Australian Government
Department of the Environment
Australian Antarctic Division

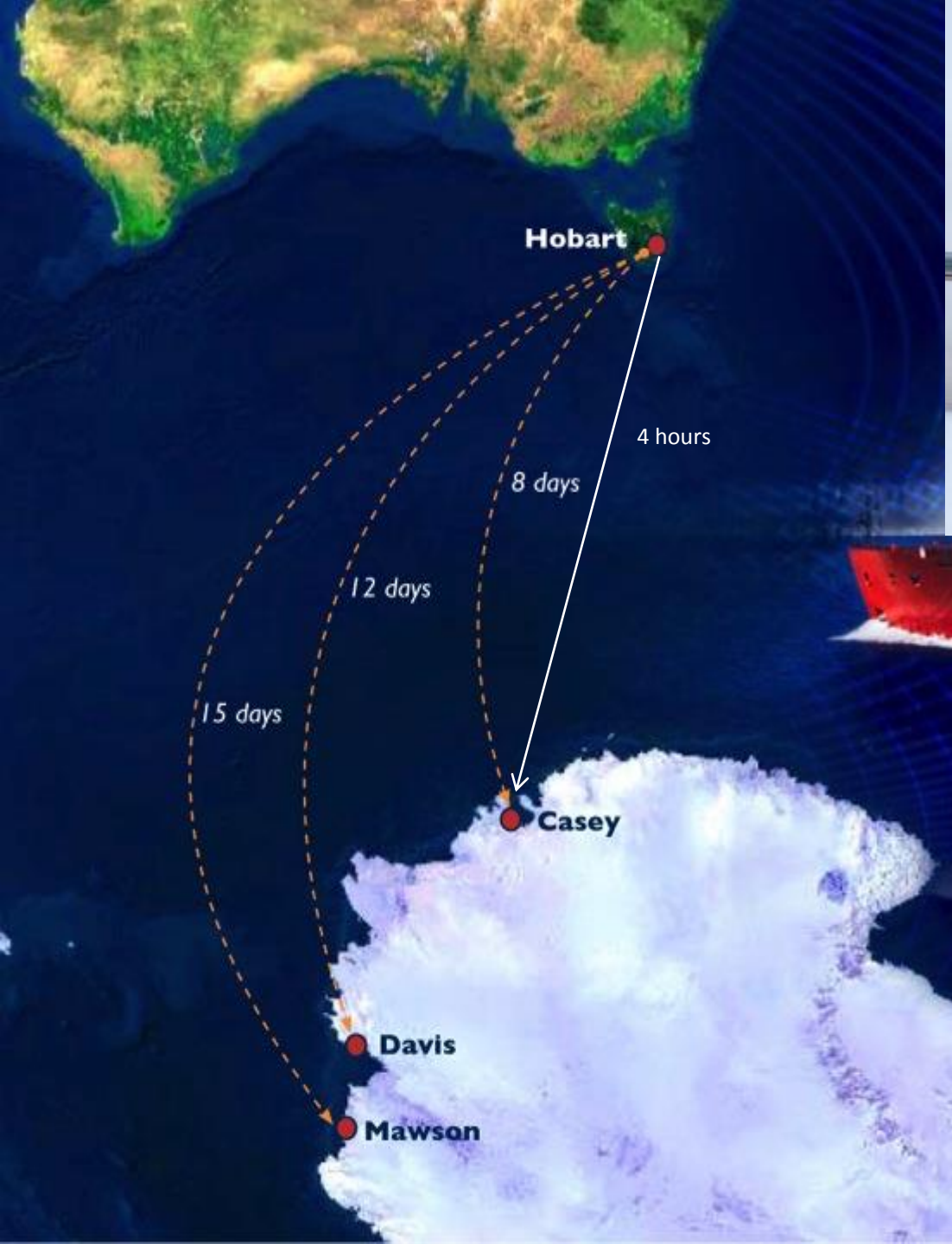
The Importance of Antarctic and Southern Ocean research to understanding our region and to our wellbeing

Nick Gales

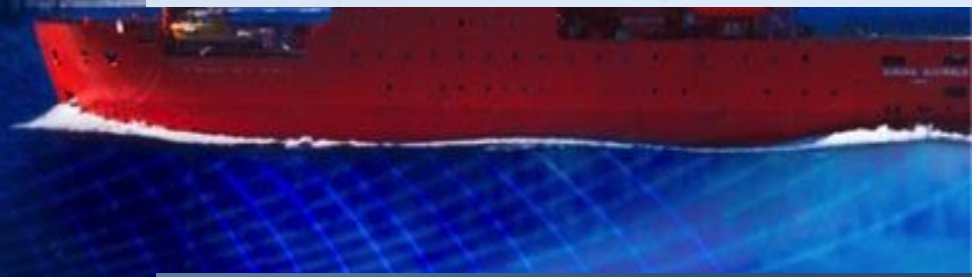
- Linkages; geography, history and economics
- Linkages; climate
- Antarctic science **in** diplomacy
- Antarctic science **for** diplomacy

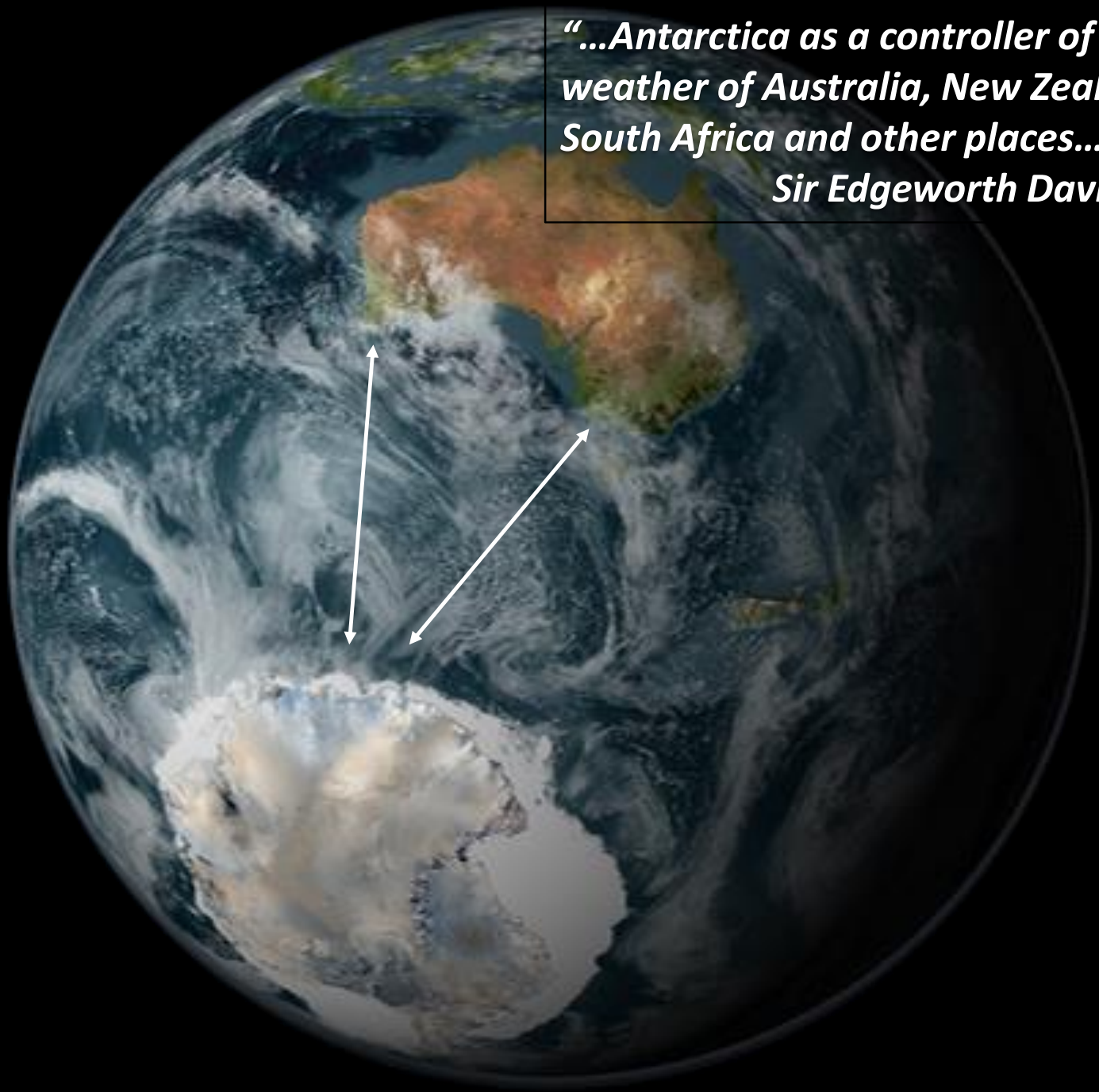

100
100 YEARS OF AUSTRALIAN ANTARCTIC EXPEDITIONS


YAMAHA
QE3


Hobart
4 hours
8 days
12 days
15 days
Casey
Davis
Mawson


U.S. AIR FORCE



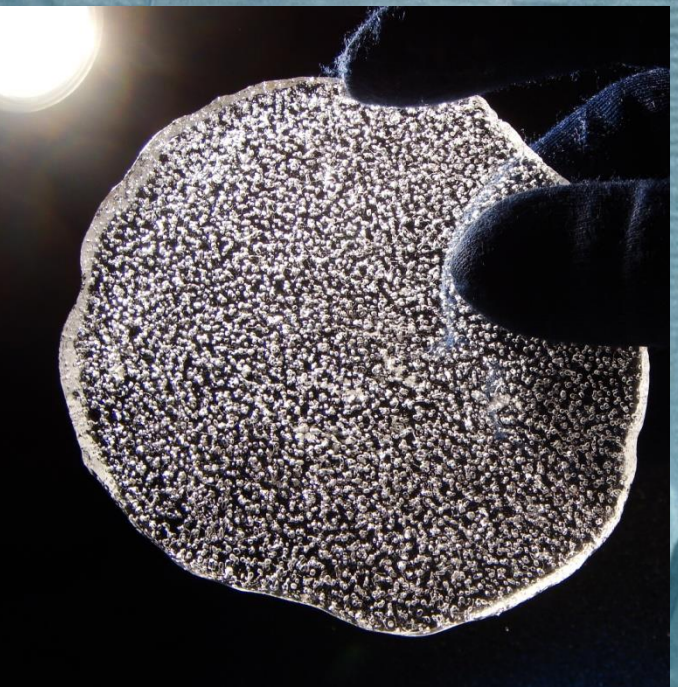


"…Antarctica as a controller of the weather of Australia, New Zealand, South Africa and other places…"

Sir Edgeworth David (1929)

Ice cores record thousands of years of information about past climate

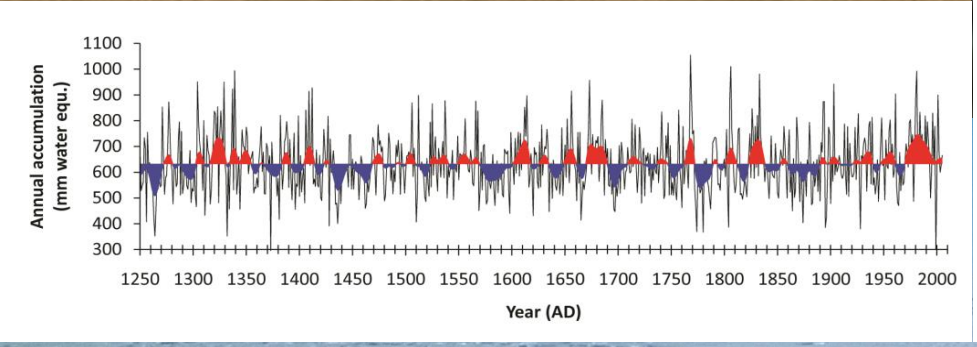
Atmospheric composition (air bubbles), winds, volcanoes and solar activity (contaminants) and past temperature (water isotopes)

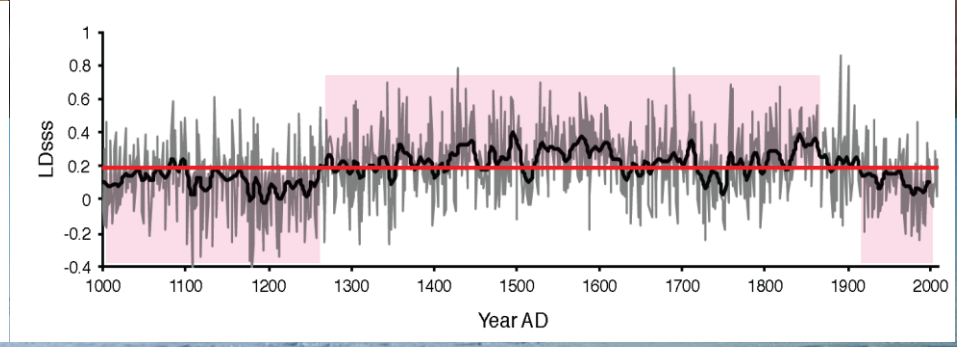



C-GJKB

LOW RAINFALL

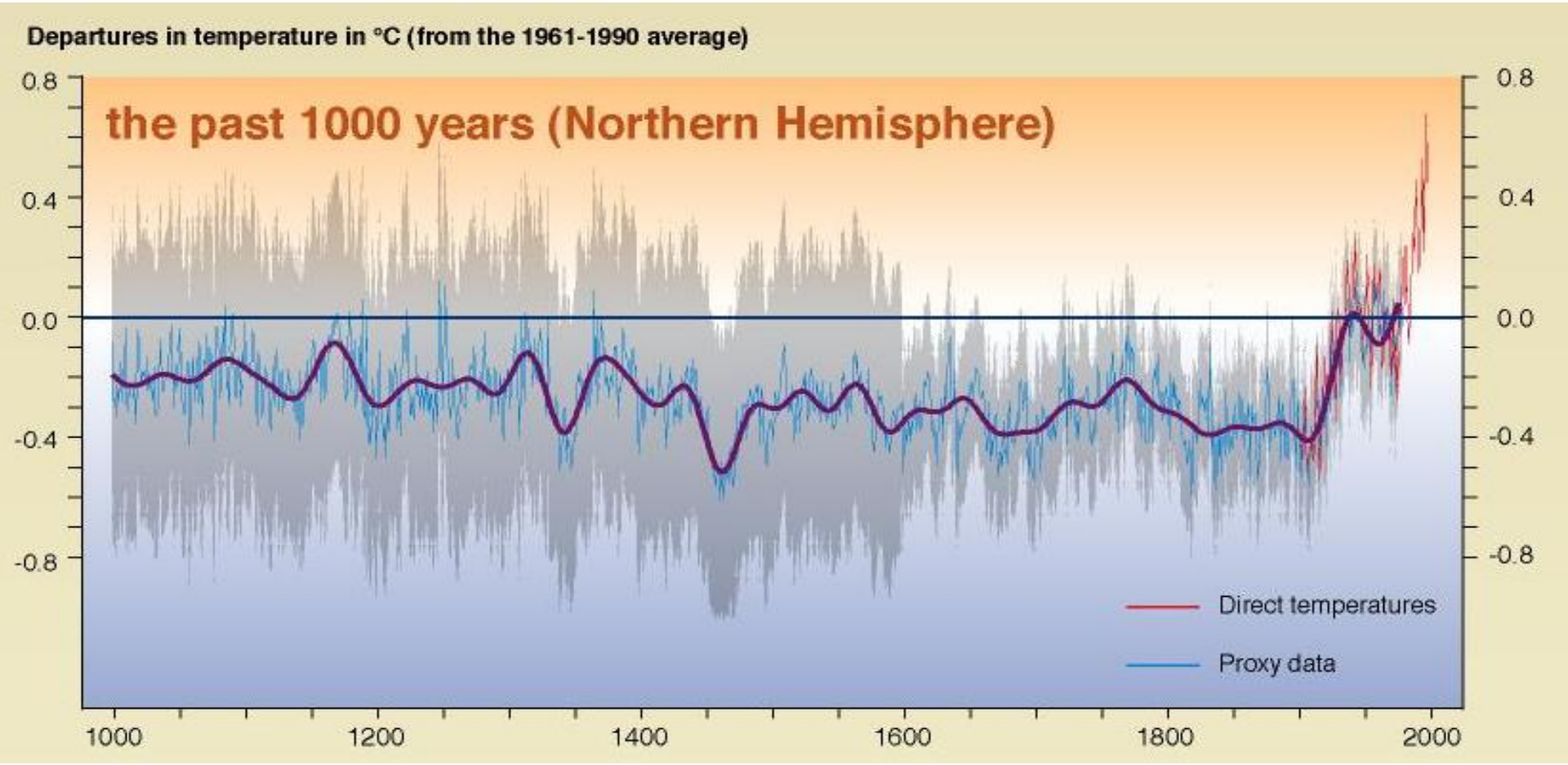
HIGH RAINFALL (La Niña)





HIGH SNOWFALL
(unprecedented multi-decade pattern in last 750yrs)
(Ozone? Other?)

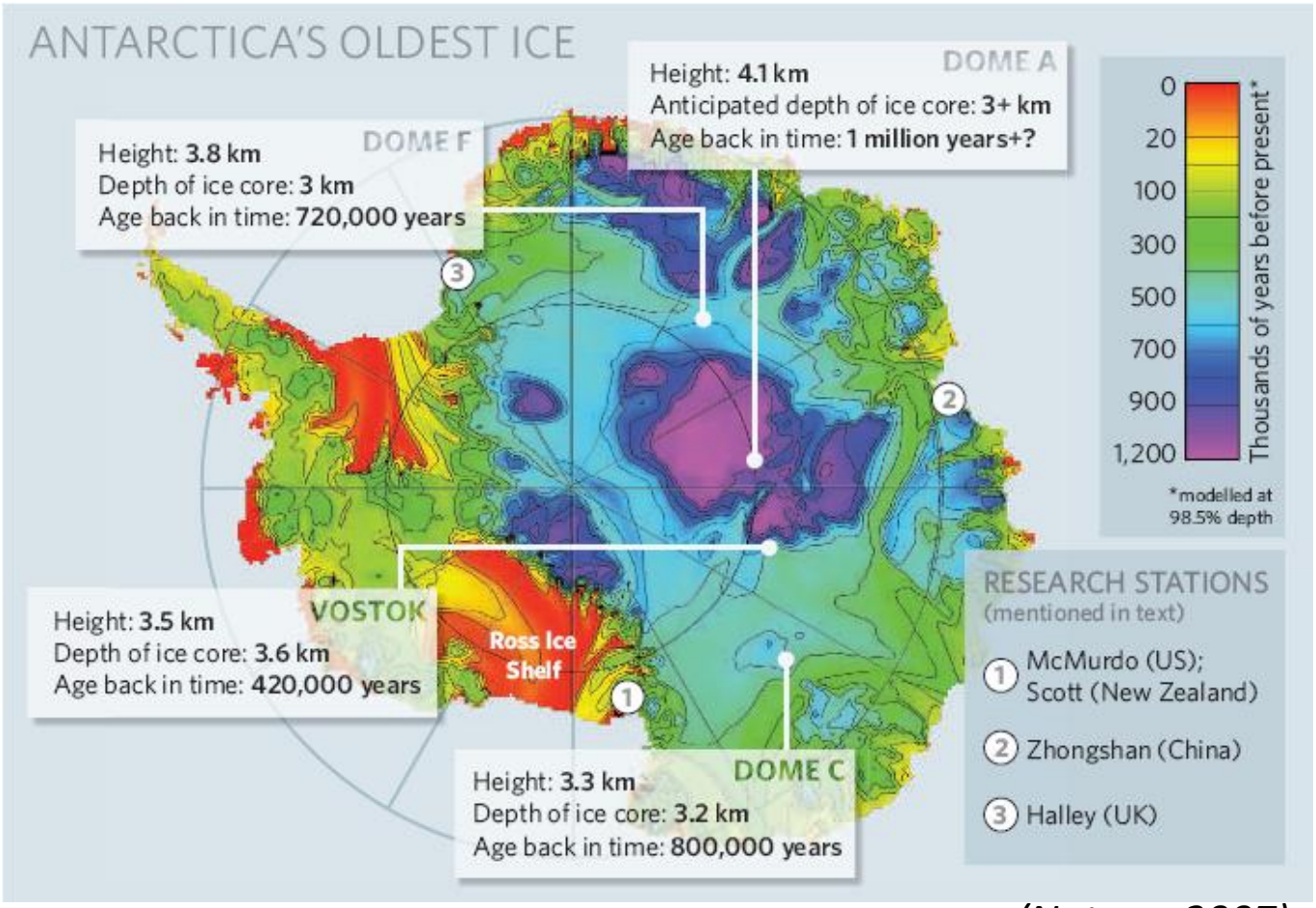
HIGH SEA SALTS (Winds)
(past century rainfall lower than multi-centennial average)
(Pacific drivers?)



Concerns noted in IPCC AR4:

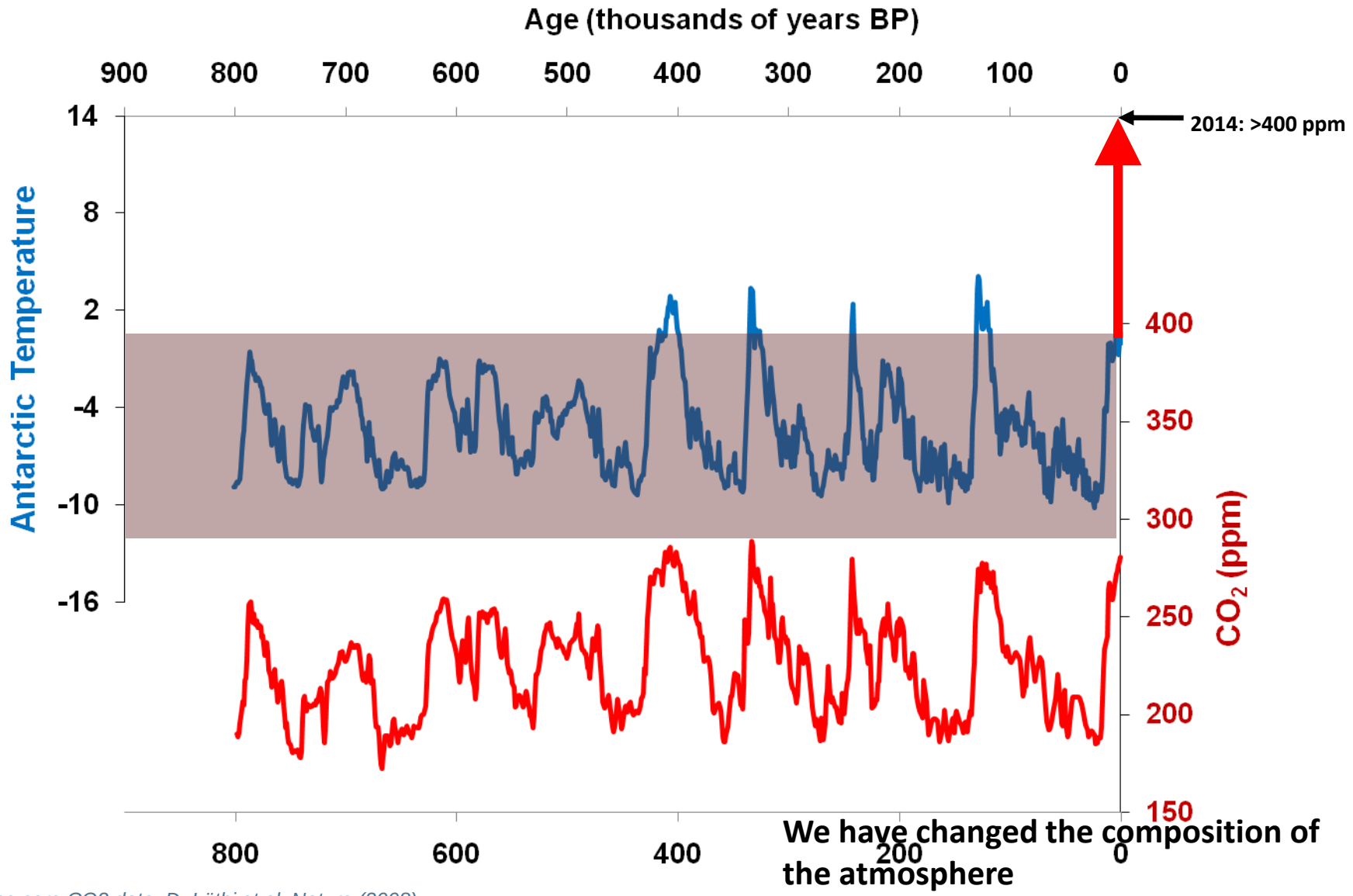
'that Southern Hemisphere climate reconstructions are limited by scarcity and quantity of well resolved palaeoclimate records'

Finding Old Ice

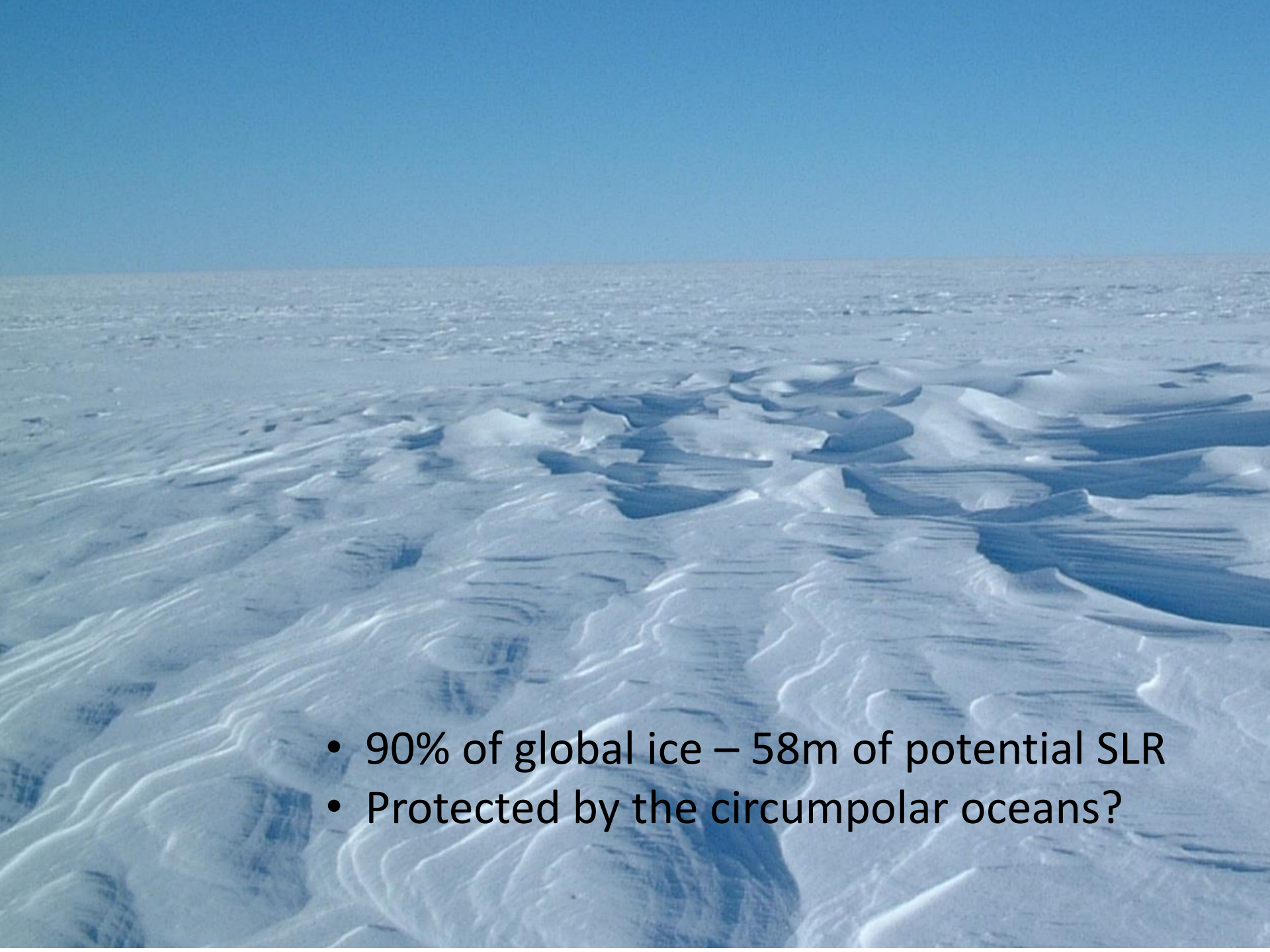


(Nature, 2007)

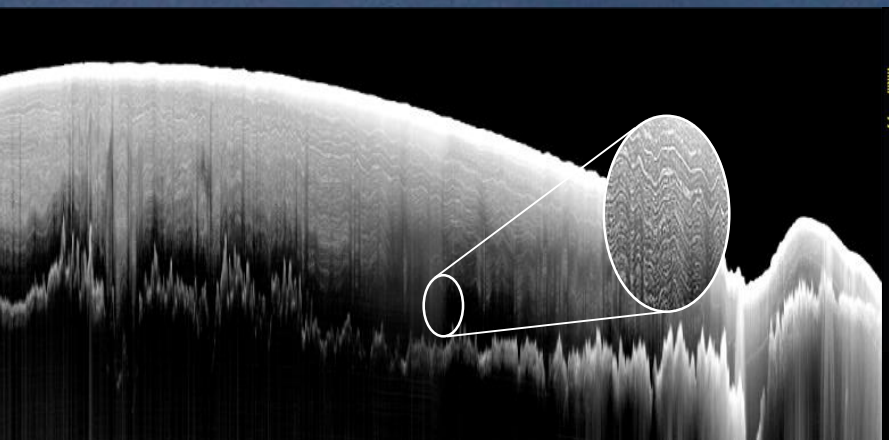
800,000 years of CO_2 and temperature

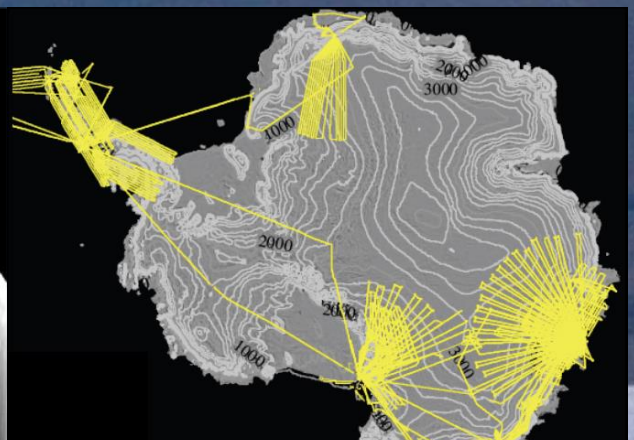


Ice core CO2 data: D. Lüthi et al. Nature (2008),
Antarctic temperature data: J. Jouzel, Nature (2007) Graphs J. Pedro.

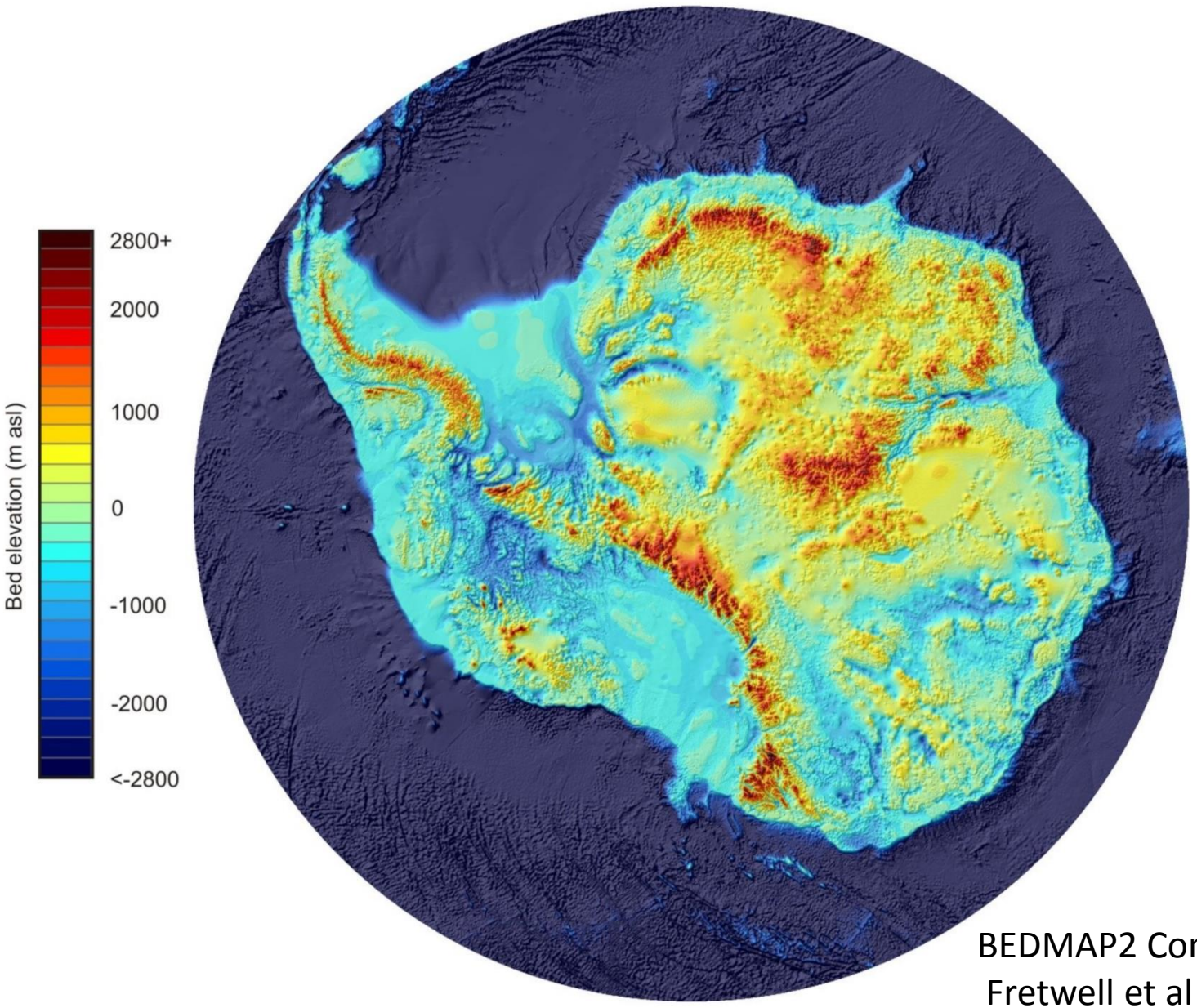


- 90% of global ice – 58m of potential SLR
- Protected by the circumpolar oceans?

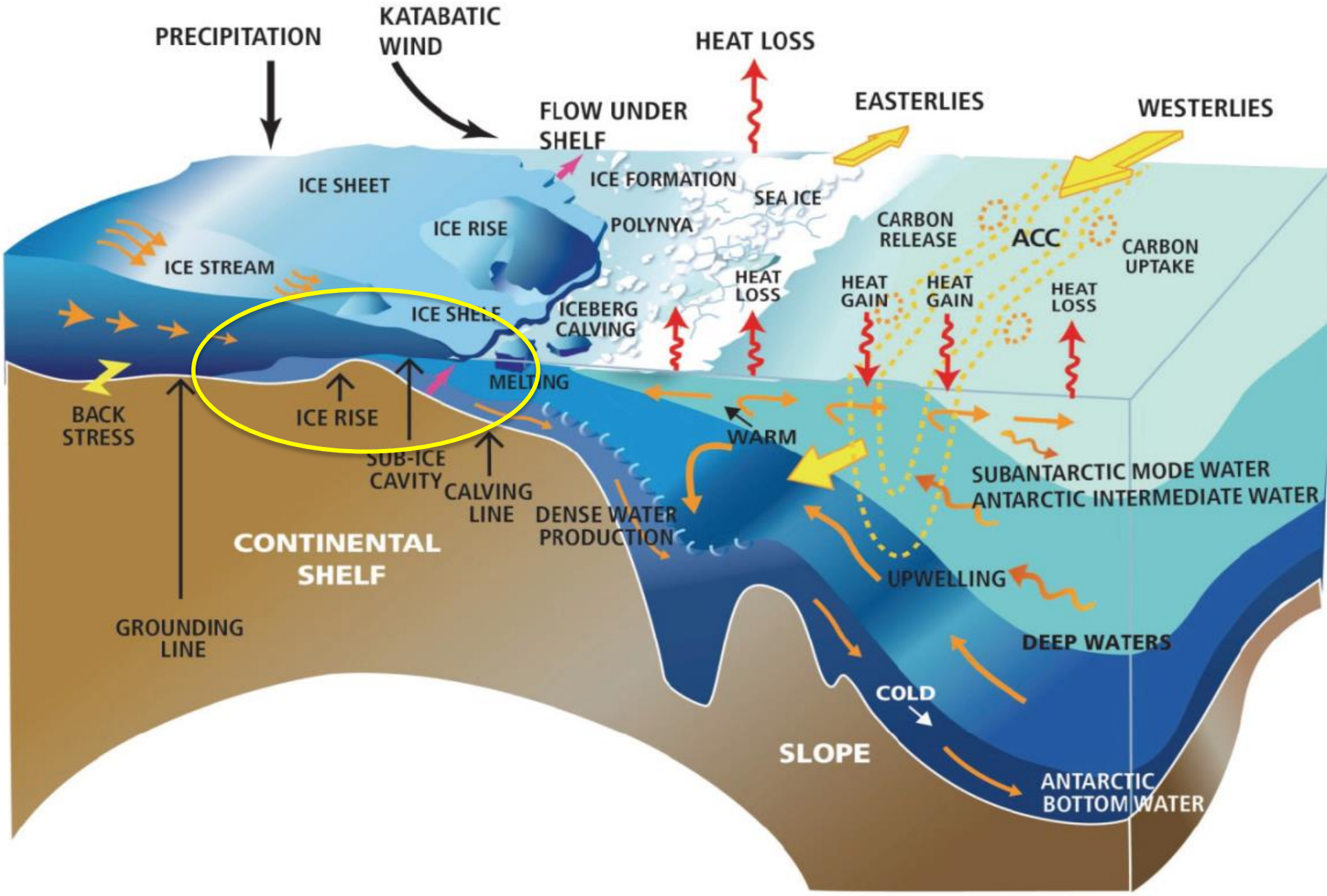


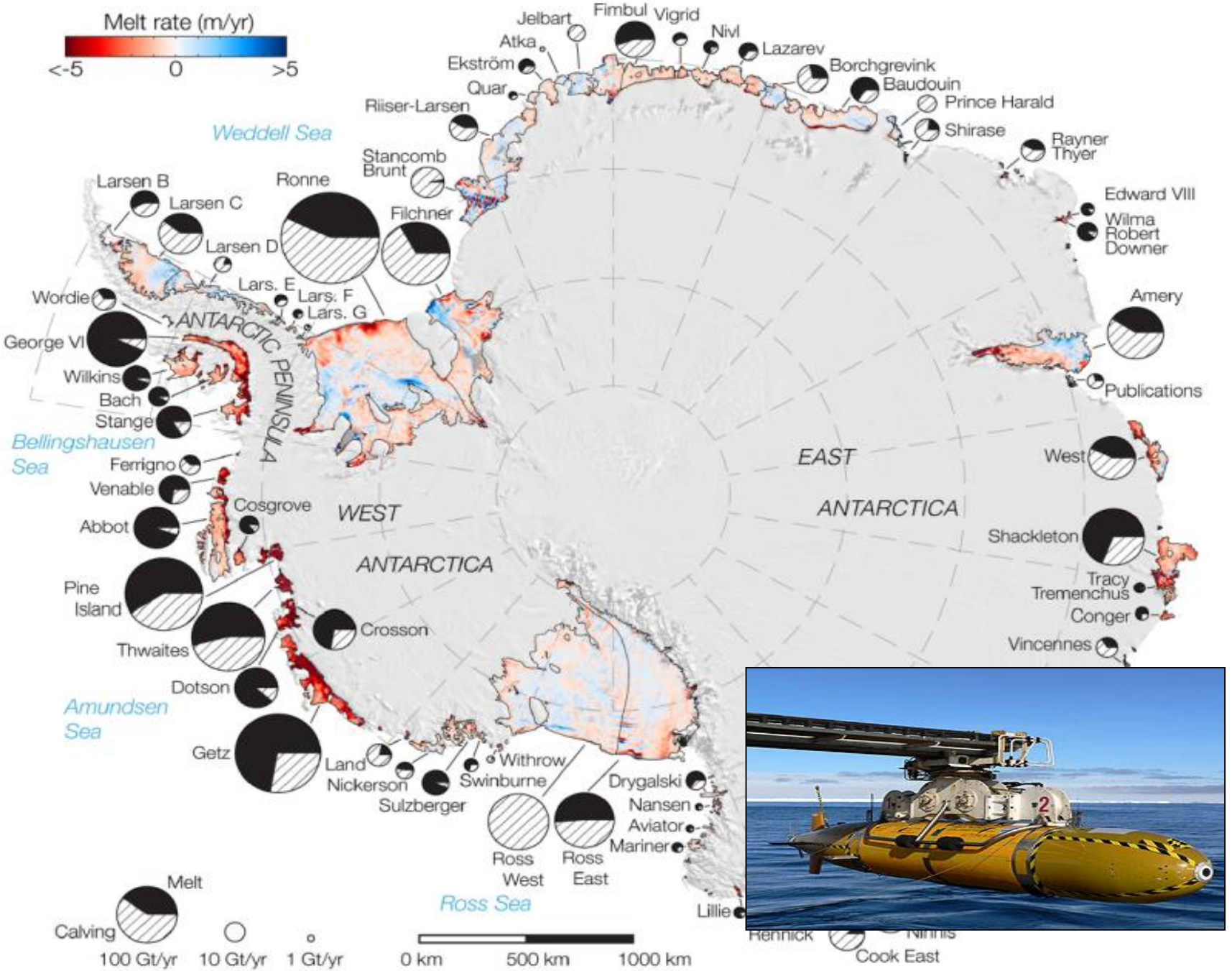

1000
2000
3000
2000
3000
2000
1000

Antarctic Bedrock Elevation

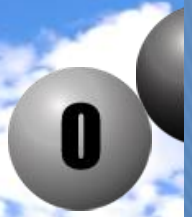


BEDMAP2 Consortium:
Fretwell et al (2012)


PRECIPITATION
KATABATIC WIND
HEAT LOSS
FLOW UNDER SHELF
EASTERLIES
WESTERLIES
ICE SHEET
ICE FORMATION
SEA ICE
ICE RISE
POLYNYA
CARBON RELEASE
ACC
CARBON UPTAKE
ICE STREAM
HEAT LOSS
HEAT GAIN
HEAT GAIN
HEAT LOSS
ICE SHELF
ICEBERG CALVING
MELTING
BACK STRESS
ICE RISE
WARM
SUB-ICE CAVITY
CALVING LINE
DENSE WATER PRODUCTION
SUBANTARCTIC MODE WATER
ANTARCTIC INTERMEDIATE WATER
CONTINENTAL SHELF
UPWELLING
GROUNDING LINE
DEEP WATERS
COLD
SLOPE
ANTARCTIC BOTTOM WATER

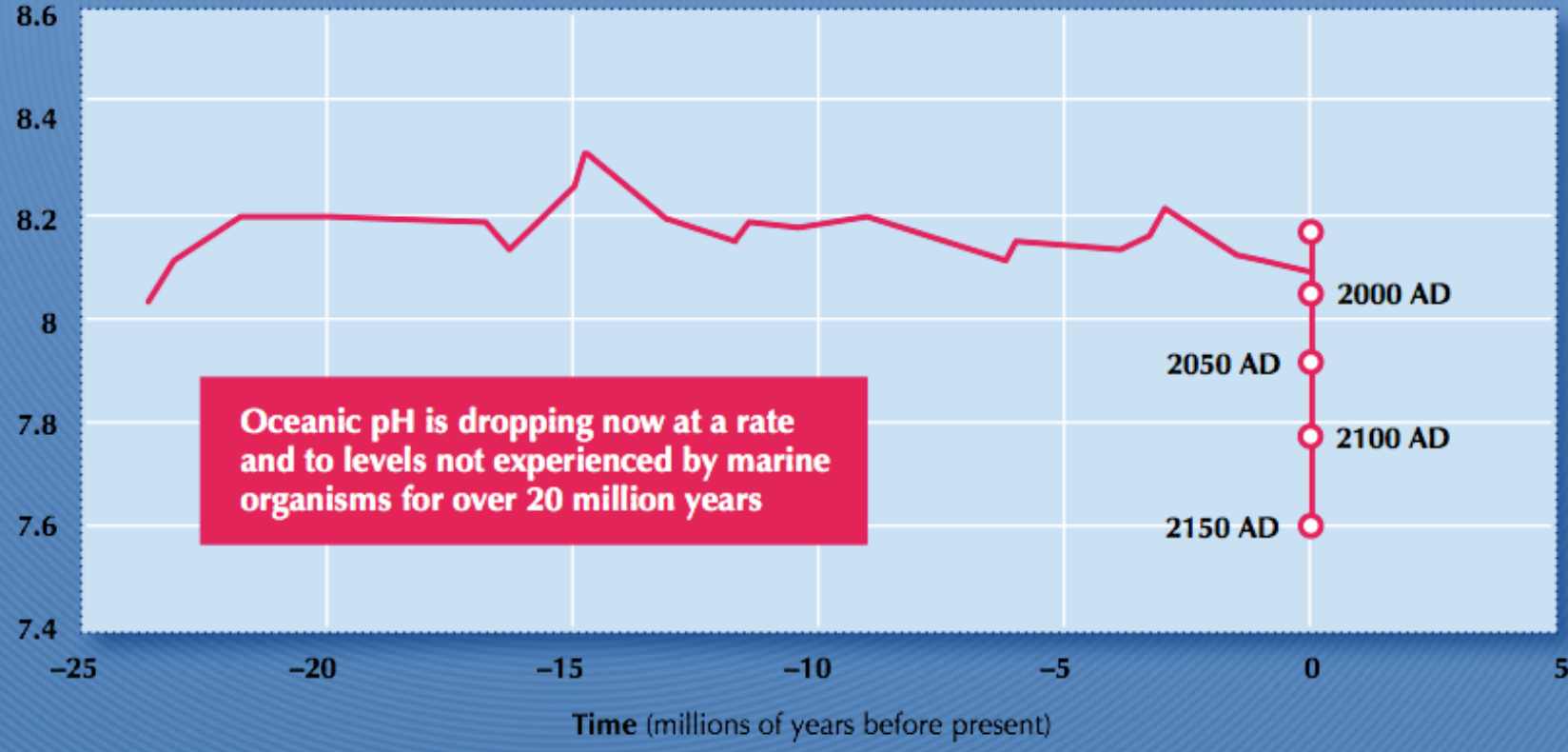

Melt rate (m/yr)
<-5
0
>5
Jelbart
Fimbul
Vigrid
Nivl
Atka
Ekström
Lazarev
Borchgrevink
Quar
Baudouin
Prince Harald
Riiser-Larsen
Shirase
Weddell Sea
Rayner
Thyer
Stancomb
Brunt
Filchner
Ronne
Edward VIII
Wilma
Robert
Downer
Larsen B
Larsen C
Larsen D
Lars. E
Lars. F
Lars. G
Wordie
Amery
ANTARCTIC PENINSULA
George VI
Wilkins
Bach
Stange
Publications
Bellingshausen
Sea
EAST
West
Ferrigno
Venable
Cosgrove
WEST
ANTARCTICA
ANTARCTICA
Abbot
Shackleton
Tracy
Tremenchus
Pine
Island
Conger
Crosson
Vincennes
Thwaites
Dotson
Amundsen
Sea
Getz
Land
Withrow
Nickerson
Swinburne
Drygalski
Sulzberger
Nansen
Aviator
Mariner
Ross
West
Ross
East
Ross Sea
Lillie
Rennick
Cook East
Melt
Calving
100 Gt/yr
10 Gt/yr
1 Gt/yr
0 km
500 km
1000 km

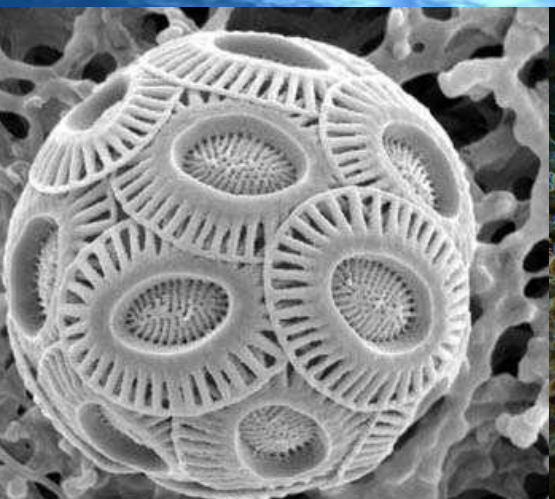
Carbon dioxide

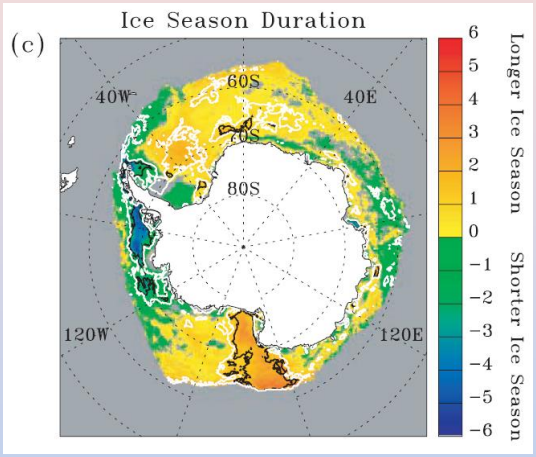


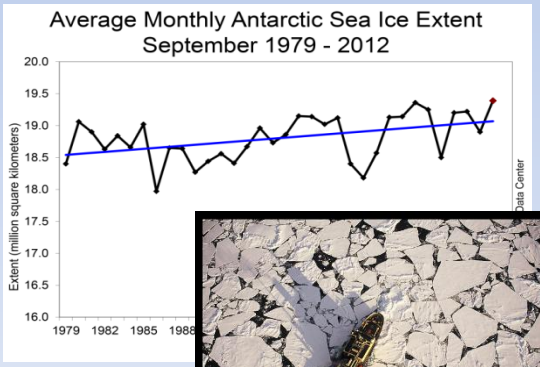
Changes in oceanic pH over the last 25 million years

Source after Turley et al. in *Avoiding Dangerous Climate Change* (2006).

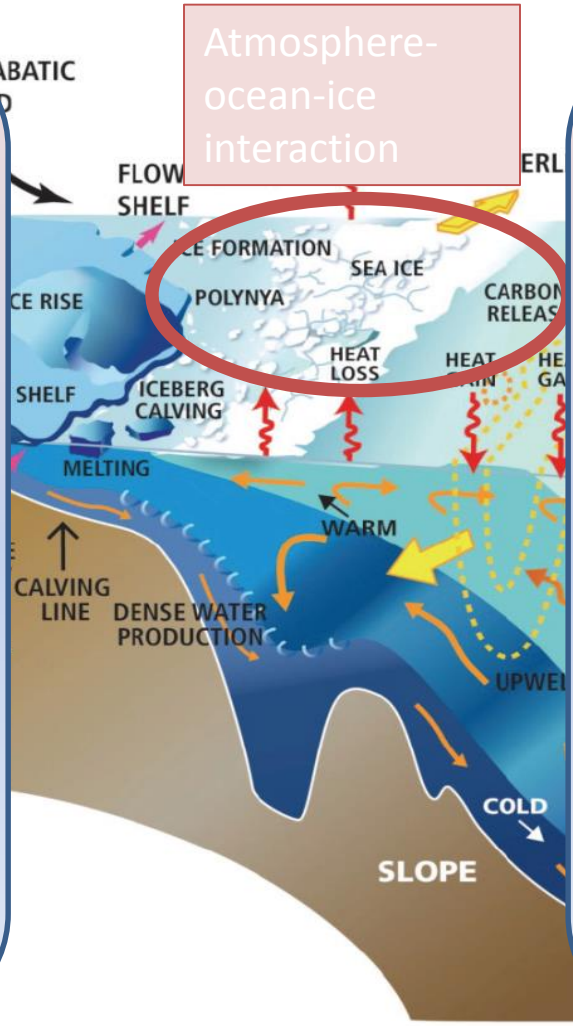


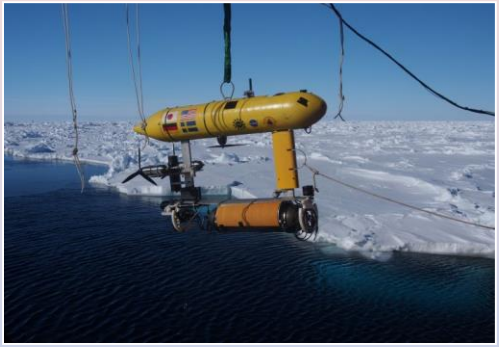


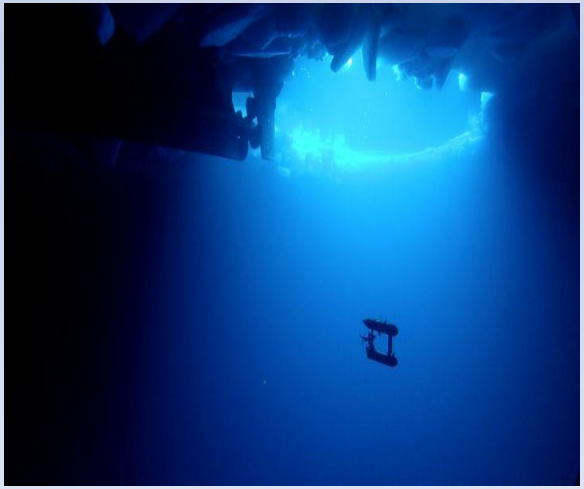


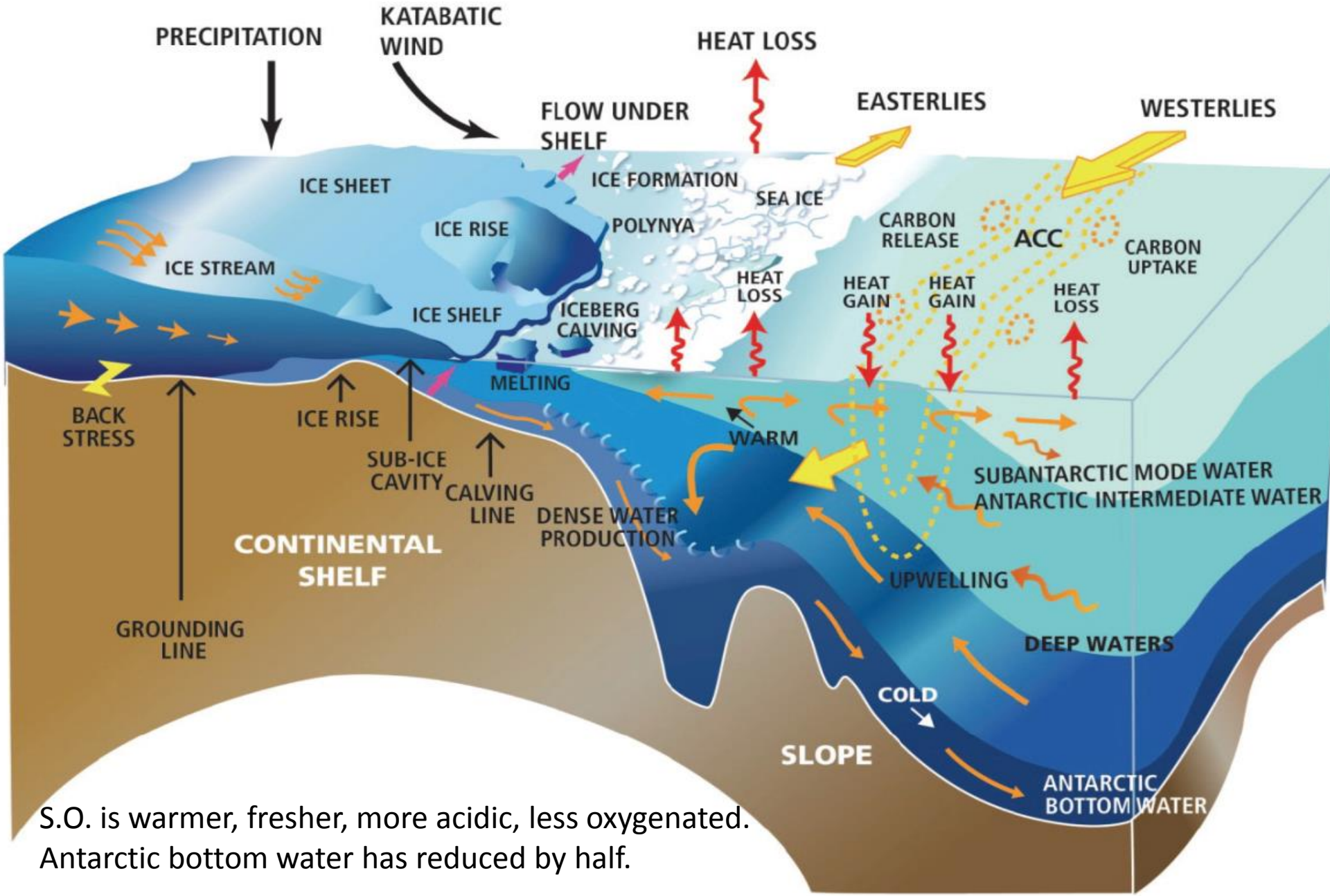


Atmosphere-ocean-ice interaction









S.O. is warmer, fresher, more acidic, less oxygenated.
Antarctic bottom water has reduced by half.

The Big Science Questions

1. Will the Southern Ocean continue to store heat and carbon dioxide and thereby slow the rate of climate change?
2. How will warming of the surrounding ocean affect mass loss from the Antarctic ice sheet and rates of future sea level rise?
3. How will Southern Ocean ecosystems respond to changes in the physical and chemical environment of the Southern Ocean?
4. Can the record of past climate contained in Antarctic ice cores help us interpret modern observations, and anticipate and respond to the challenges of climate change and variability?

Antarctic Science matters: Science **in** Diplomacy (policy)

- Drives our region's and the globe's climate (averages and extremes) – Antarctic science drives the global climate models
- SO mitigates temperature rise and atmospheric gases (environmental services)
- Tells us about our past climate
- Shapes our future coasts
- 1/3 of our marine estate lies to our south
- Australians care about Antarctic icons

Antarctic Science matters: Science **for** Diplomacy

- Antarctic is preserved for peace and science – managed through the Antarctic Treaty System
- Relationships and influence are built on cooperation and collaboration; '*science is the lingua franca of Antarctica*'
- Geopolitics of Antarctica are changing fast

The Future?
20 Year Australian Antarctic Plan

- Oct 10: Australia's Environment Minister released a 20yr Australian Antarctic Strategic Plan
- Key observations :
  - Australia's science output is world class and fundamentally important to Australians
  - Australia's has been a leader in Antarctic affairs for the past Century, but this position is under threat because of historical underinvestment at a time when new players are emerging in Eastern Antarctica
  - Australia should match the efforts of others in the region and become the partner of choice in east Antarctica
  - 35 recommendations on a wide range of issues, from simple/procedural to complex/expensive