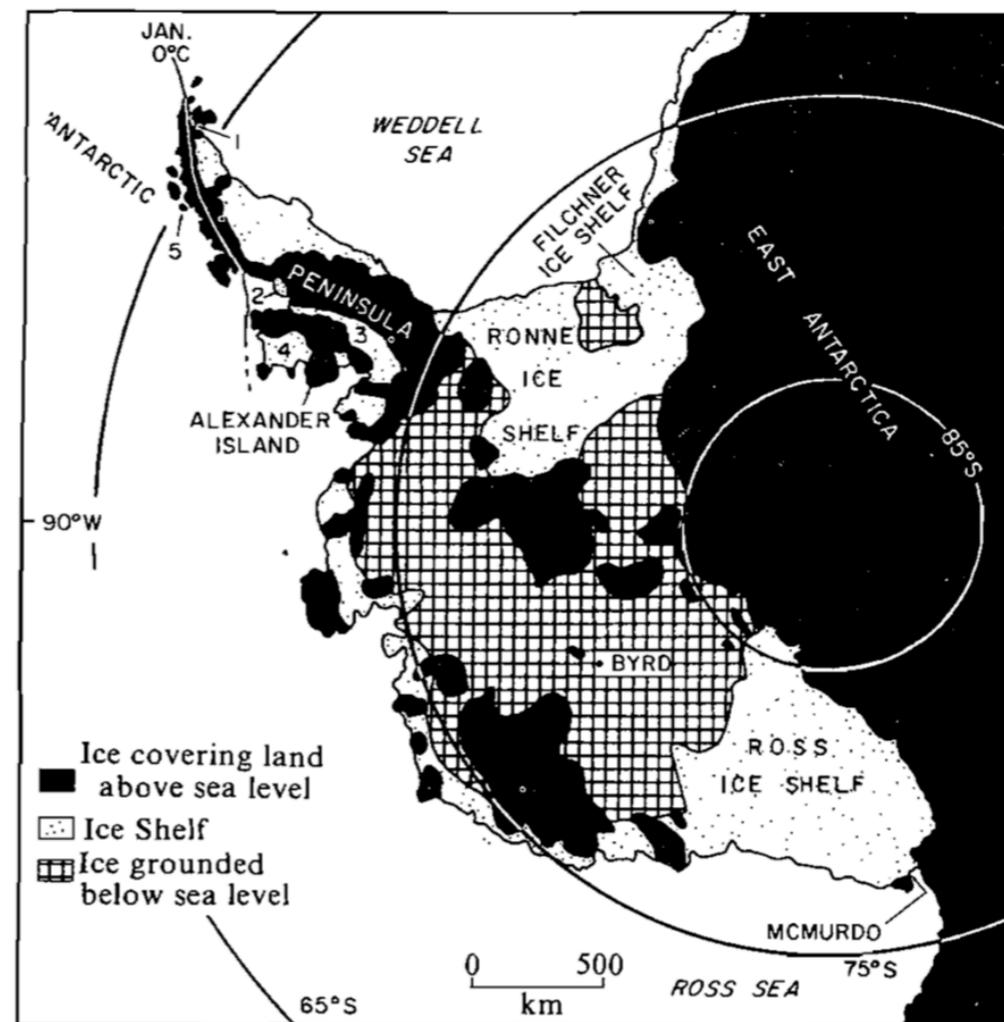
West Antarctic Ice Sheet vulnerable to subsurface warming with major implications for the future



Thanks to Mark Kurz!

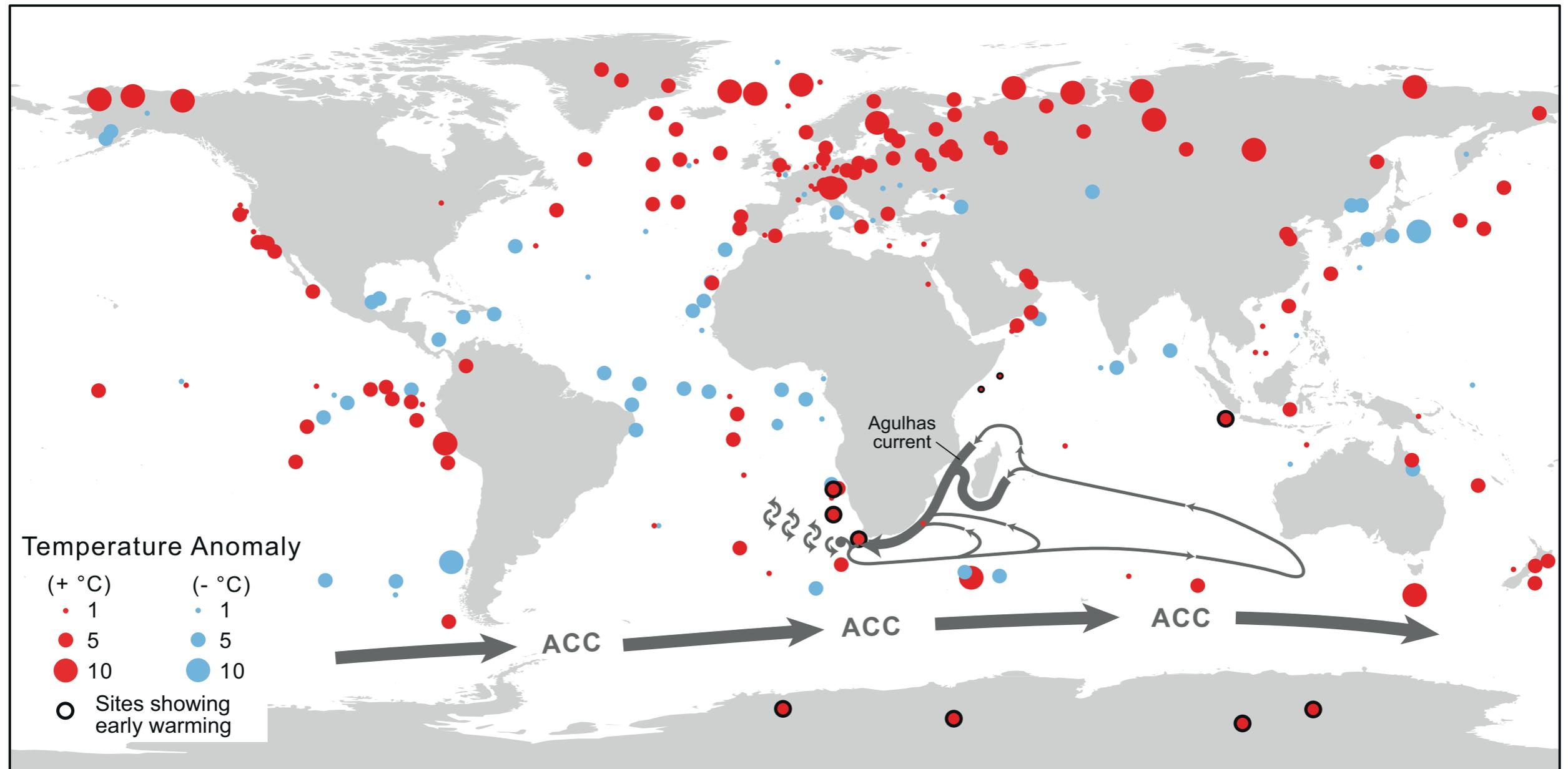


Golledge *et al.*, 2015, *Nature*



Mercer, 1978, *Nature*

A GLOBAL AVERAGE RECONSTRUCTION ACROSS THE LAST INTERGLACIAL: 2°C WARMER THAN 1961-1990

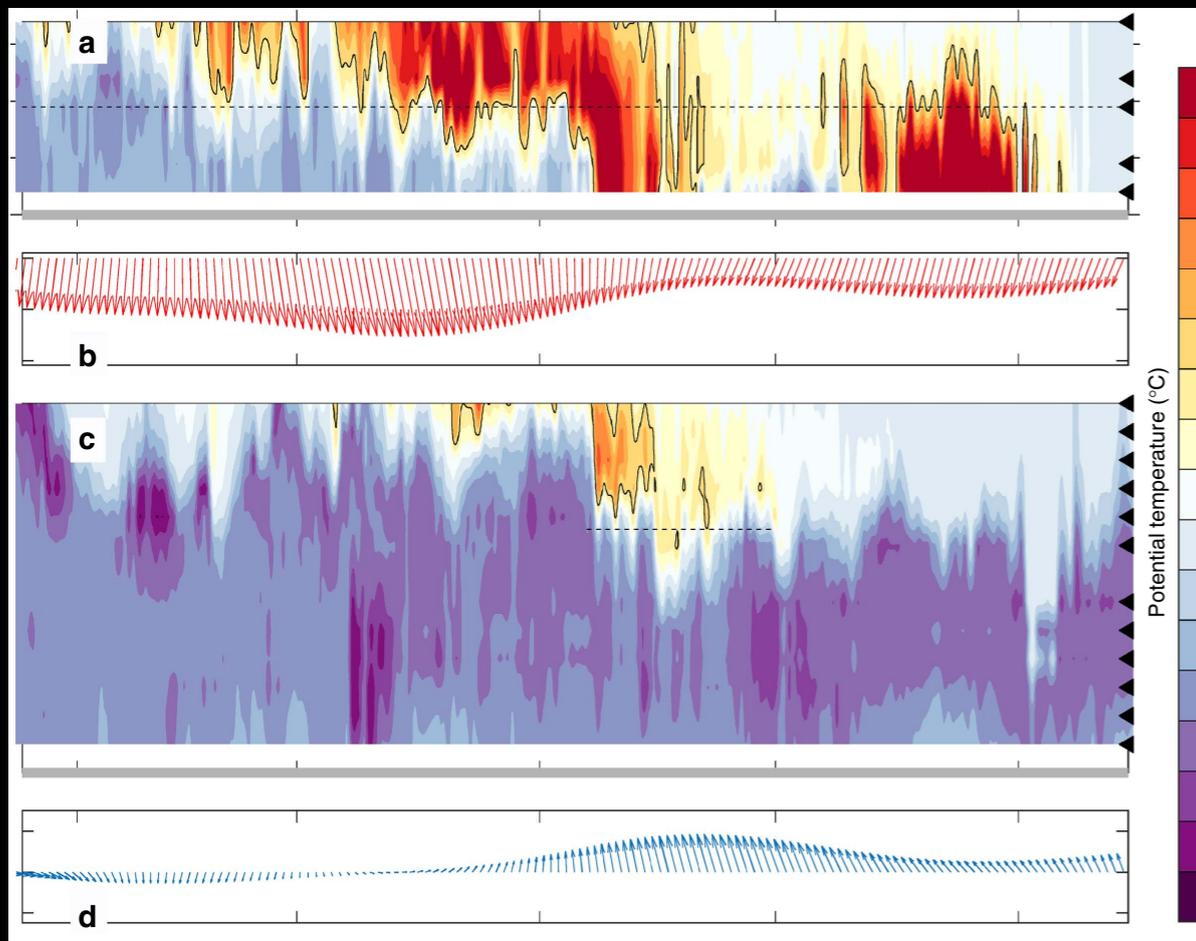
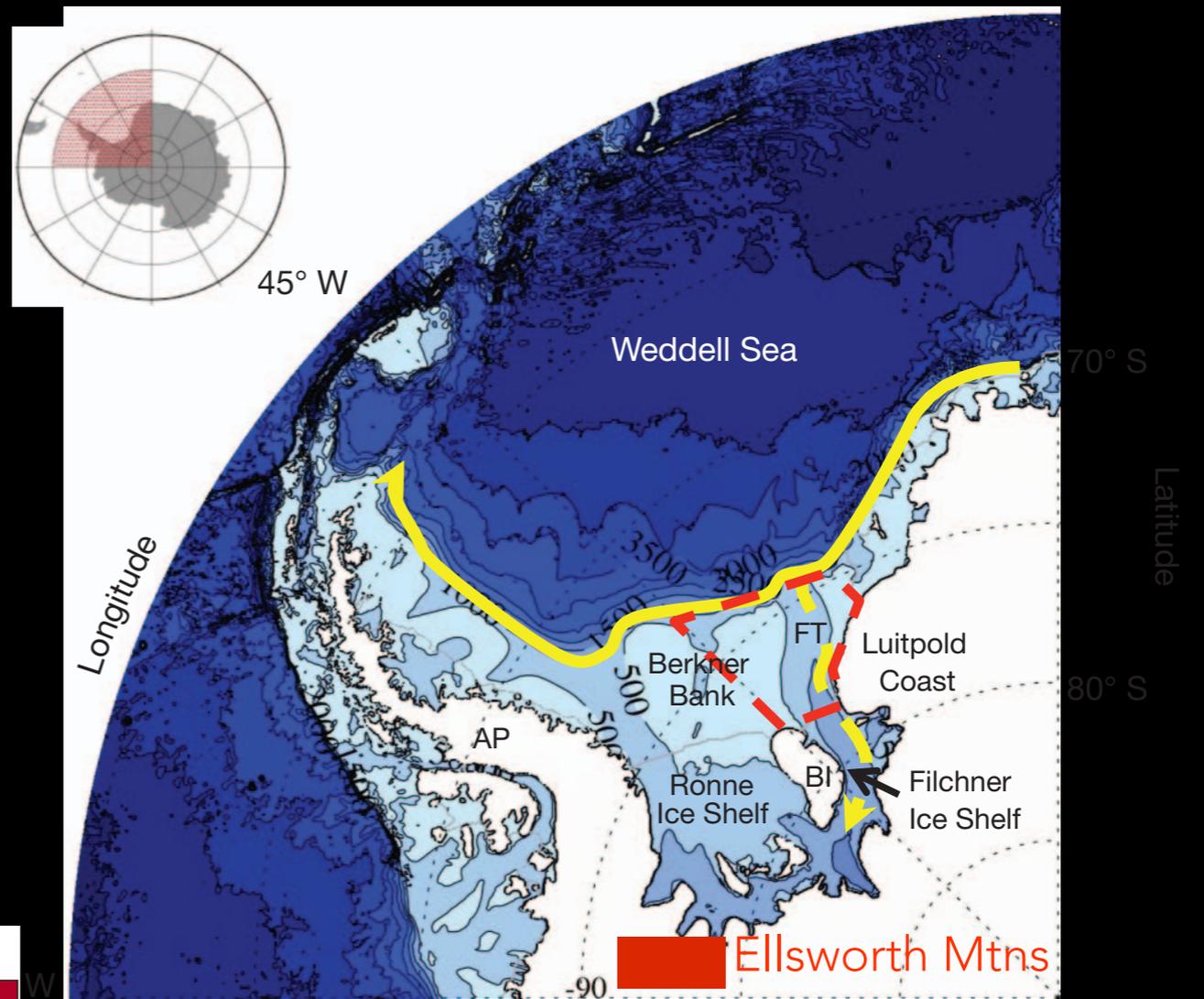


INSIGHTS FOR A PARIS CLIMATE AGREEMENT
WORLD

[Turney and Jones, 2010, *Journal of Quaternary Science*, 25, 839-843](#)

THE WEDDELL SEA EMBAYMENT

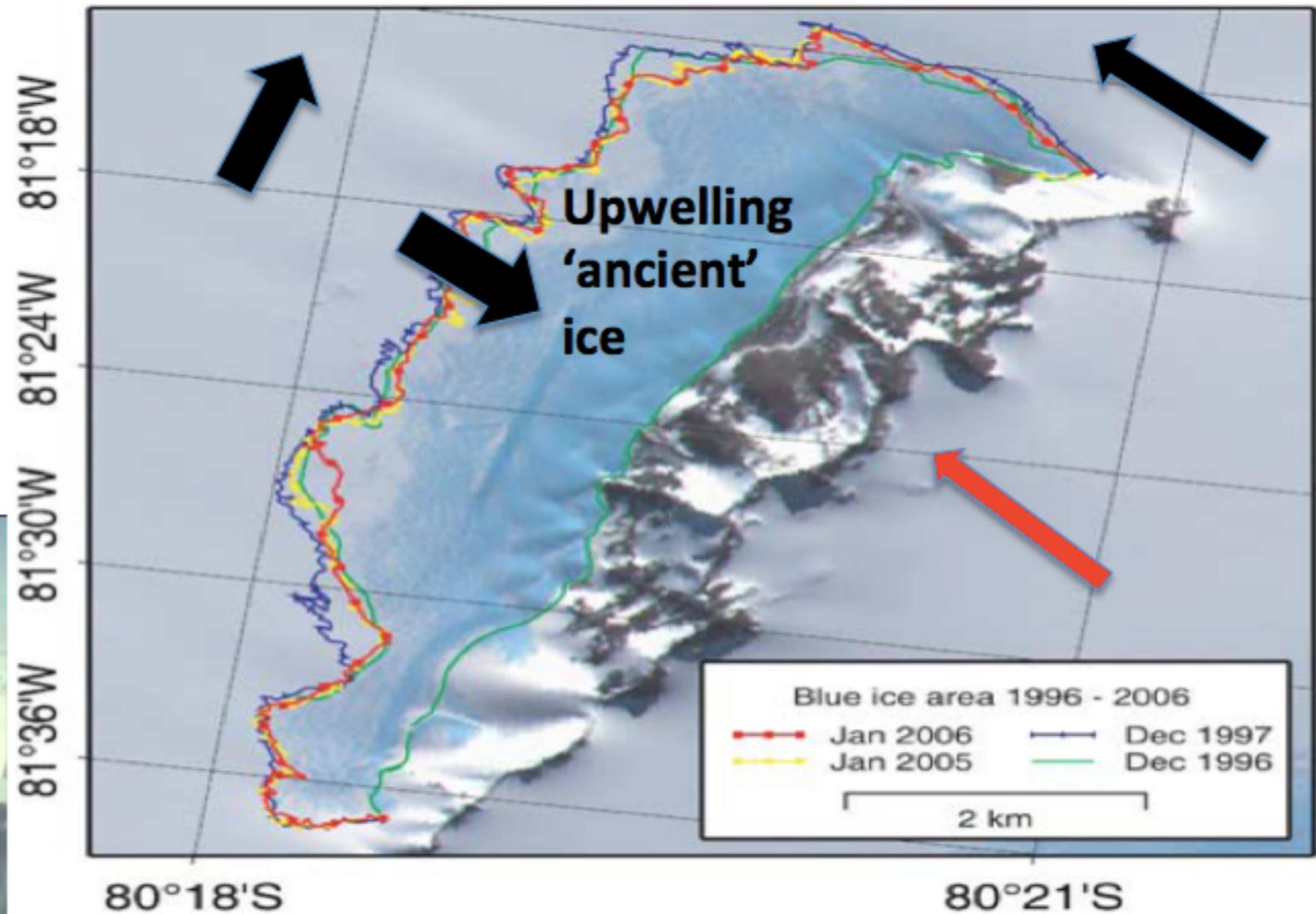
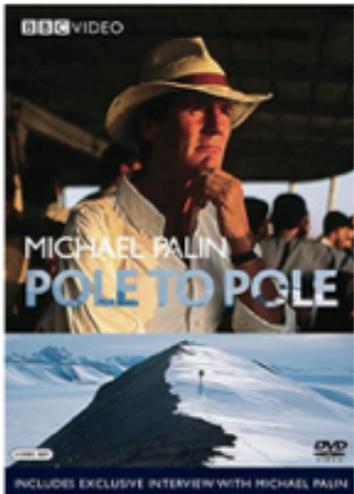
- Drains some 22% of Antarctica
- Ronne-Filchner Ice Shelf buttressing both WAIS and EAIS



- An area of contemporary apparent ice sheet ‘stability’
- But Ronne-Filchner Ice Shelf sensitive to warming ocean (Hellmer *et al.*, 2013, *Nature*; Darelus *et al.*, 2016, *Nature Communications*)

PATRIOT VALLEY: A BLUE ICE AREA (BIA)

- Ice flow in Antarctica is 'largely' gravity driven
- BIA's ice flow can be diverted from the norm by high ablation
- BIA have long been exploited for landing wheeled aircraft in Antarctica
- Patriot Hills in the Ellsworth Mountains is a BIA and well studied



Buttressed by Institute Ice Stream and close to contemporary grounding line makes Patriot Hills highly sensitive to elevation changes across the broader Weddell Sea Embayment

PATRIOT HILLS

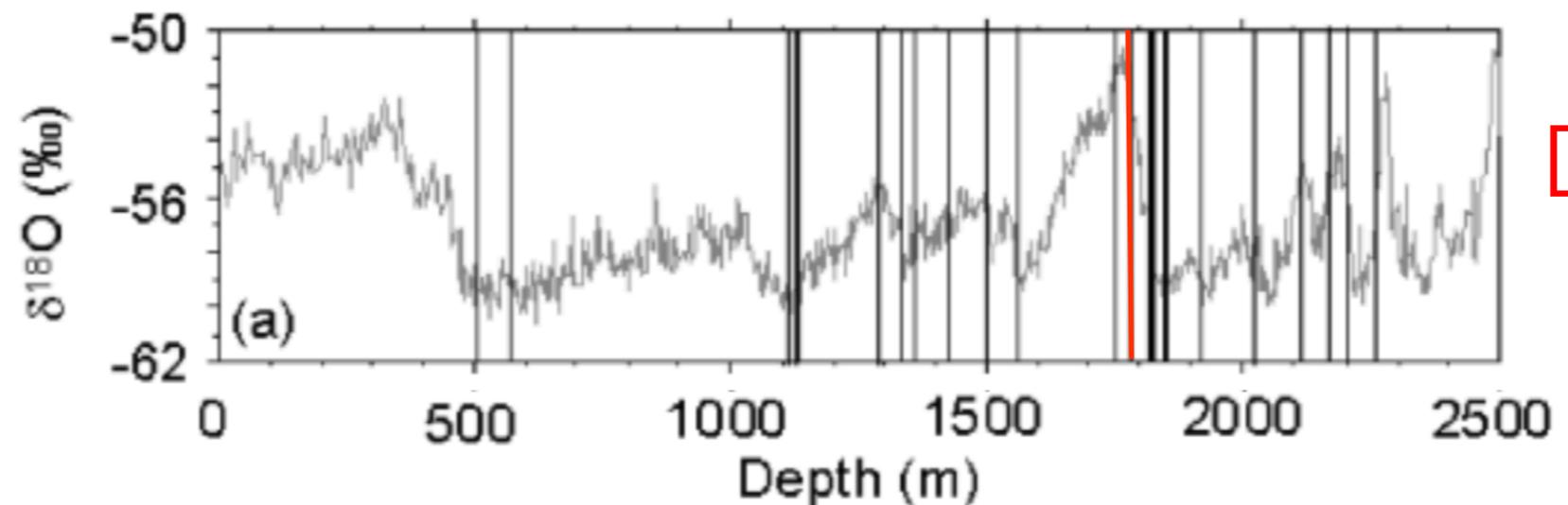
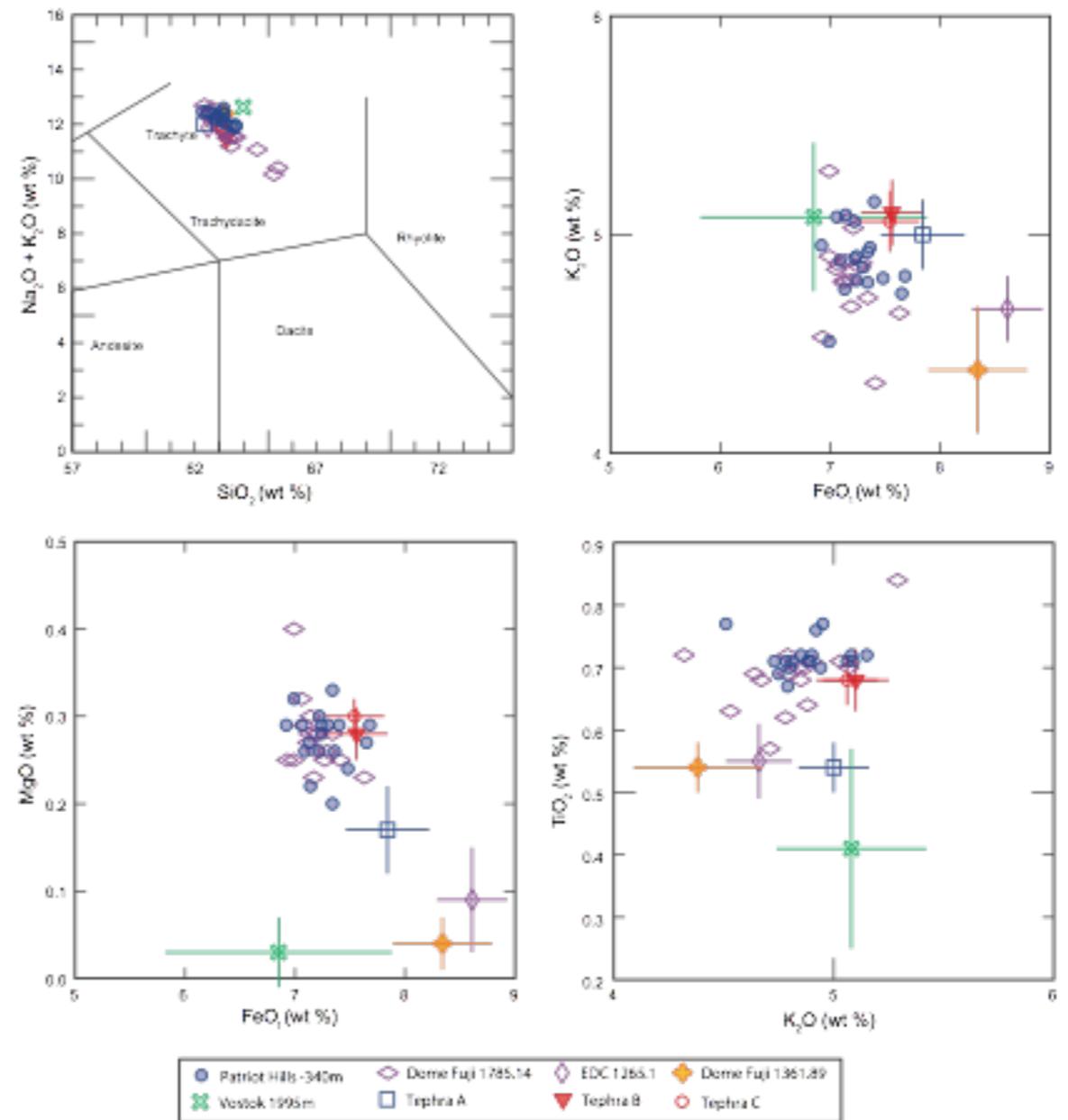


> 30,000 YEARS MISSING ACROSS THE LAST INTERGLACIAL: DOES NOT APPEAR TO BE A PRESERVATION ISSUE

VOLCANIC ASH: PRECISE CORRELATION BETWEEN PATRIOT HILLS AND DOME FUJI AT END OF TERMINATION II

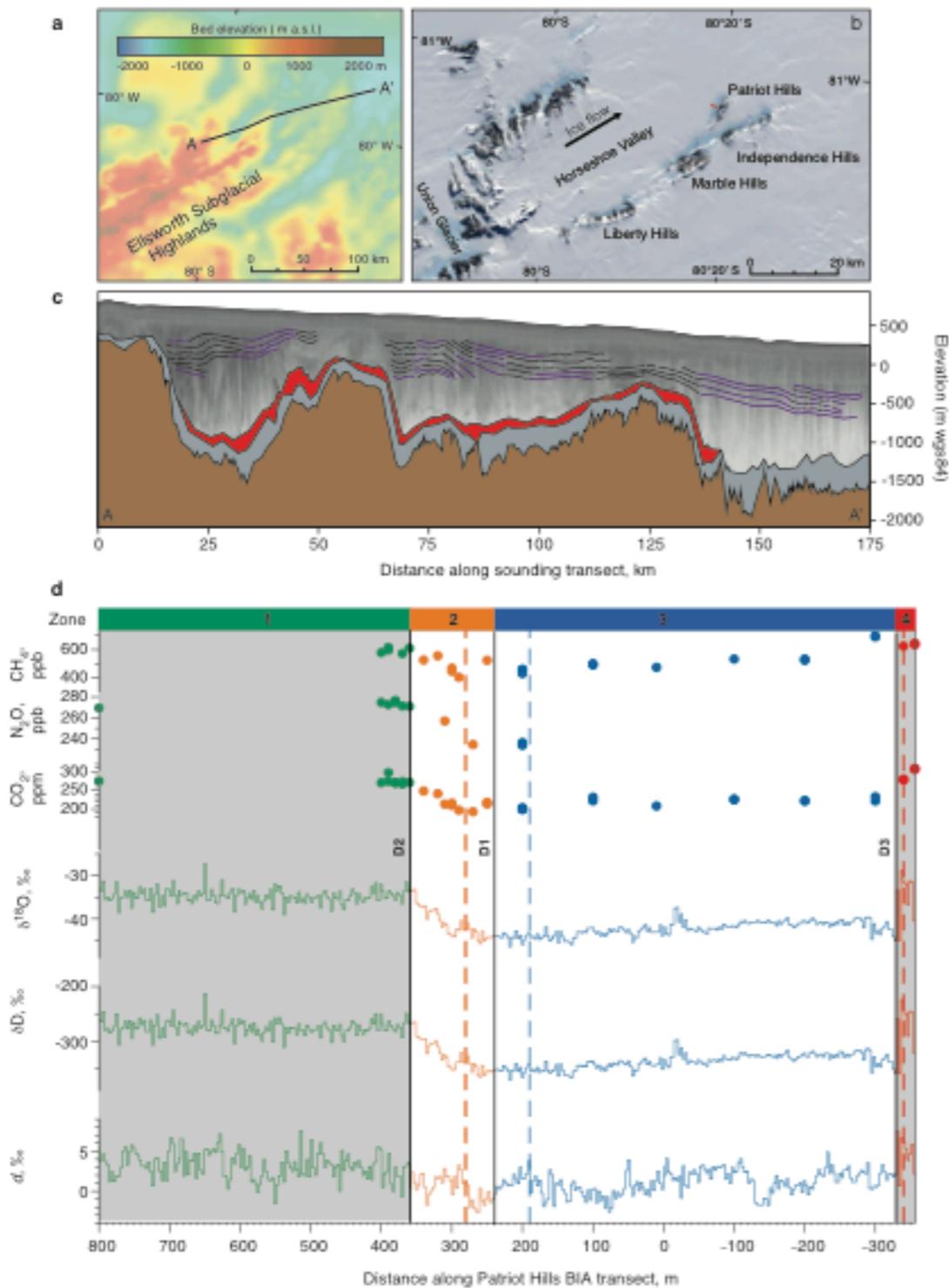


Kohno *et al.*,
2004, *Annals
of Glaciology*

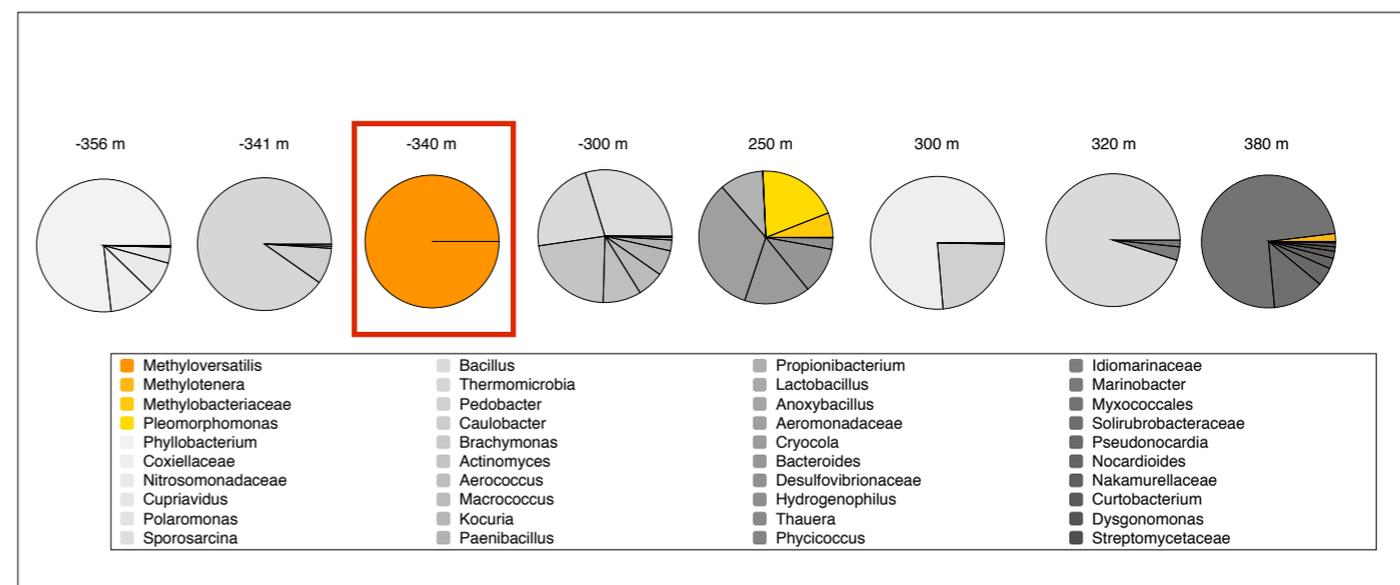


Turney *et al.*, PNAS, 2020

Sampling the Patriot Hills Blue Ice Area for stable isotopes, DNA and trace gases

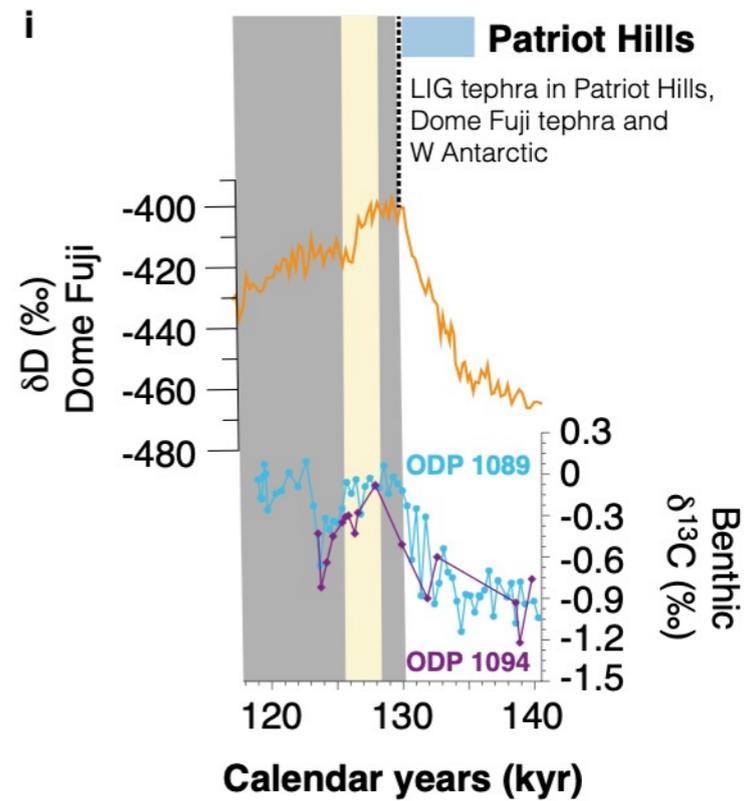
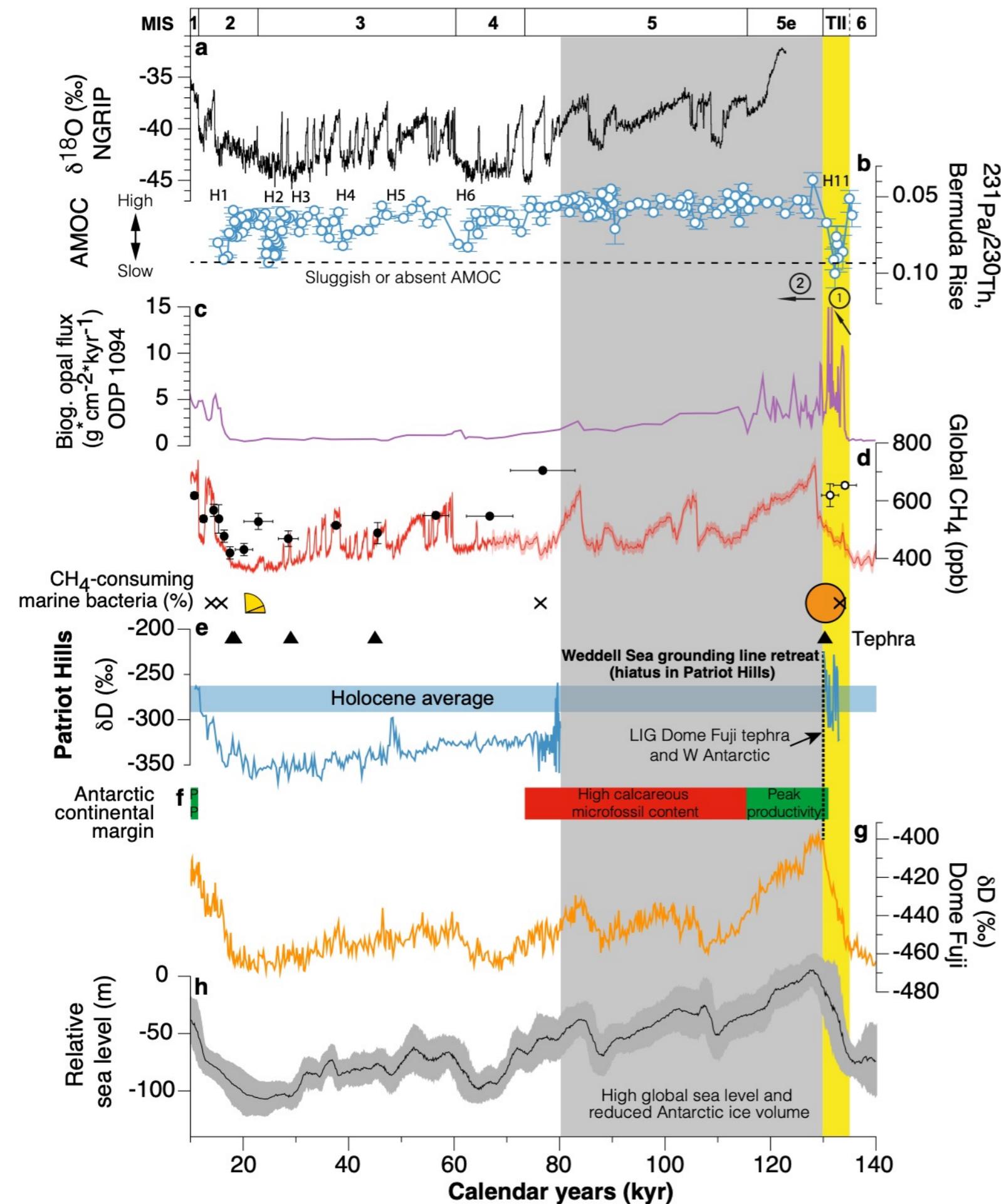


16S ribosomal RNA analysis of point samples suggests end of Termination II ice dominated by DNA from marine methane-consuming bacteria: release of continental shelf methane hydrate (Wadham *et al.*, 2012, *Nature*)?



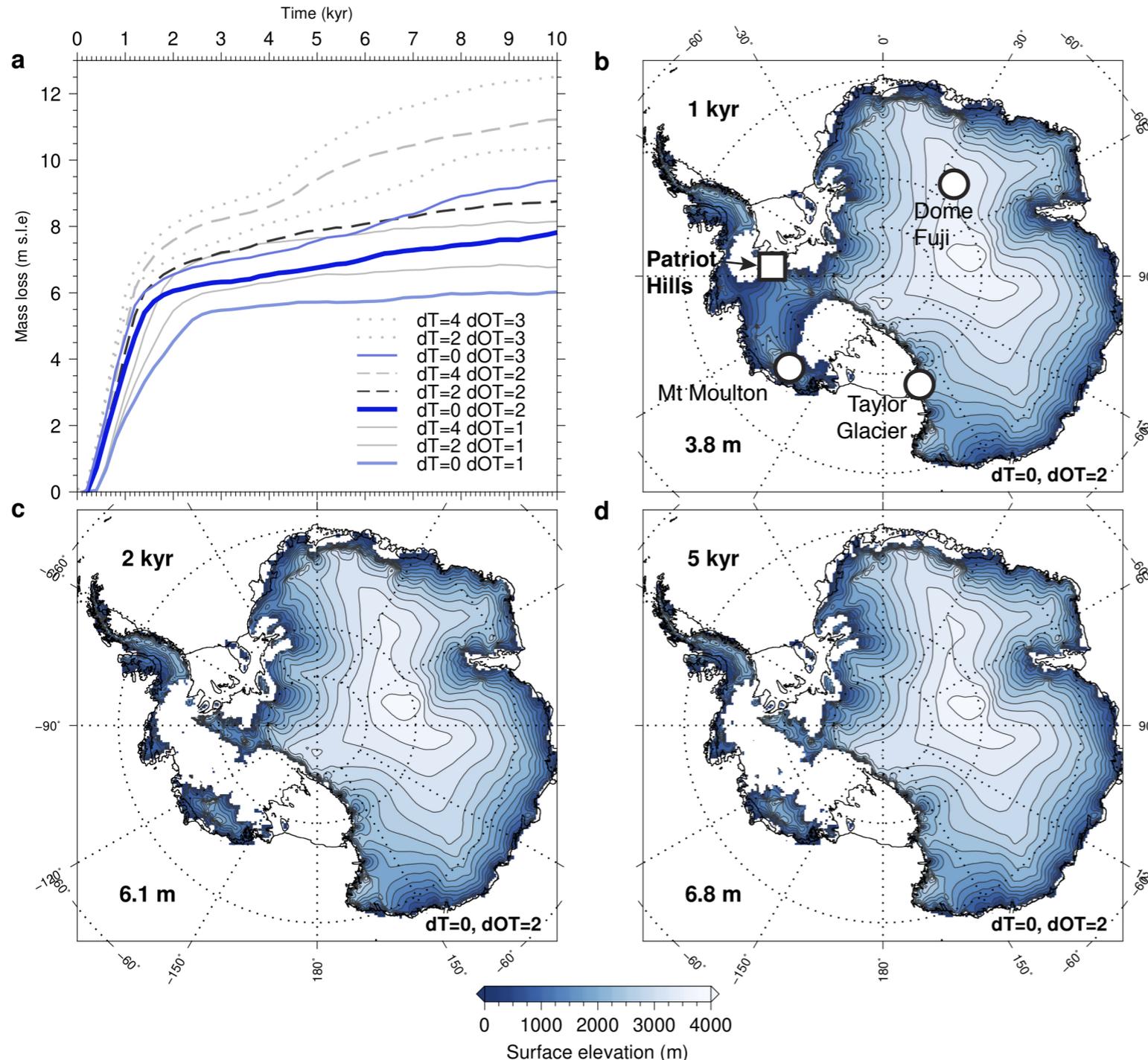
Distance, m

Turney *et al.*, PNAS, 2020



The Patriot Hills Record implies loss of the West Antarctic Ice Sheet through most of the Last Interglacial: crucially, the tephra provides direct link between the Southern Ocean and West Antarctic Ice Sheet at the very start of the LIG

Ice Sheet Modelling



Forced by 2°C SST warming (no air warming)

3.8 metre sea level rise within first millennium

Further details in Turney *et al.*, 2020, PNAS

IMPLICATIONS AND FUTURE WORK

- The Last Interglacial provides a process analogue for the future
- We need to improve the dating and correlation of records to better understand rates of change and mechanisms (www.earthspastfuture.com)
- Fully coupled climate and ice models are critical
- But the Patriot Hills record provides strong evidence the WAIS lost a substantial amount of mass very early in the Last Interglacial - driven by ocean warming
- As we continue to observe polar warming, where is the threshold for collapse?

'One of the warning signs that a dangerous warming trend is under way in Antarctica will be the breakup of ice shelves on both coasts of the Antarctic Peninsula, starting with the northernmost and extending gradually southward.'

Mercer, 1978, Nature

