The need for a rapid-access drill

IDPO Meeting, April 2011

Jeff Severinghaus

BIG QUESTIONS:

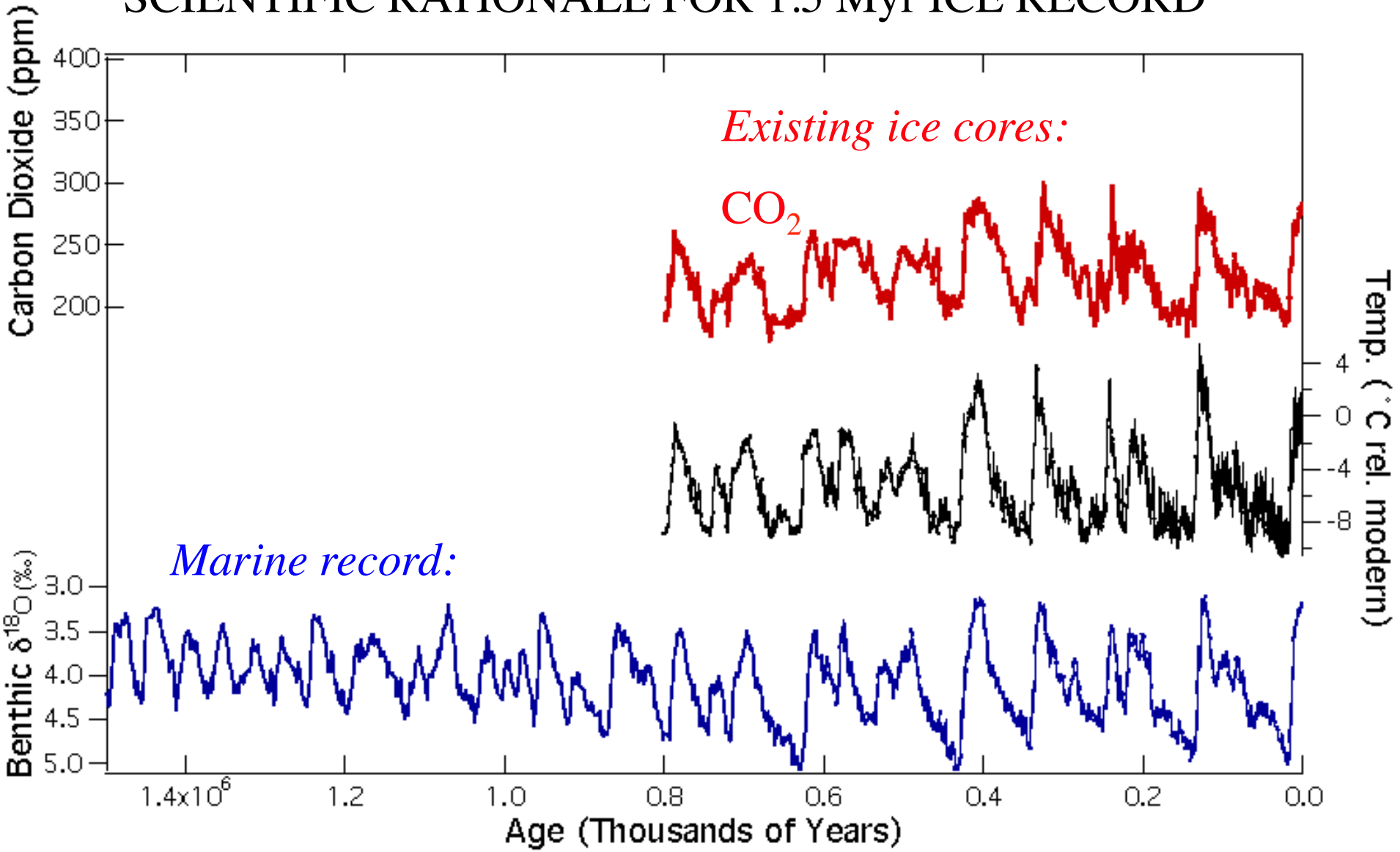
- Did WAIS collapse 130 kyr ago?

  Last interglacial sea level 7-9 m higher than present.

- Why did the ice ages cycle at 41 kyr periods >1 million years ago? Was it CO_2?

Hunting for the Oldest Ice:
A 1.5 million-year record of greenhouse gases and climate

SCIENTIFIC RATIONALE FOR 1.5 Myr ICE RECORD



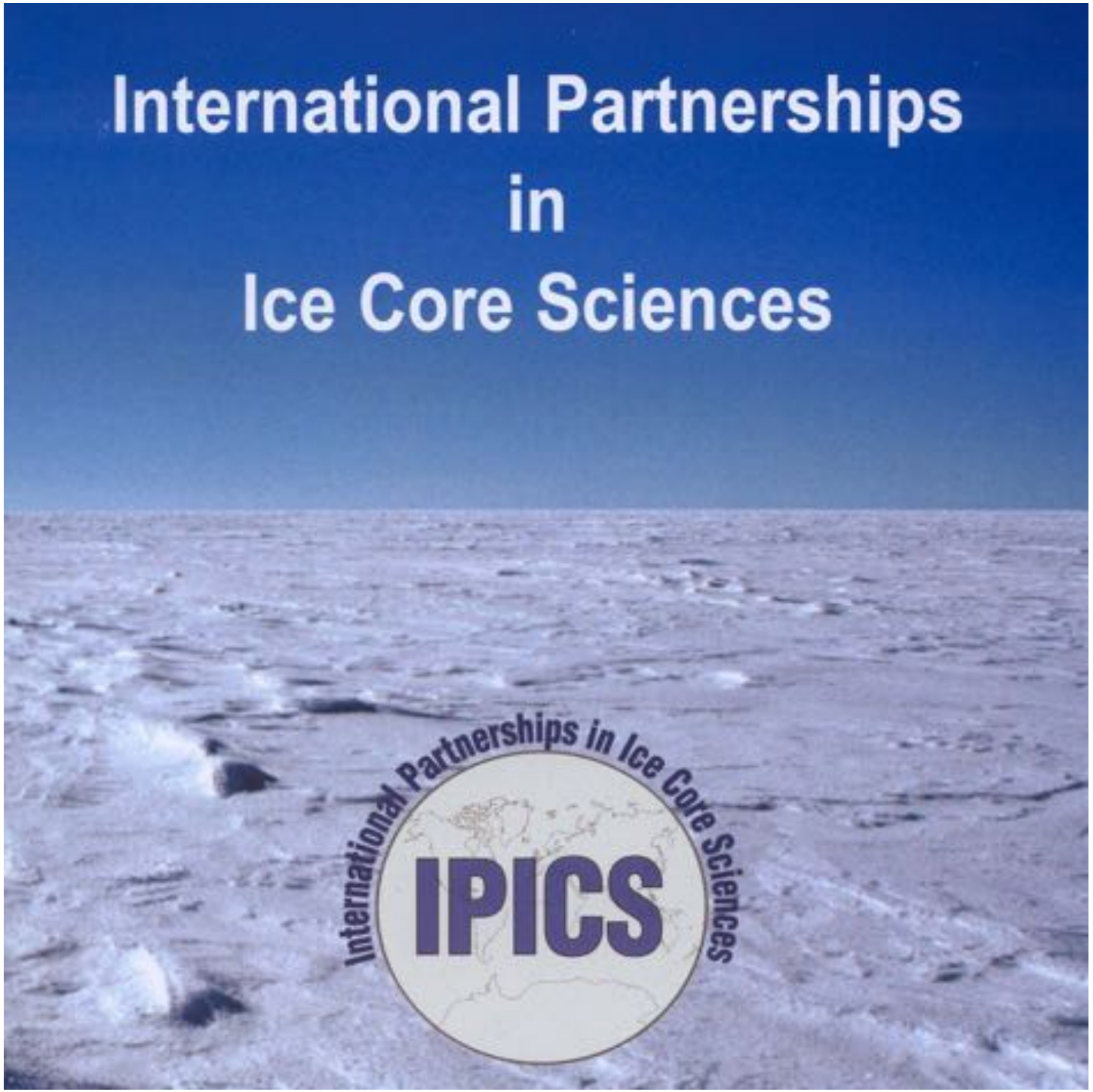
EPICA Dome C ice core, Lüthi et al. (2008); Lisiecki and Raymo (2005)

Scientific Rationale:

-test hypothesis that falling atmospheric CO_2 caused the “41k world” to turn into the “100k world”

-test hypothesis that 41k marine $d^{18}O$ signature was caused by existence of land-based Antarctic ice sheet margins, which were sensitive to precession-band local insolation forcing (Raymo)

---> *testable prediction*: Antarctic temperature proxies (dD_{ice}) should have strong local insolation signature in 41k world, despite absence of precession in deep sea


International Partnerships
in
Ice Core Sciences
International Partnerships in Ice Core Sciences
IPICS

“OldestIce” desired site characteristics

-accumulation rate < 2 cm a^{-1}

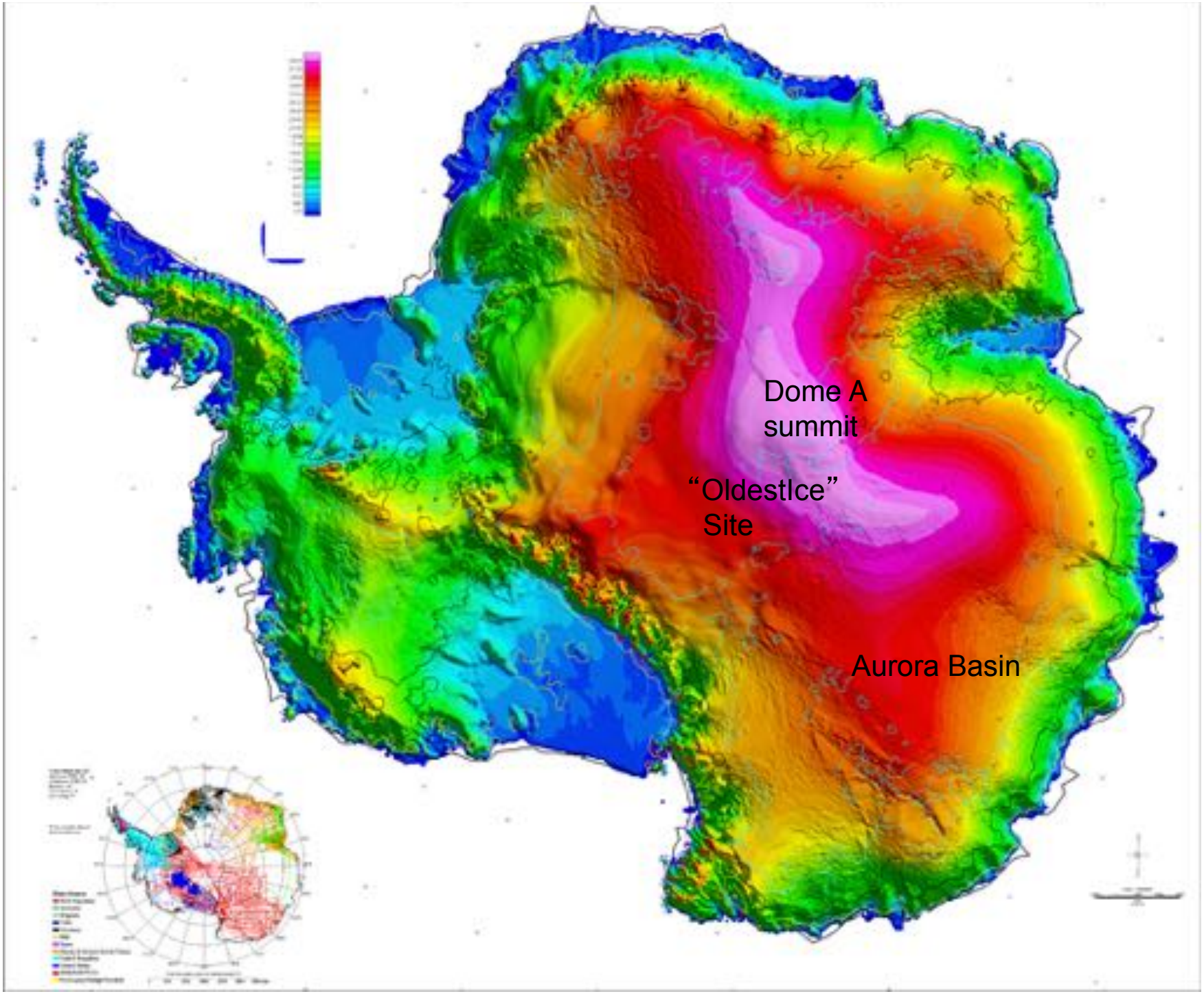
-ice thickness > 3500 m

-low heat flow at base (~50 mW m^{-2})

-surface temperature < -55 ˚C

-flat bottom topography

-slow ice velocity


Dome A
summit
“OldestIce”
Site
Aurora Basin

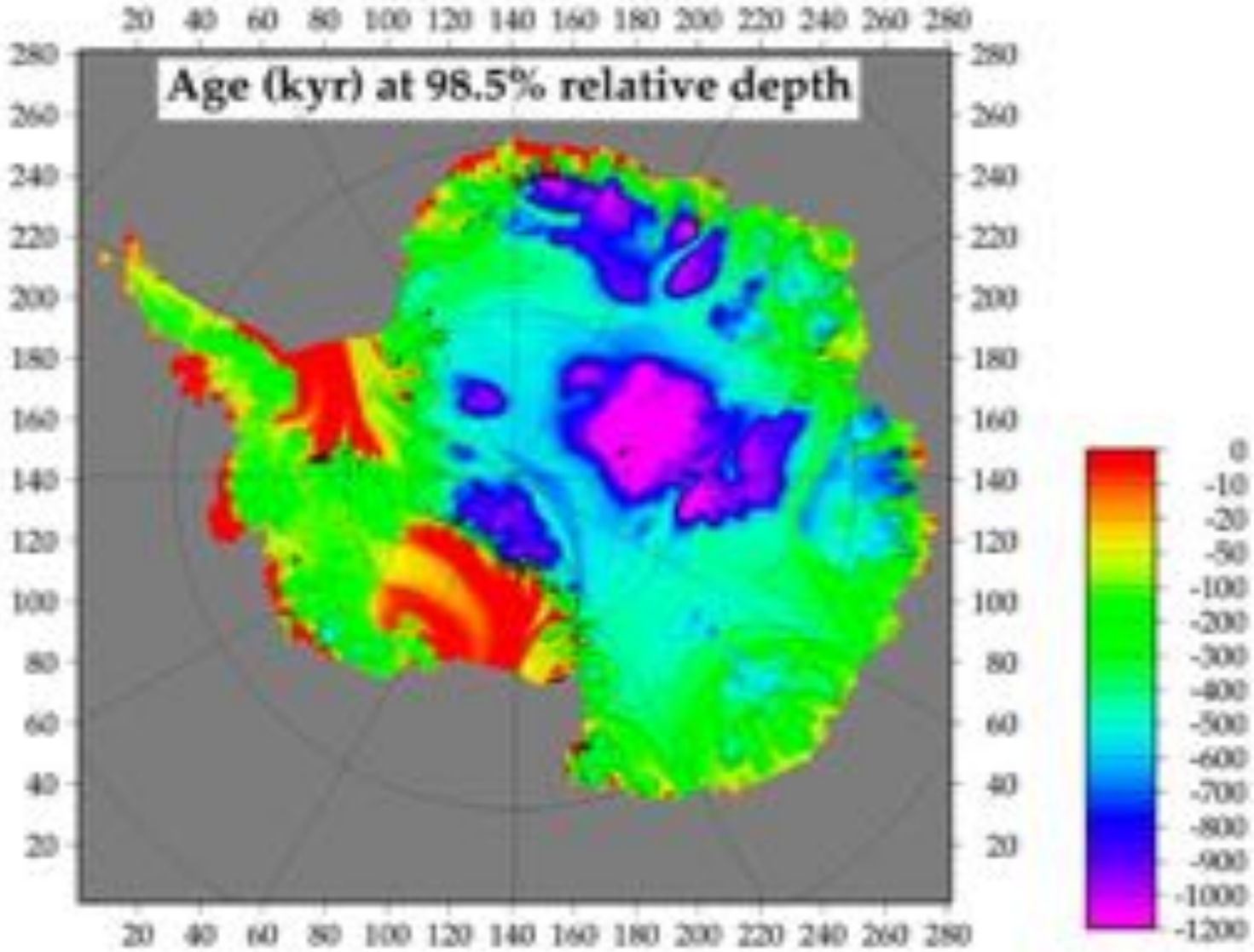


Figure 5. Estimated location of sites with oldest ice, based on knowledge as of 2005, courtesy of Philippe Huybrechts. Contours are age (in ka BP) at 98.5% depth (typically 50 m above the bed).

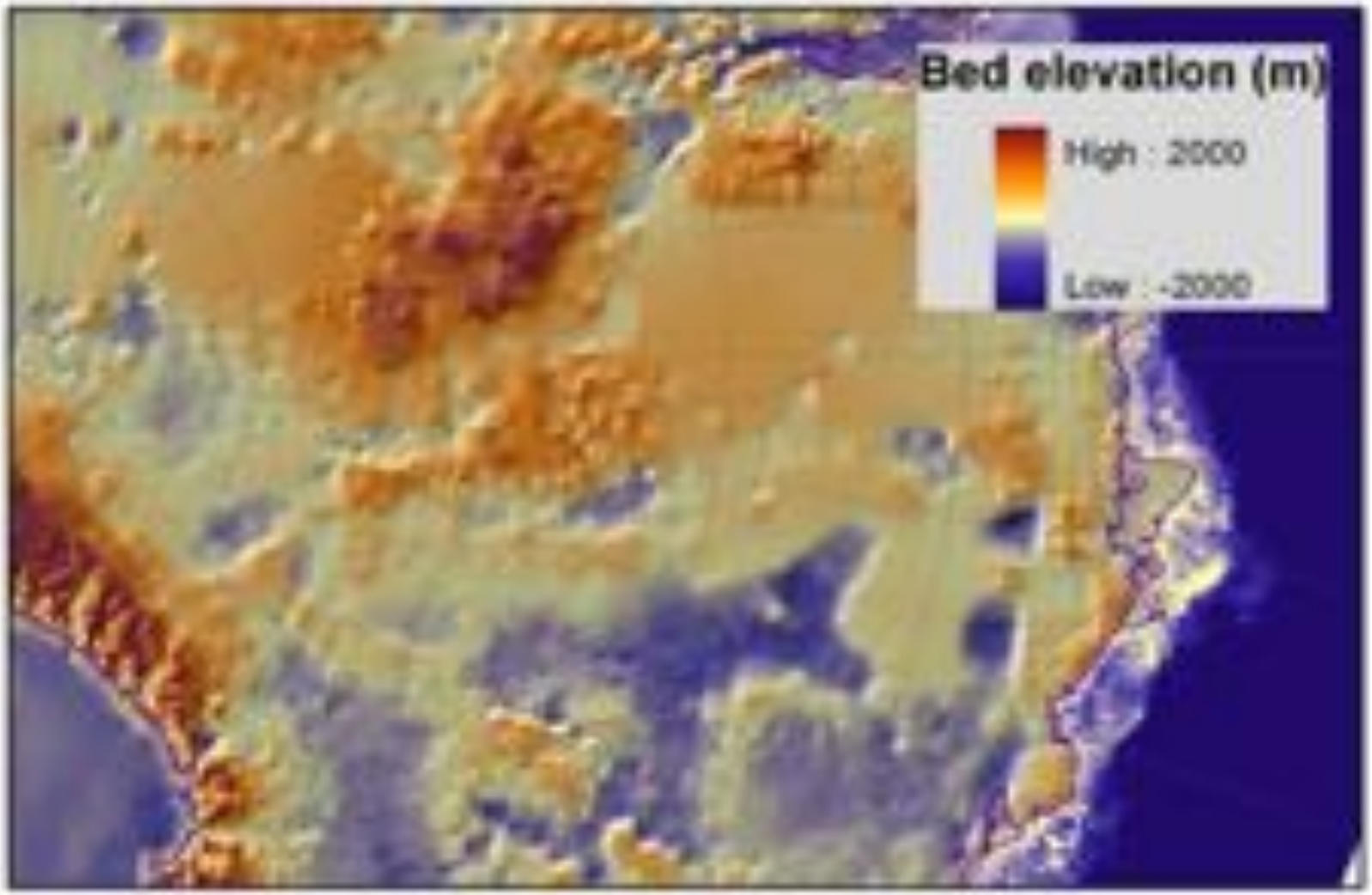


Figure 3. A map of the bedrock under the East Antarctic ice sheet (taken from the BEDMAP compilation (Lythe and Vaughan, 2001)). Apparently smooth regions are mainly areas with no data!

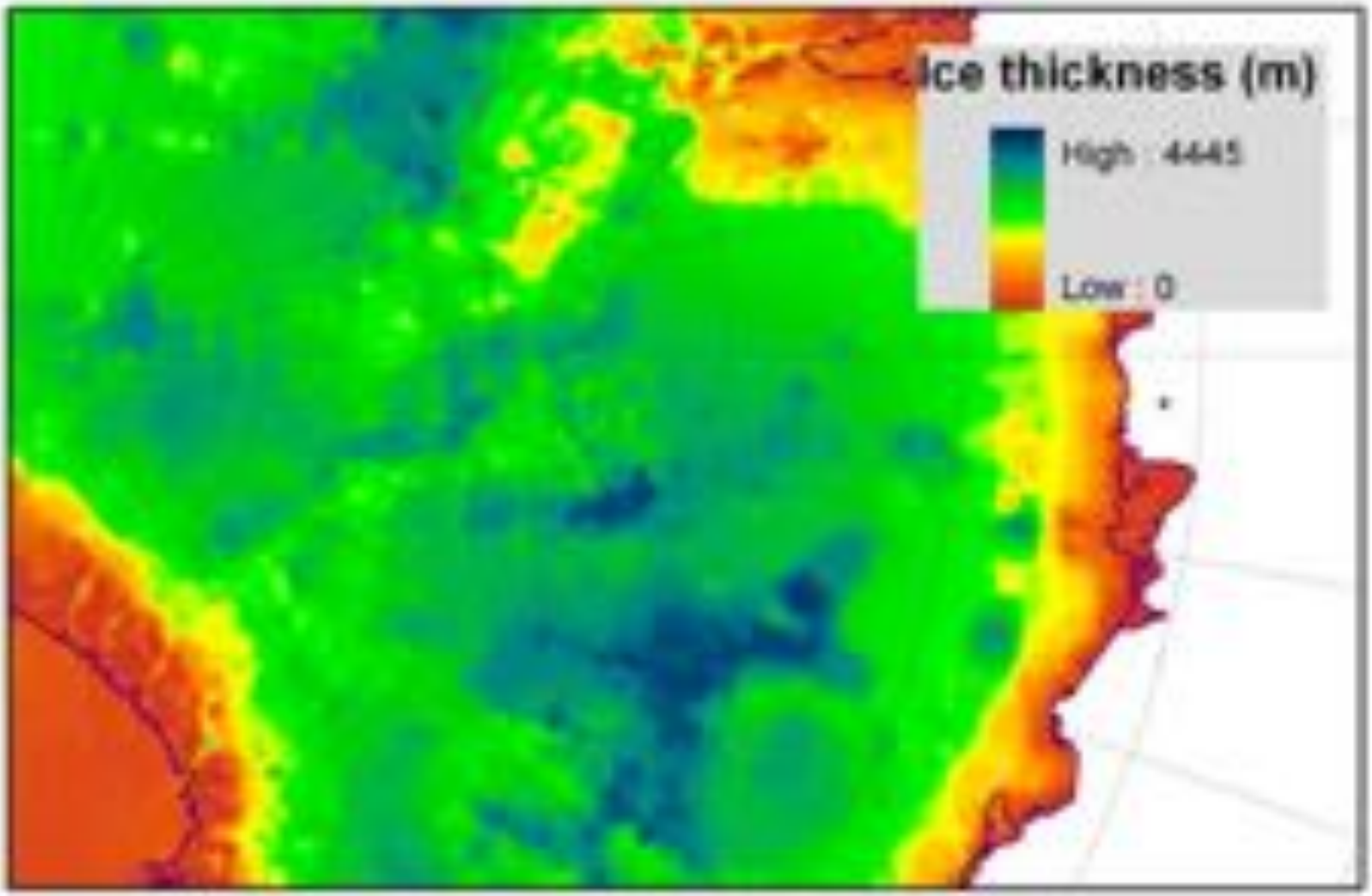
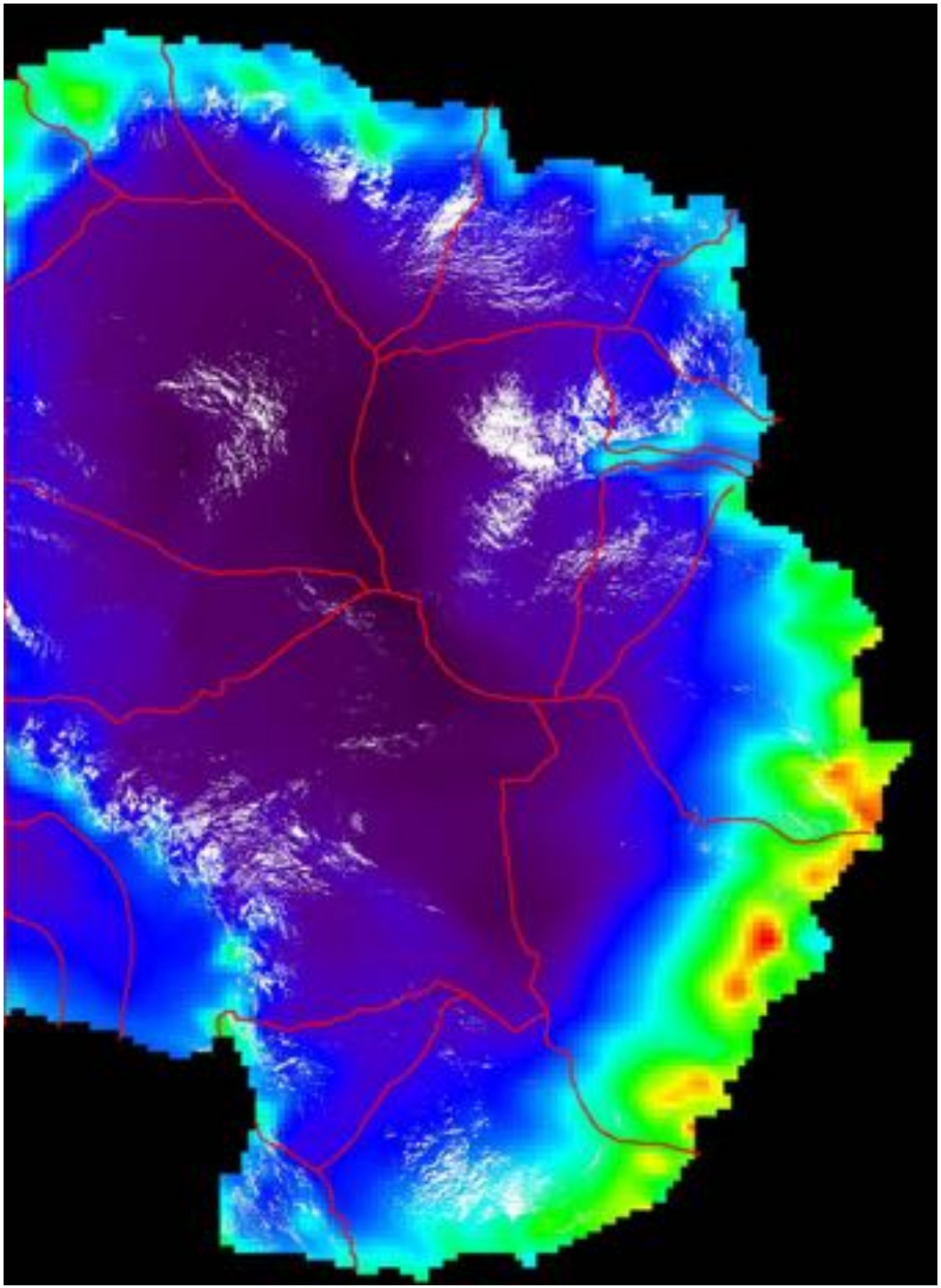


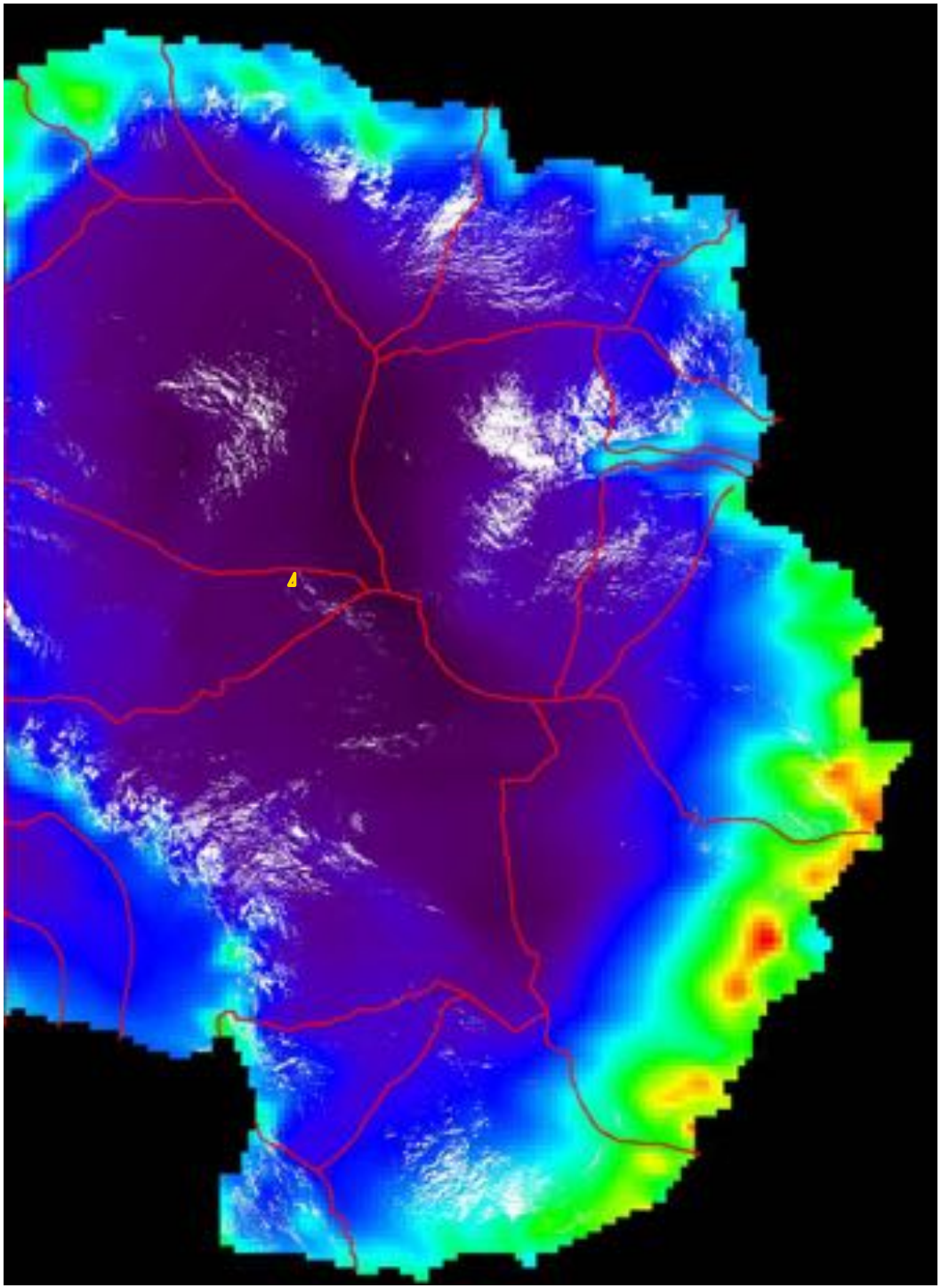
Figure 4. A map of the ice thickness over the East Antarctic plateau (taken from the BEDMAP compilation (Lythe and Vaughan, 2001)).

Glazed regions with very low snow accumulation
(white areas)

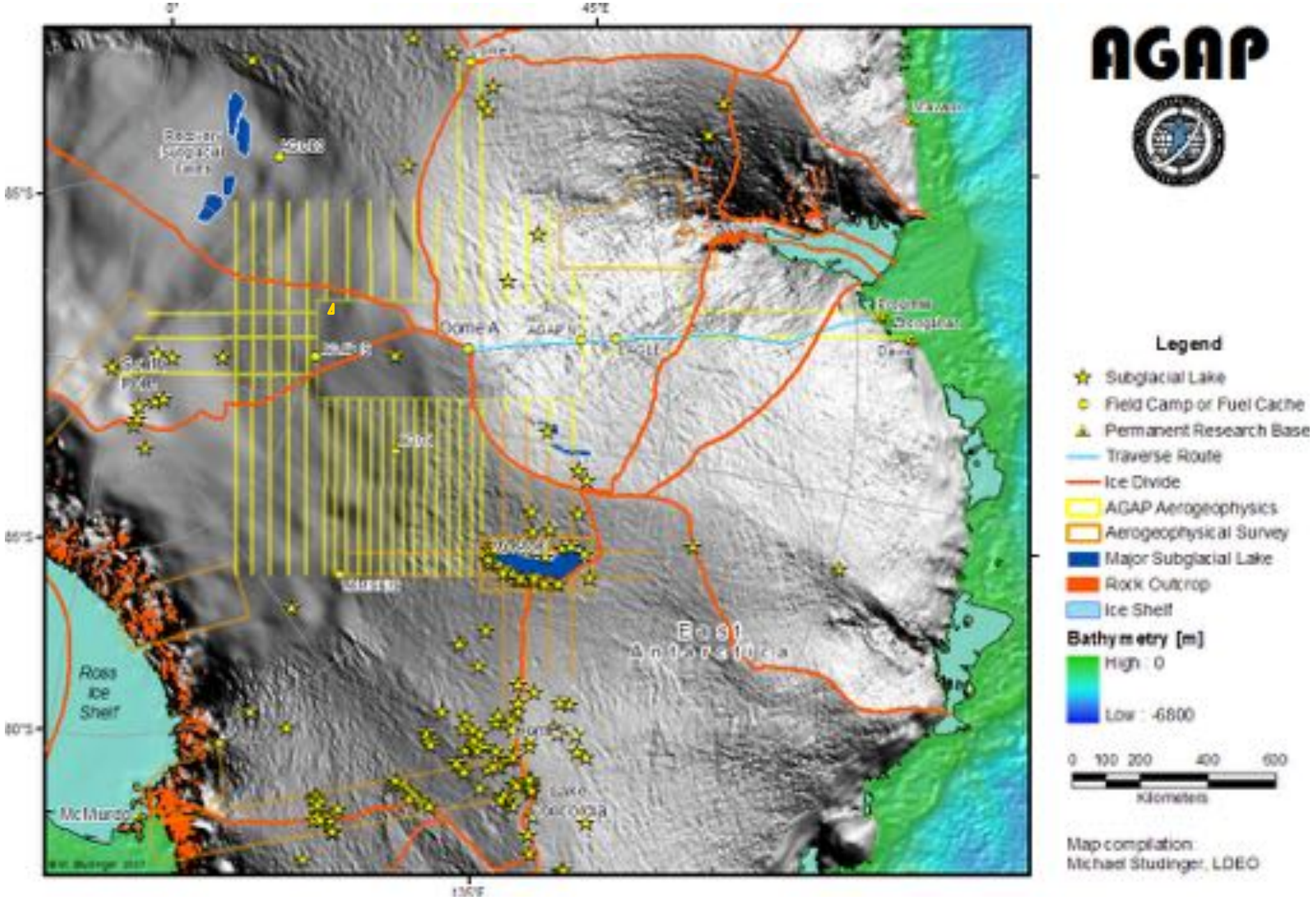


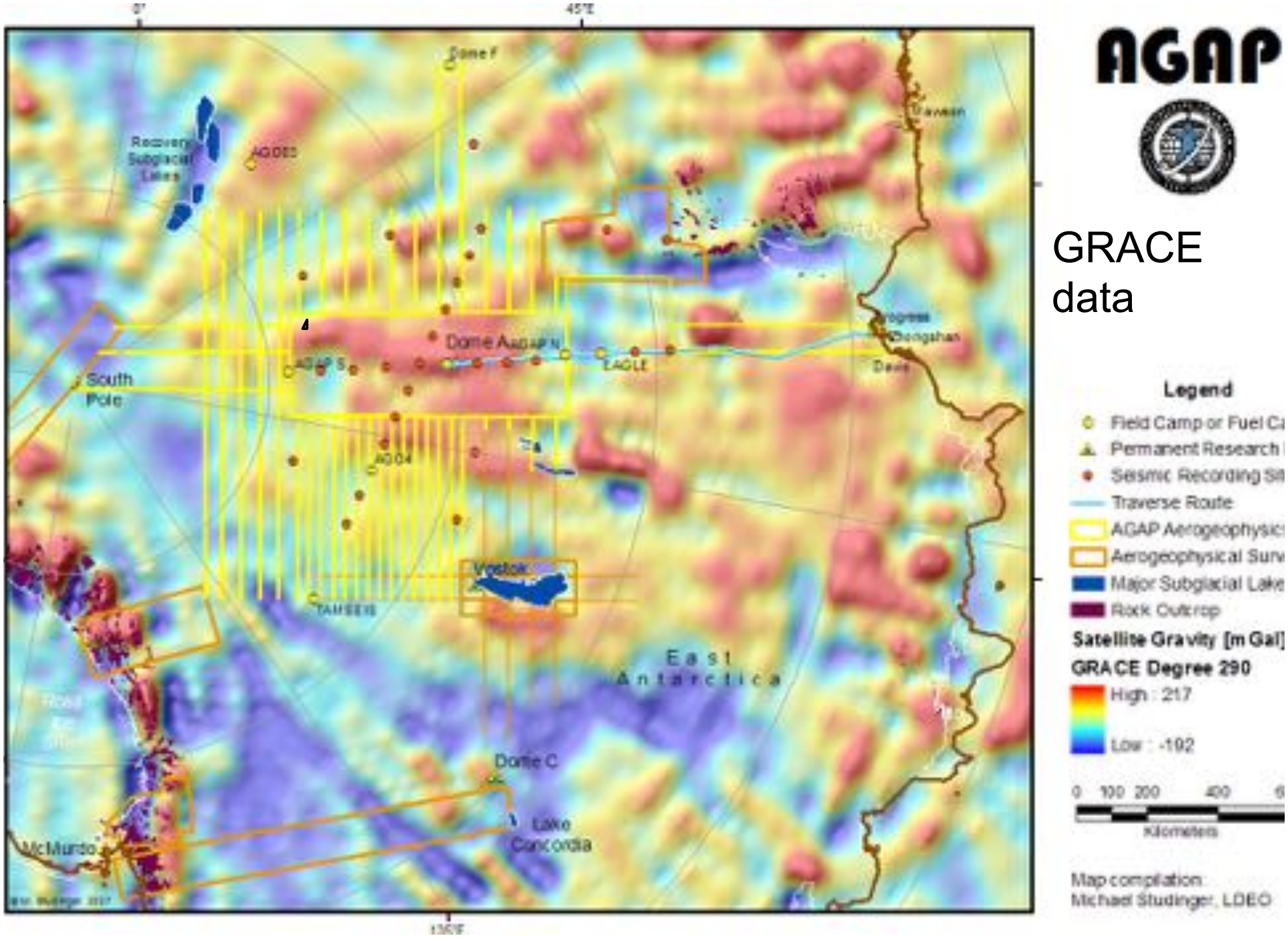
Courtesy of Ted Scambos, NSIDC

Glazed regions with very low snow accumulation
(white areas)



Courtesy of Ted Scambos, NSIDC


AGAP
Legend
Subglacial Lake
Field Camp or Fuel Cache
Permanent Research Base
Traverse Route
Ice Divide
AGAP Aerogeophysics
Aerogeophysical Survey
Major Subglacial Lake
Rock Outcrop
Ice Shelf
Bathymetry [m]
High : 0
Low : -6800
0 100 200 400 600
kilometers
Map compilation
Michael Studinger, LDEO
Dome A
Ross Ice Shelf
McMurdo
East Antarctica
45°E
135°E


AGAP
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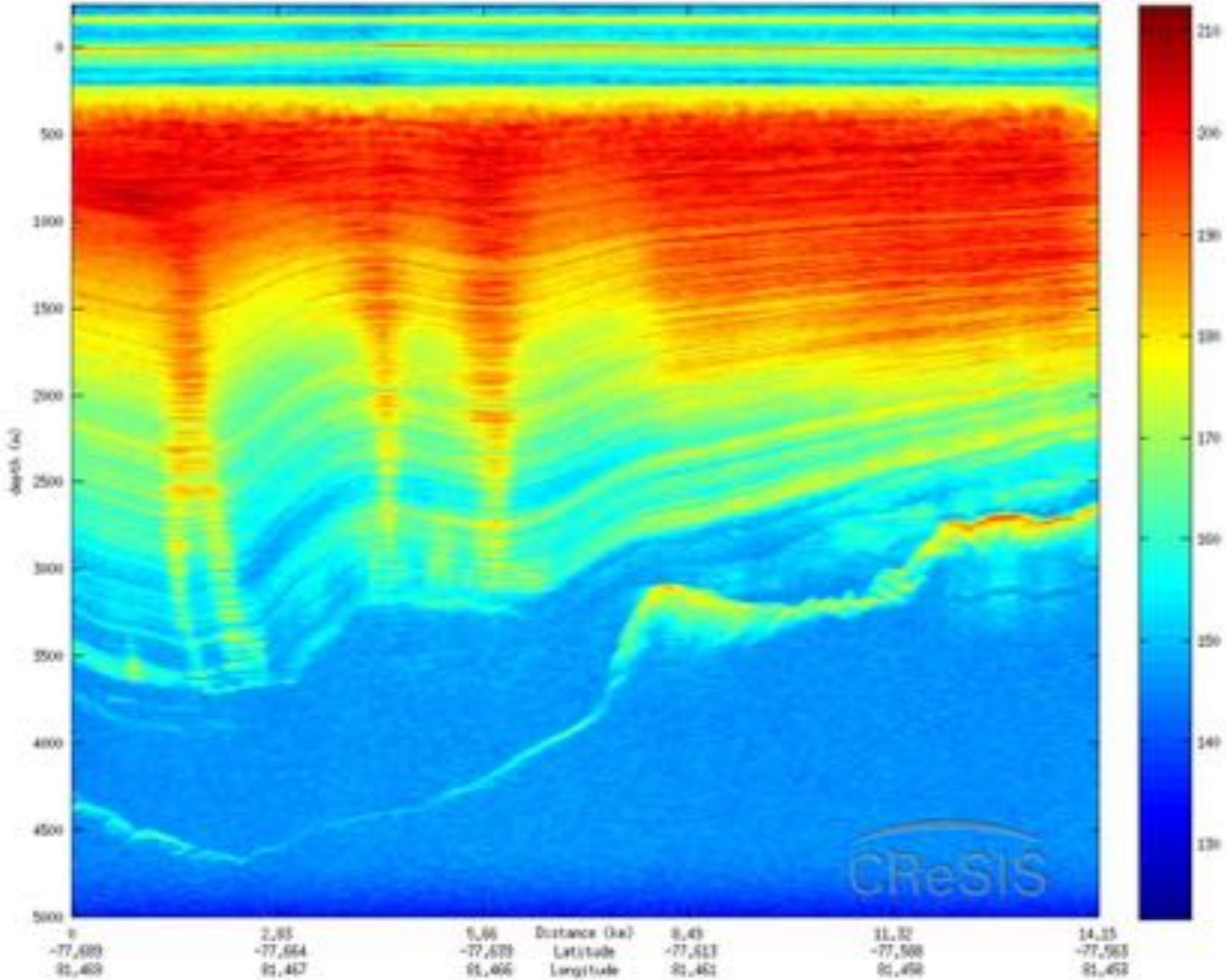
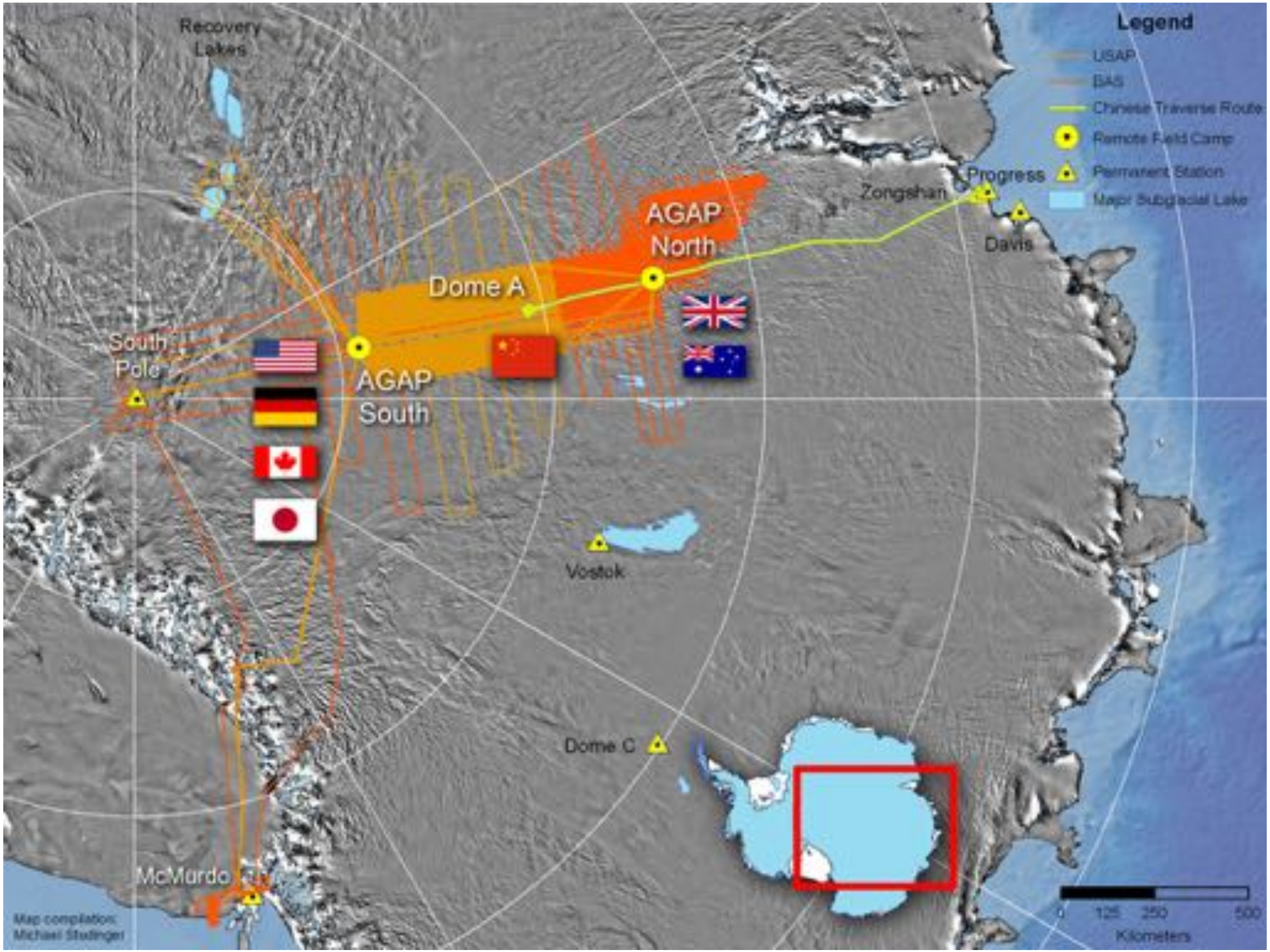
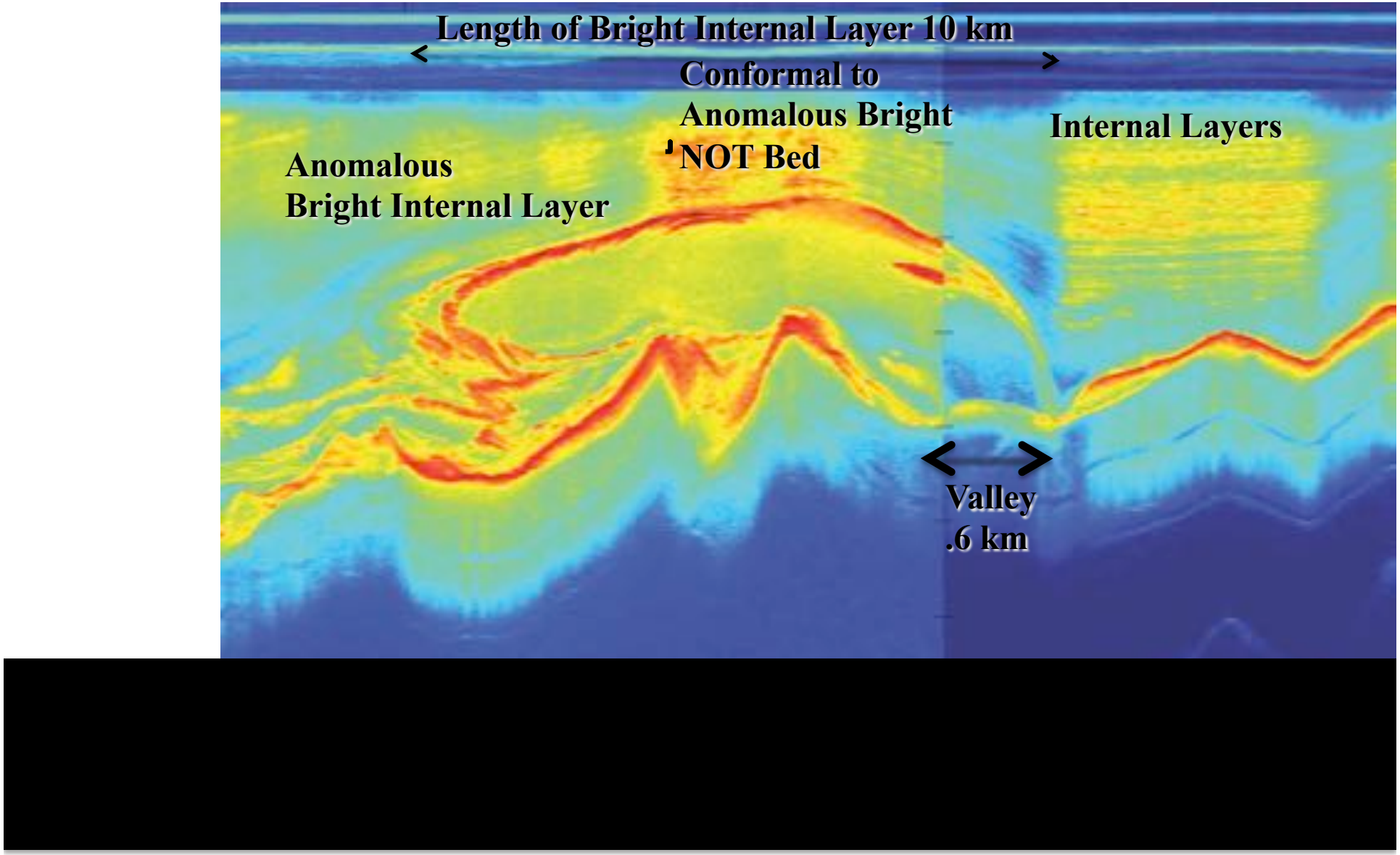
Major Subglacial Lake
Rock Outcrop
Satellite Gravity [m Gal]
GRACE Degree 290
High : 217
Low : -192
0 100 200 400
Kilometers
Map compilation
Michael Studinger, LDEO
Dome F
Recovery Subglacial Lakes
AGO63
Dome A
AGAP S
EAGLE
South Pole
AGO4
TAMSEIS
Vostok
East Antarctica
Dome C
Lake Concordia
McMurdo

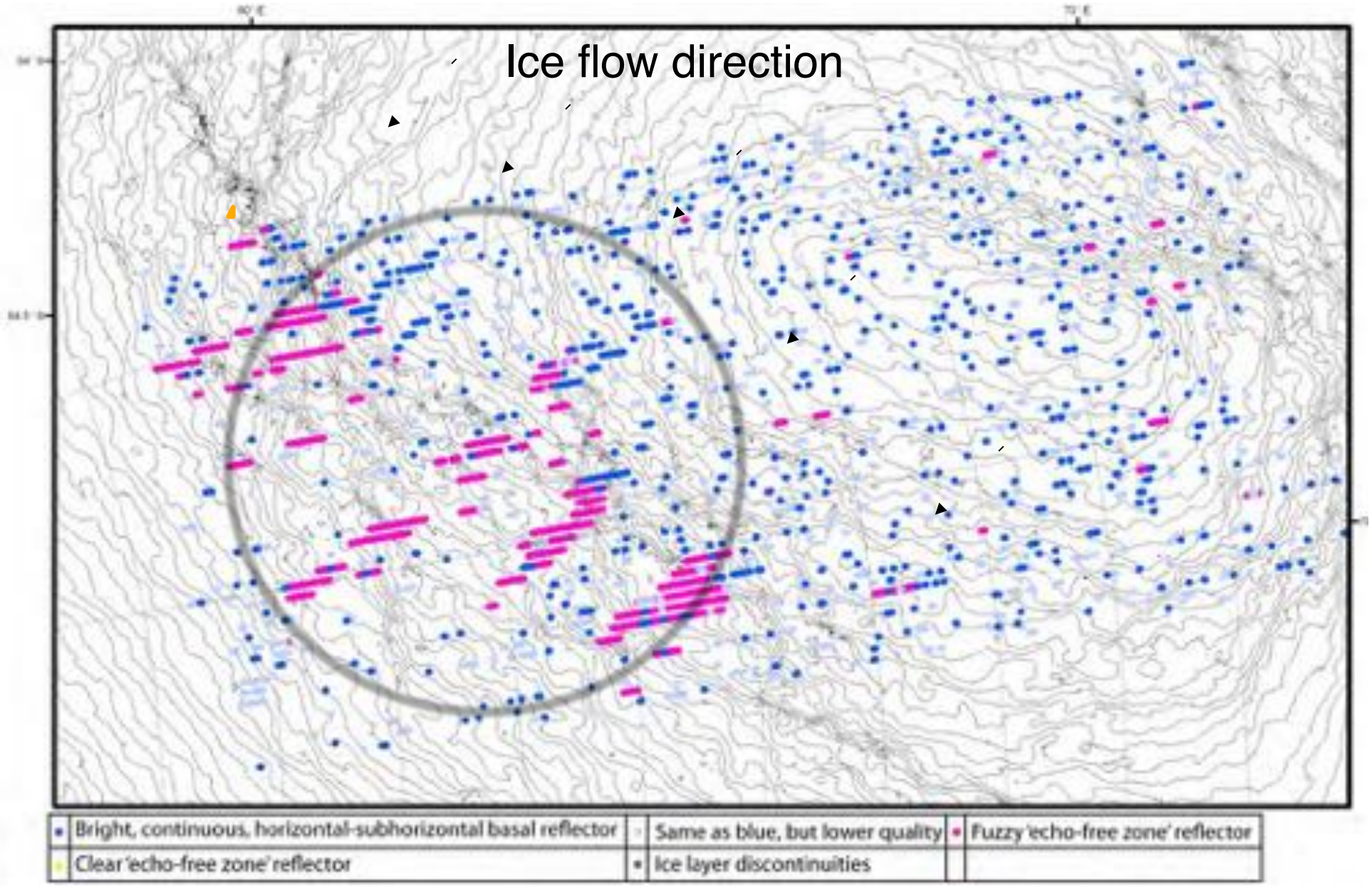


A radioechogram from the Gamburtsev Mountains in East Antarctica, showing internal layering within the 4680 m ice thickness at this site. The Center for Remote Sensing of Ice Sheets (CReSIS) processed and analyzed these radar data, which were obtained by the AGAP collaboration (http://www.ldeo.columbia.edu/~mstuding/AGAP/).


Recovery Lakes
Legend
USAP
BAS
Chinese Traverse Route
Remote Field Camp
Permanent Station
Major Subglacial Lake
Progress
Zongshan
Davis
AGAP North
Dome A
South Pole
AGAP South
Vostok
Dome C
McMurdo
Map compilation: Michael Studinger
0 125 250 500
Kilometers



Radar Profile 15 km Down Hydrologic Potential from Melt Zone


Ice flow direction
Bright, continuous, horizontal-subhorizontal basal reflector
Same as blue, but lower quality
Fuzzy 'echo-free zone' reflector
Clear 'echo-free zone' reflector
Ice layer discontinuities