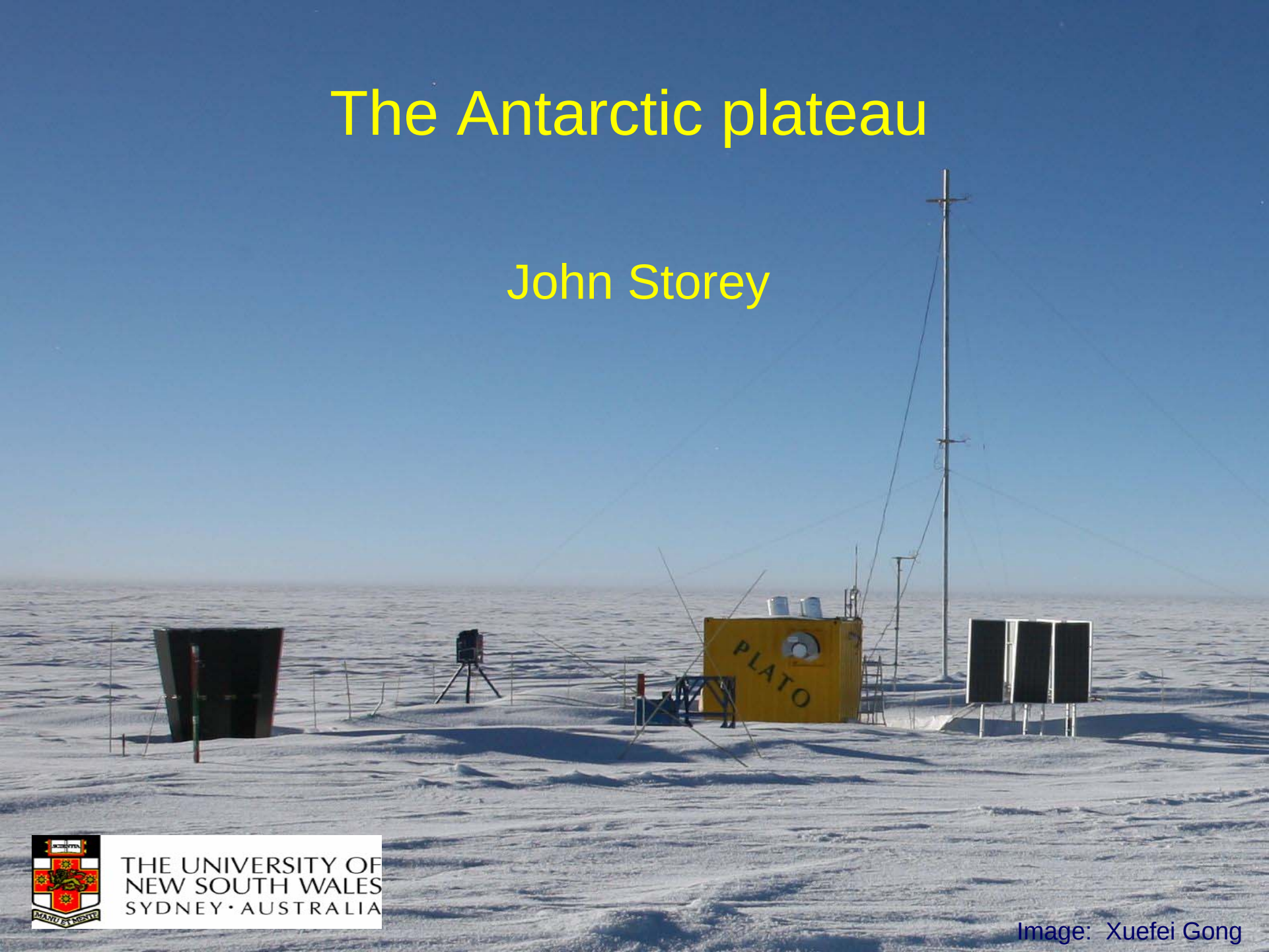
The Antarctic plateau

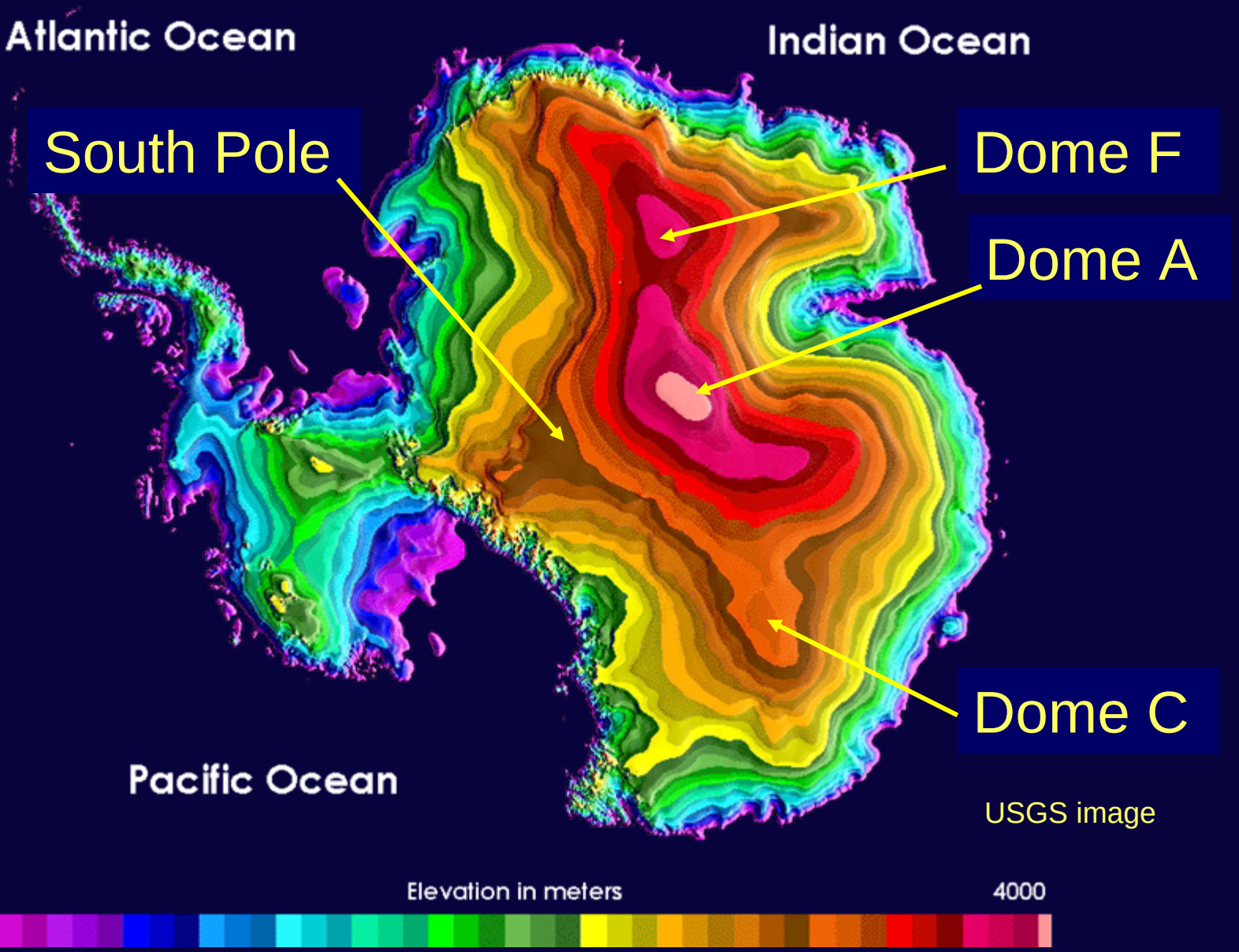
John Storey



THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY · AUSTRALIA

Image: Xuefei Gong

Contour map of Antarctica



Launch costs to Low-Earth Orbit

- Rocket $15,000/kg
- Shuttle $60,000/kg

- Antarctica < $10/kg

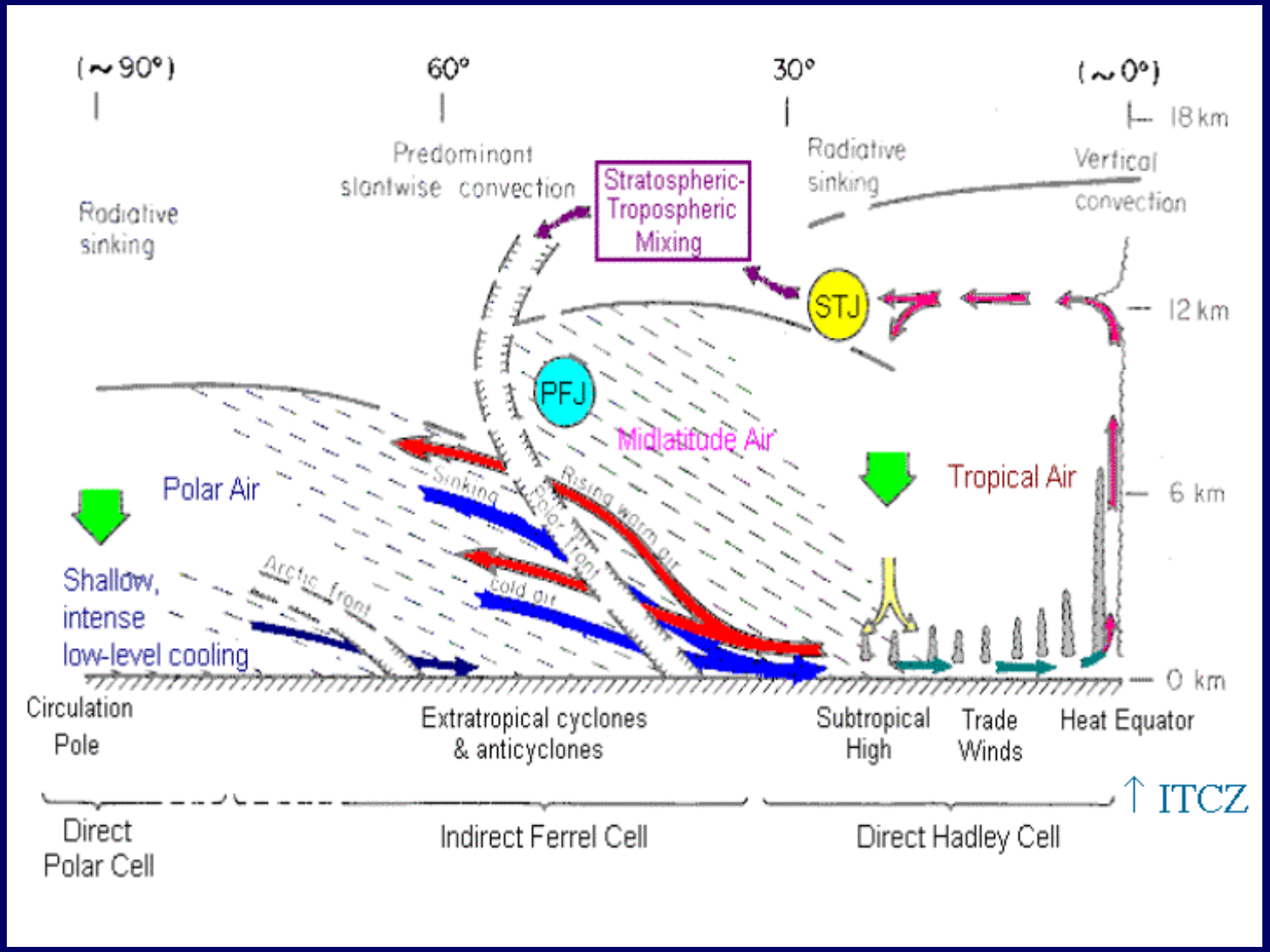
Why Antarctica? (for optical astronomers)

- Infrared sky 20 – 50 times darker
- Image quality twice as good as at temperate sites (from 30m).
- Photometric precision twice as good
- Long periods of uninterrupted darkness
- “Big science” with small telescope

Unique opportunity for wide-field, high precision astronomy

Image: Camillo Calvaresi

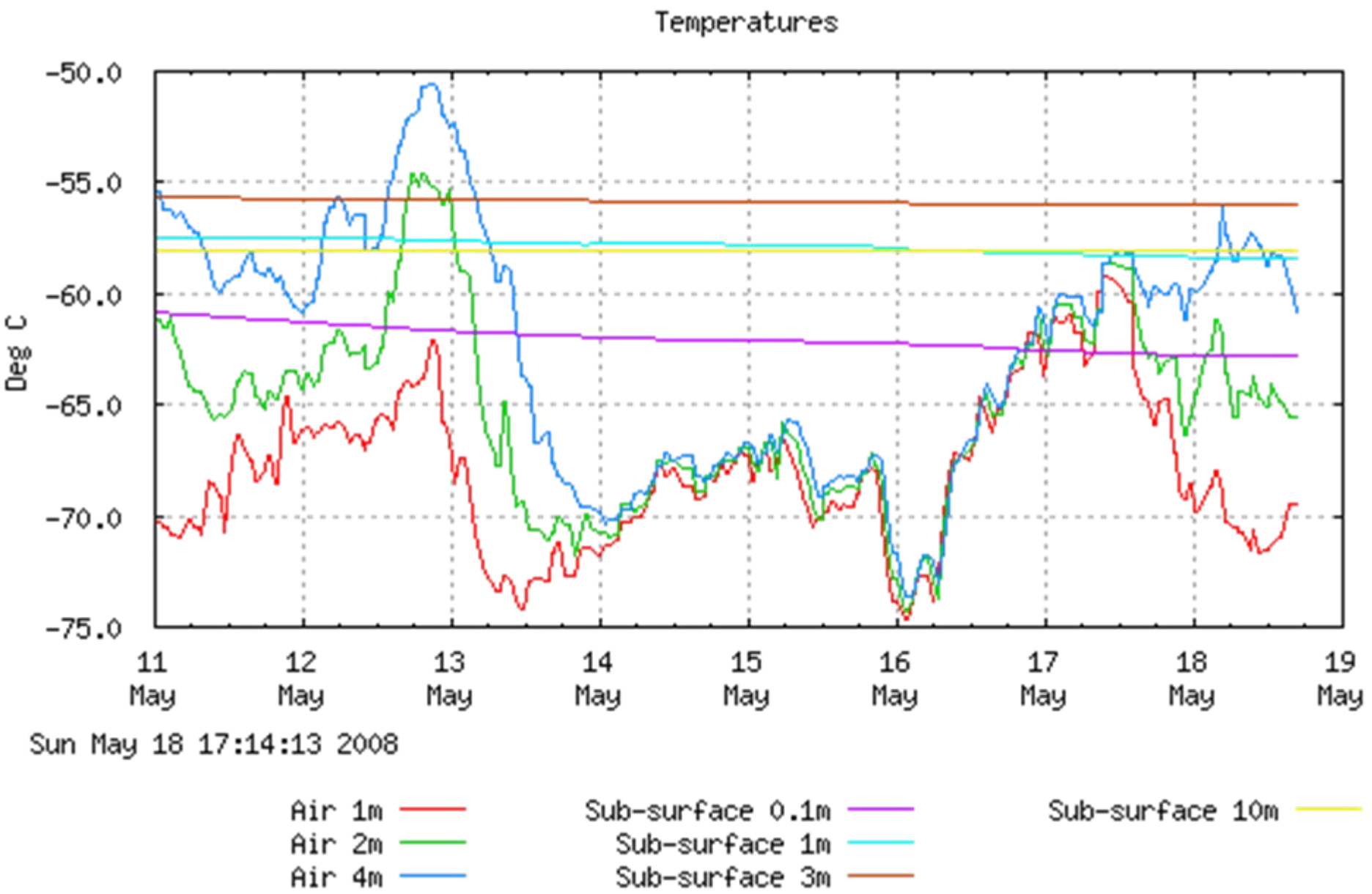
Not just cold, but clear and calm.



Why Antarctica is *different*

- The temperature inversion is huge (often 5ºC/metre)
- The Stable Boundary Layer is thin (~ 25 metres)
- As a result, the Stable Boundary Layer is *stable*

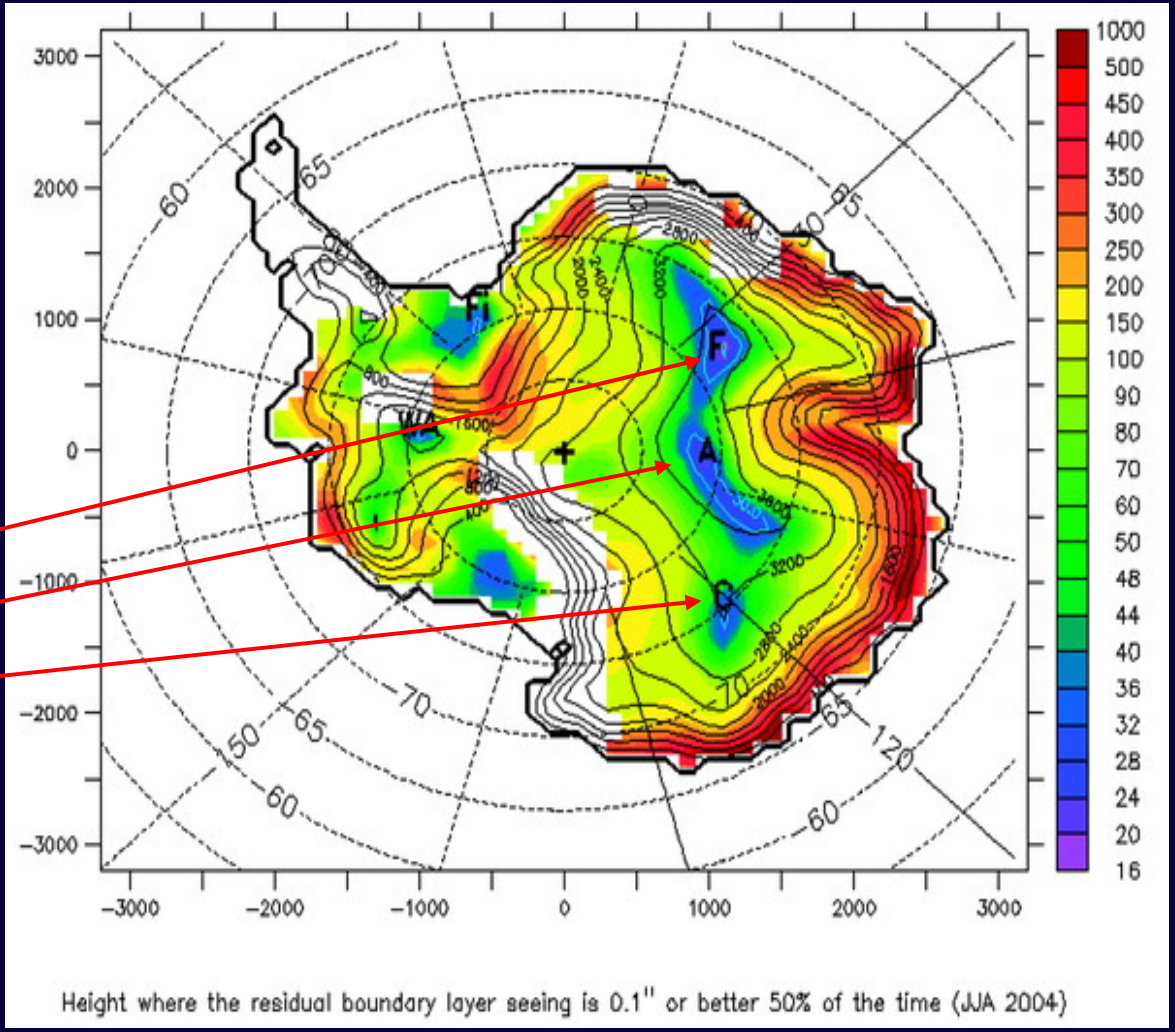
Image: Guillaume Dargaud



Data: AAD/CHINARE AWS

Boundary layer height

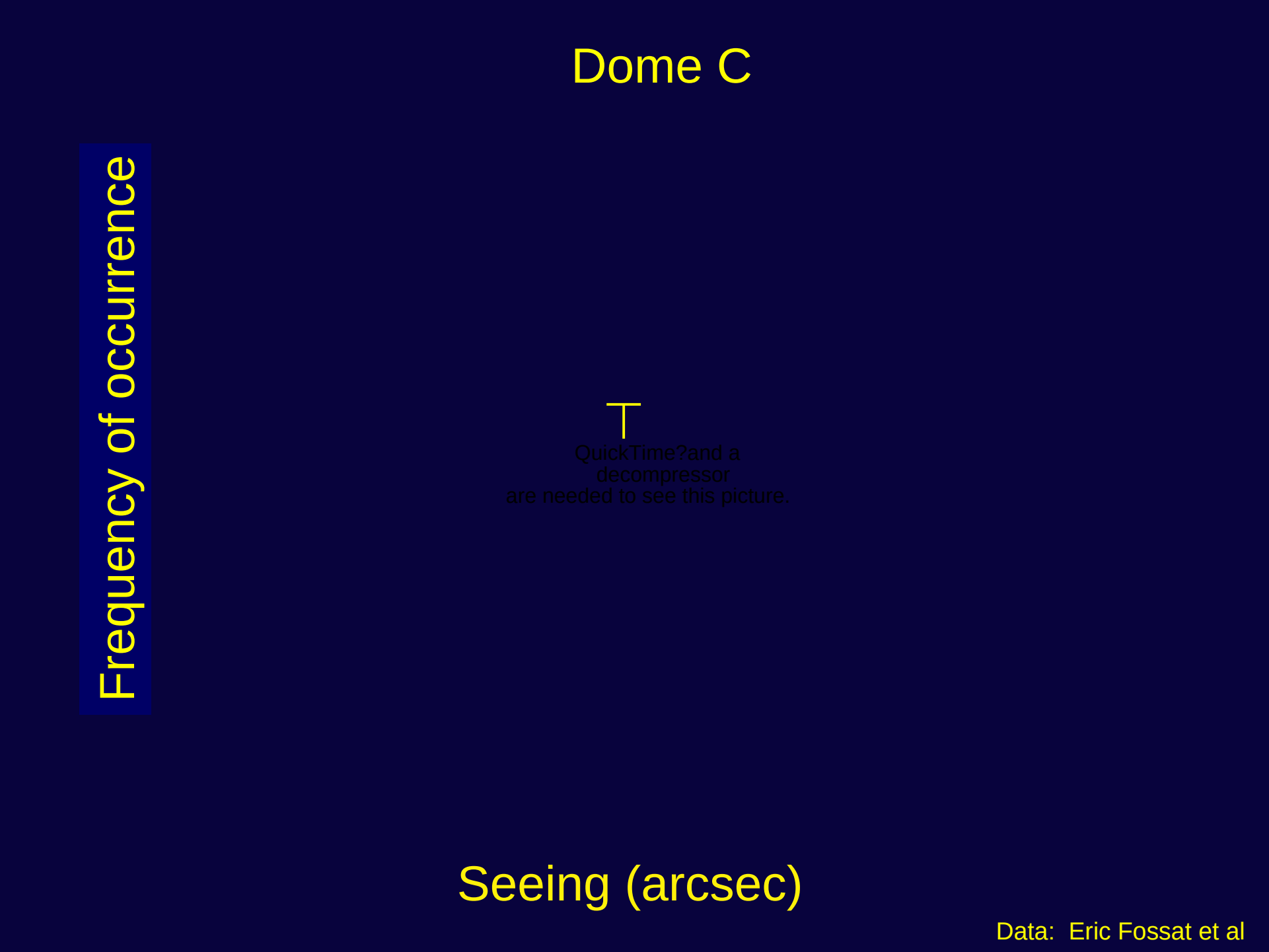
~18 m
~21 m
~27 m



Swain and Gallee, 2006

Dome C

Frequency of occurrence



Seeing (arcsec)

Data: Eric Fossat et al

Why Antarctica? (for sub-mm astronomers)

- Water vapour is extremely low
- Sky emission is extremely stable
- There's plenty of room

Unique opportunity for big dishes, big interferometers

Image: Camillo Calvaresi

QuickTime?and a
decompressor
are needed to see this picture.

PWV = 100 microns

Yang *et al* PASP (2009)

Australian postage stamp issued September 2008

Airlink

- Established 2007 with Australian government funding of $46m
- Hobart – Casey in 4.2 hours in Antarctic Division A319 Airbus
- Intra-continental flights in ski-equipped CASA 212 aircraft

Image: Australian Antarctic Division

Wilkins runway, ~70 kms SE of Casey Station

Image: Australian Antarctic Division

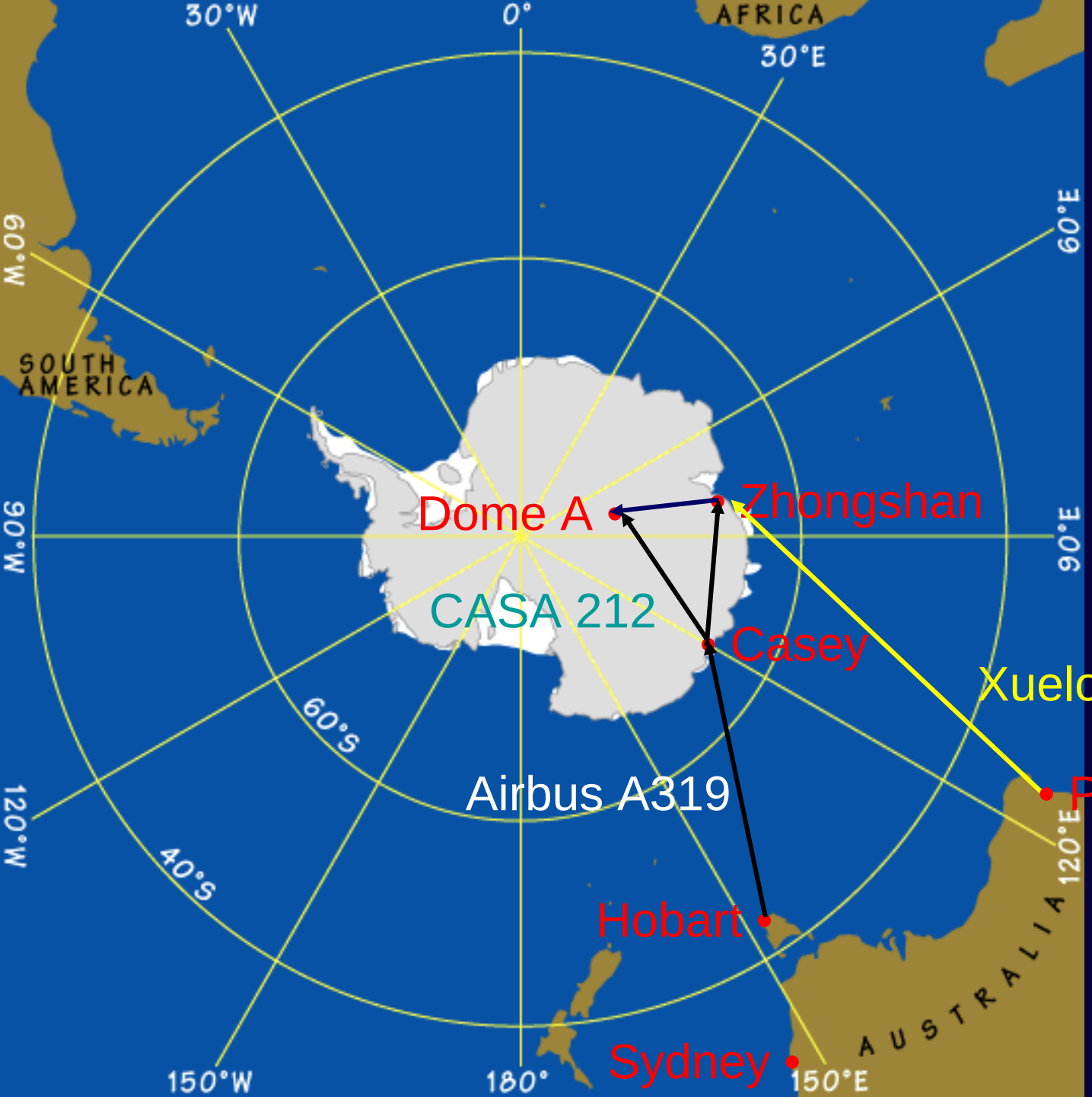

Image: Australian Antarctic Division

Australia also has two ski-equipped CASA 212 aircraft

Image: Skytraders

Logistic support of Dome C from Hobart

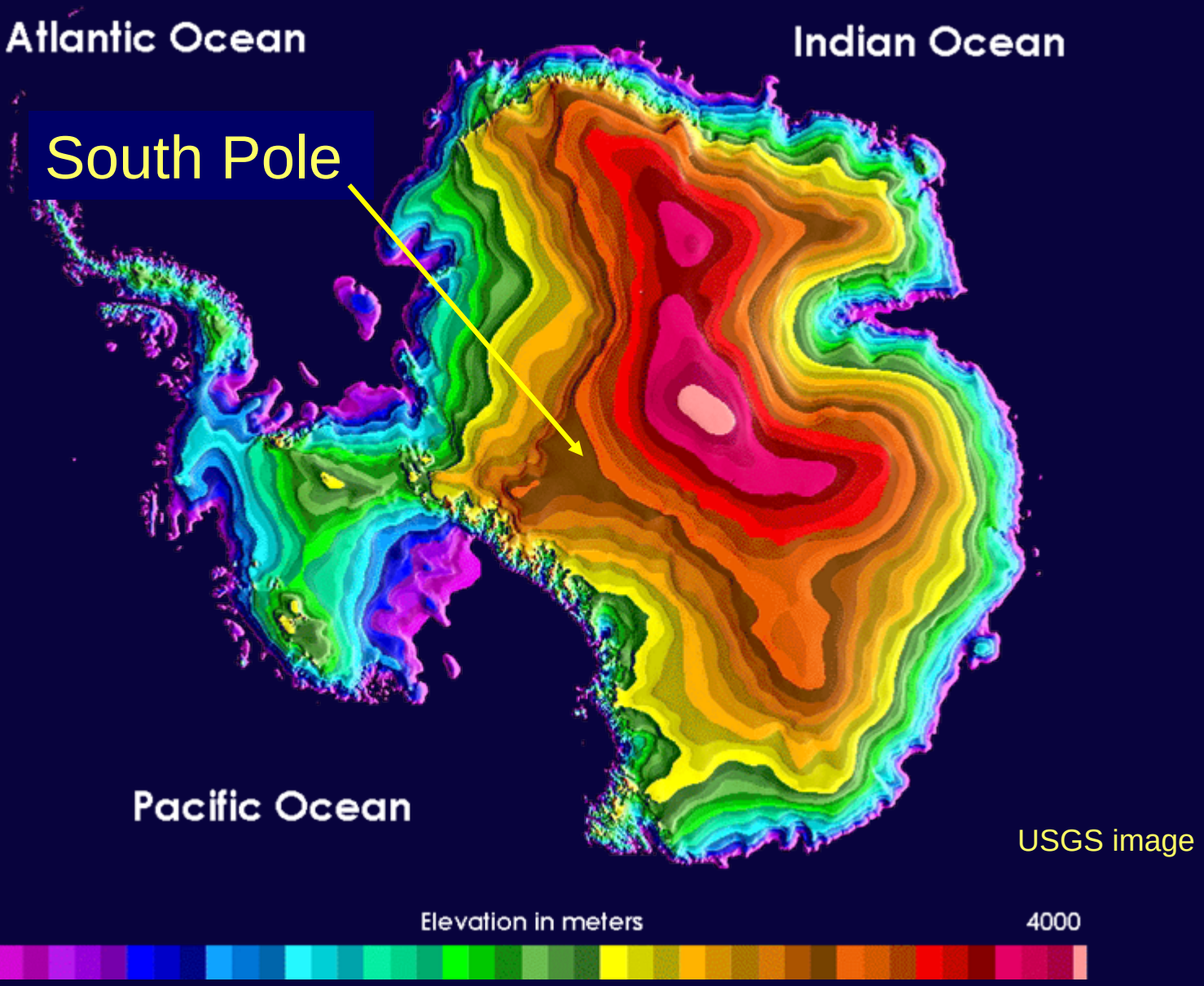
Image: Australian Antarctic Division



Logistic support of Dome A from Perth

Image: Australian Antarctic Division

Contour map of Antarctica



South Pole

Station owner	USA
Completion date	1957
In AAT	Sort of
Geostationary satellites visible	No
Advantages	Constant ZD sources
Disadvantages	Cloud cover Thick boundary layer Low elevation

Image: Seth White

South Pole Telescope will answer fundamental questions about the structure of the Universe.

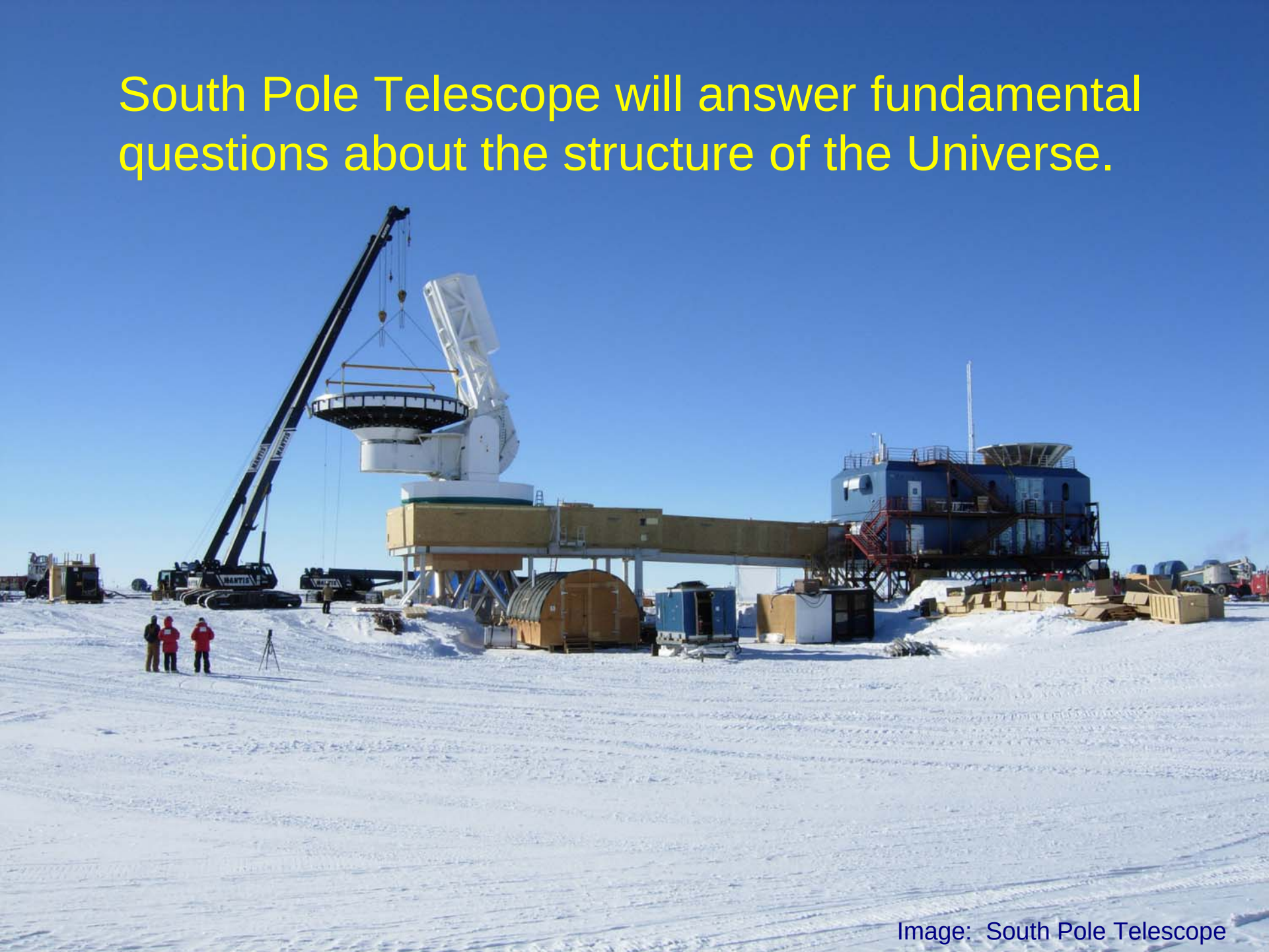


Image: South Pole Telescope


These folk are astronomers, too.
Image: http://icecube.wisc.edu

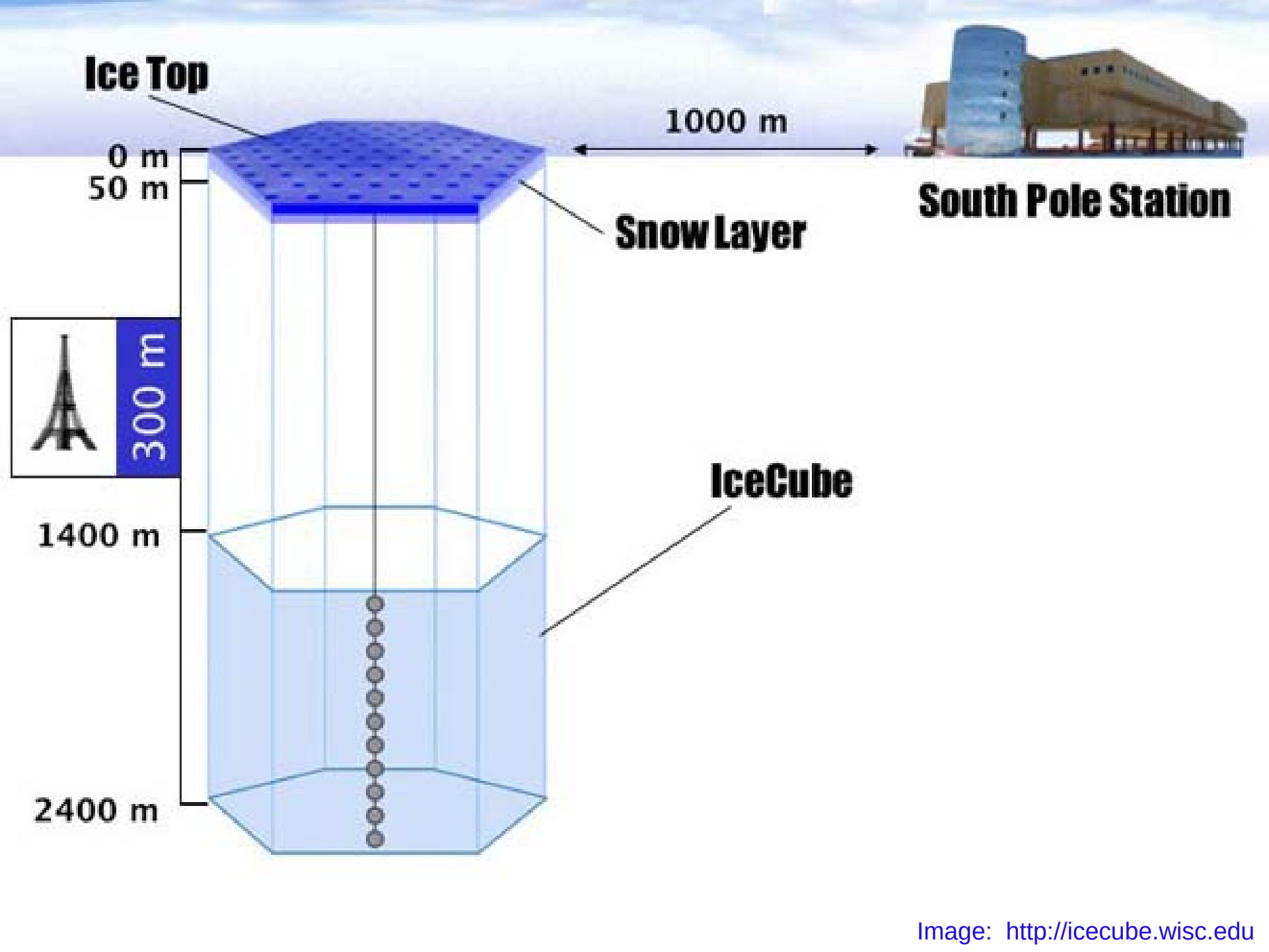
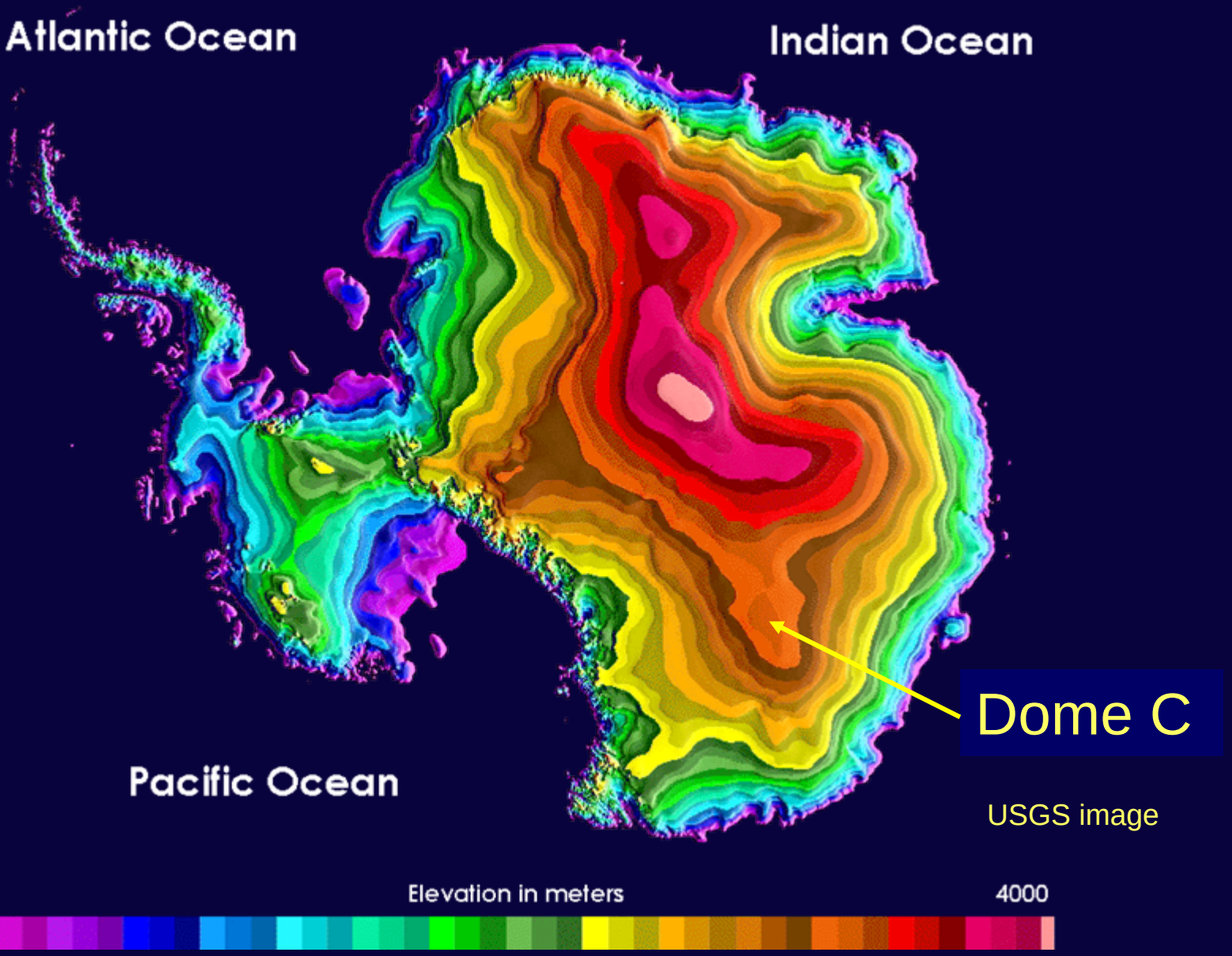


Image: http://icecube.wisc.edu

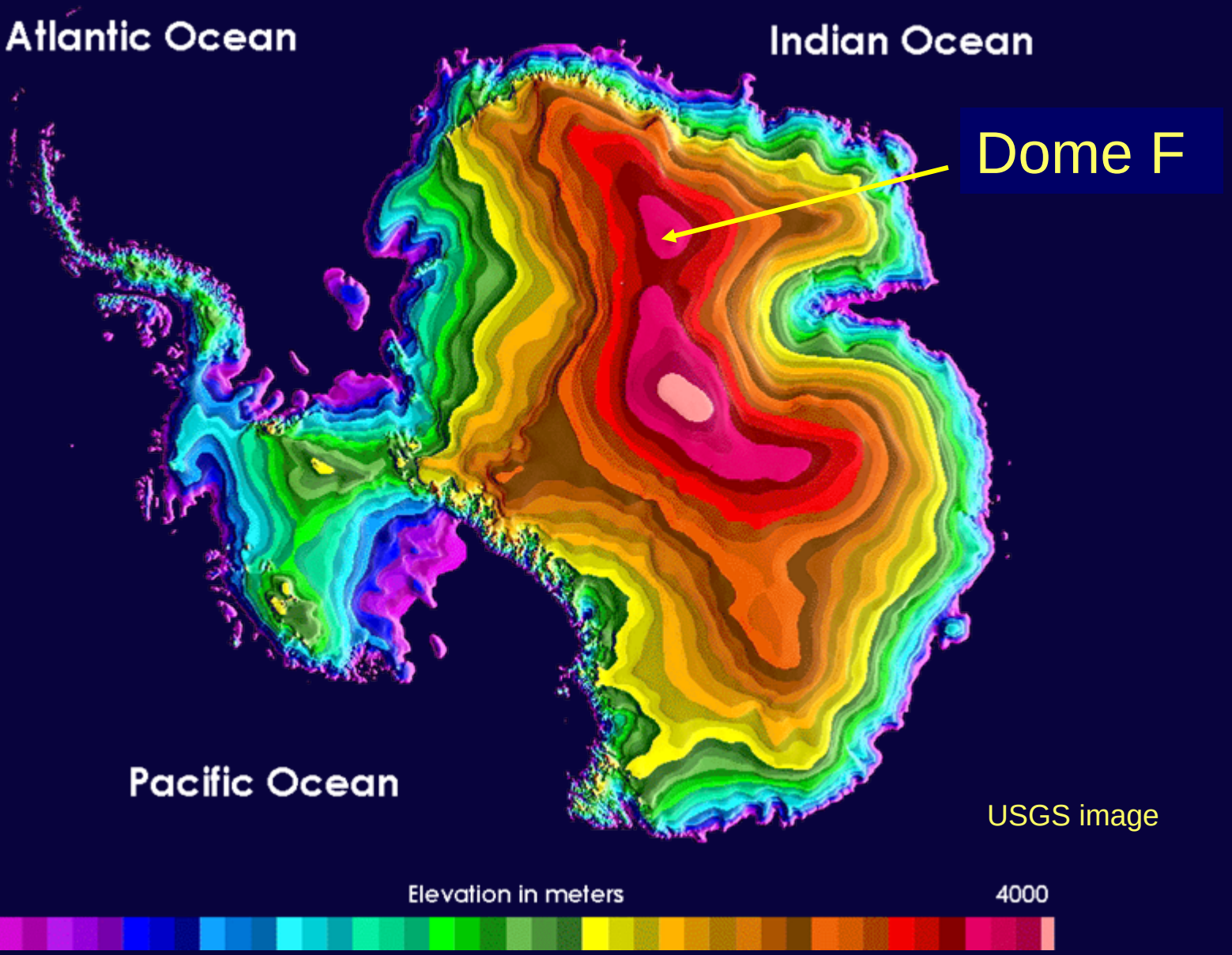
Contour map of Antarctica



Dome C

Station owner	France/Italy
Completion date	2005
In AAT	Yes
Geostationary satellites visible	Yes
Advantages	Minimal cloud cover Thin boundary layer
Disadvantages	Rapid temperature variations

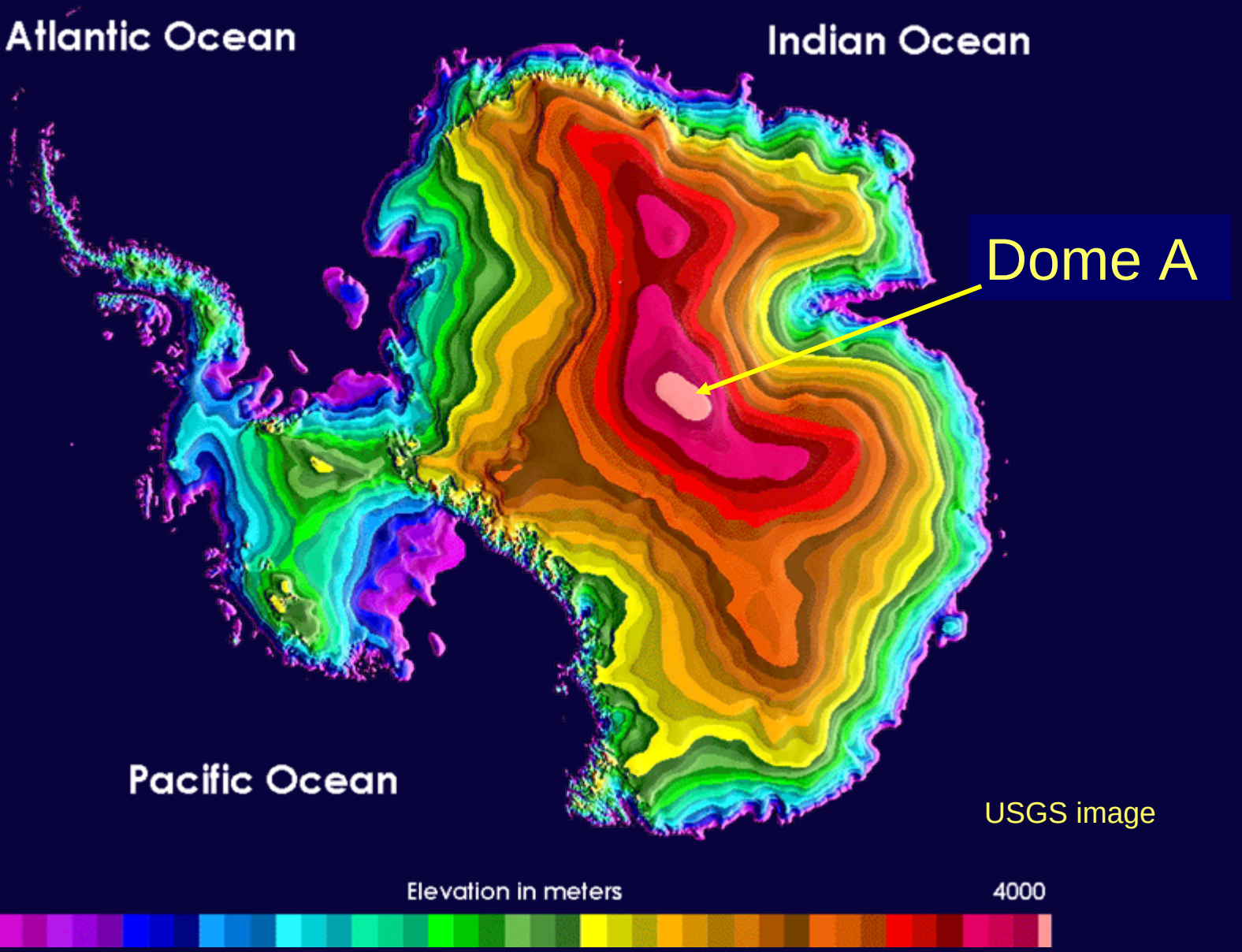
Contour map of Antarctica



Dome F

Station owner	Japan
Completion date	2014
In AAT	No
Geostationary satellites visible	Just
Advantages	High
Disadvantages	Aurora

Contour map of Antarctica



Dome A

Station owner	China
Completion date	2015?
In AAT	Yes
Geostationary satellites visible	Almost
Advantages	Very good THz transmission Thin boundary layer
Disadvantages	?

McMurdo

Station owner	USA
Completion date	1957
In AAT	No
Geostationary satellites visible	Easily
Advantages	Long-duration balloons
Disadvantages	Useless for everything else

PILOT
PATHFINDER FOR AN INTERNATIONAL LARGE OPTICAL TELESCOPE

- 2.5 metre optical/infrared telescope
- Dual role: pathfinder and unique science
- International project
- Sited at Concordia Station, Dome C, Antarctica

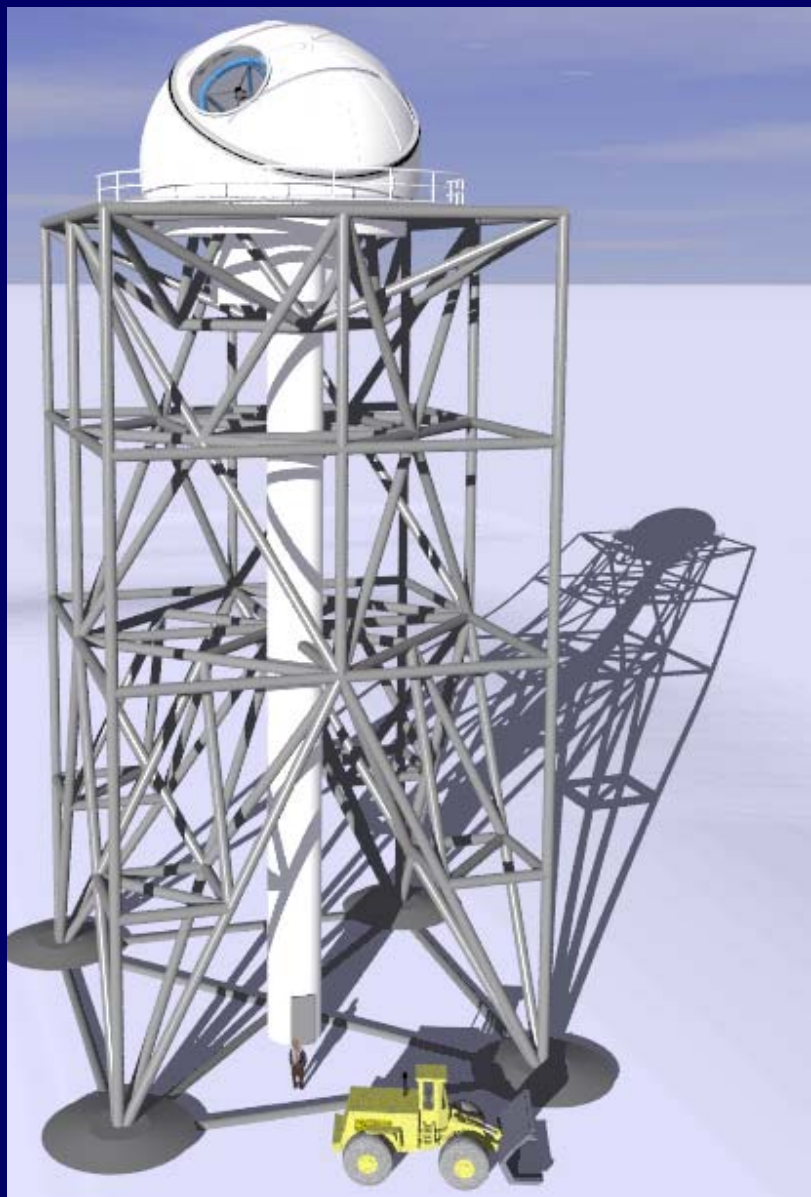


Image: Andrew McGrath

The PILOT Phase A study

- NCRIS funding of $1m awarded to UNSW for 2007
- Additional $250k from UNSW
- Technical study subcontracted to Anglo-Australian Observatory
- Additional resources contributed by AAO
- Additional resources contributed by ARENA partners
- Phase A study completed 31 July 2008.

Image: Guillaume Dargaud

PILOT science

PILOT has unique capabilities in:

- Wide-field, high resolution imaging
  - 5 ~ 20 times the survey speed of VISTA
  - 10 times survey speed (to given depth) of the 8 m VLT *FIRES*
- Terahertz astronomy
- Time-series astronomy
- Asteroseismology

Four identified “big science” drivers:

– H_2 in our Galaxy
– The first light in the Universe
– The earliest stellar populations
– The Equation of State of the Universe

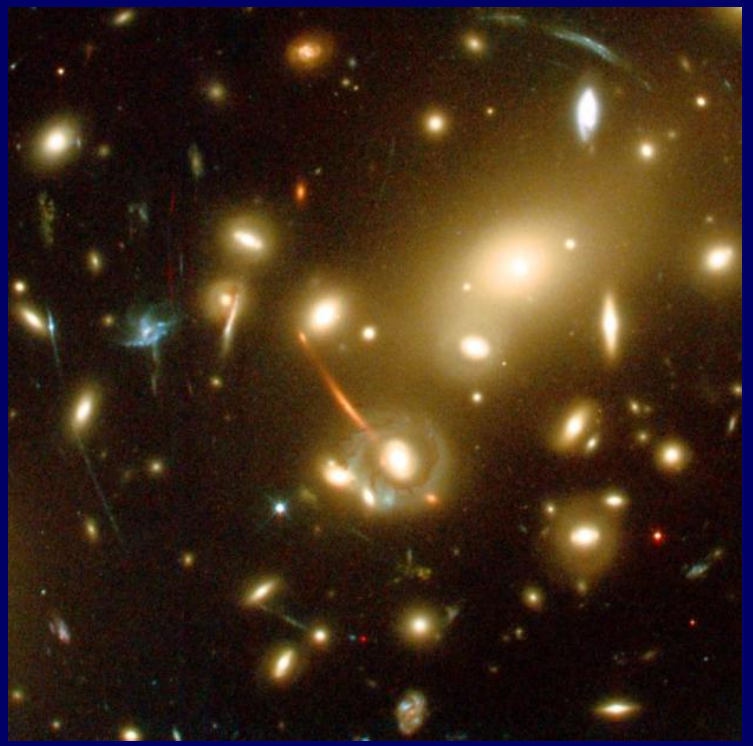
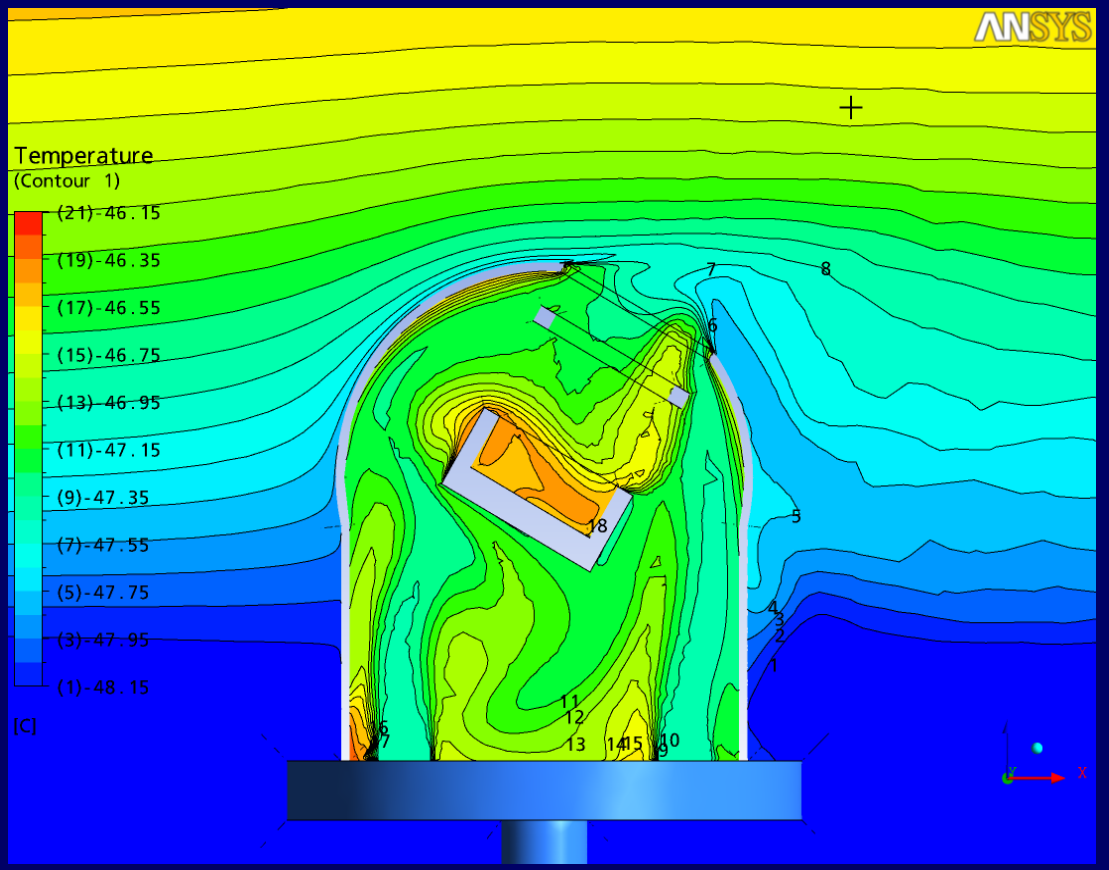


Image: HST

Pilot engineering

Phase A contracts were let to:

- Atacama Engineering
- Bassets
- Connell Wagner
- EDAG Australia
- EOST
- Fast Automation
- LEAP
- PPC
- SKM
- SAGEM



CFD simulation of PILOT airflow by LEAP Pty Ltd

8.6 Results for ZD 30° downwind with 1°C offset in temperature of supply air

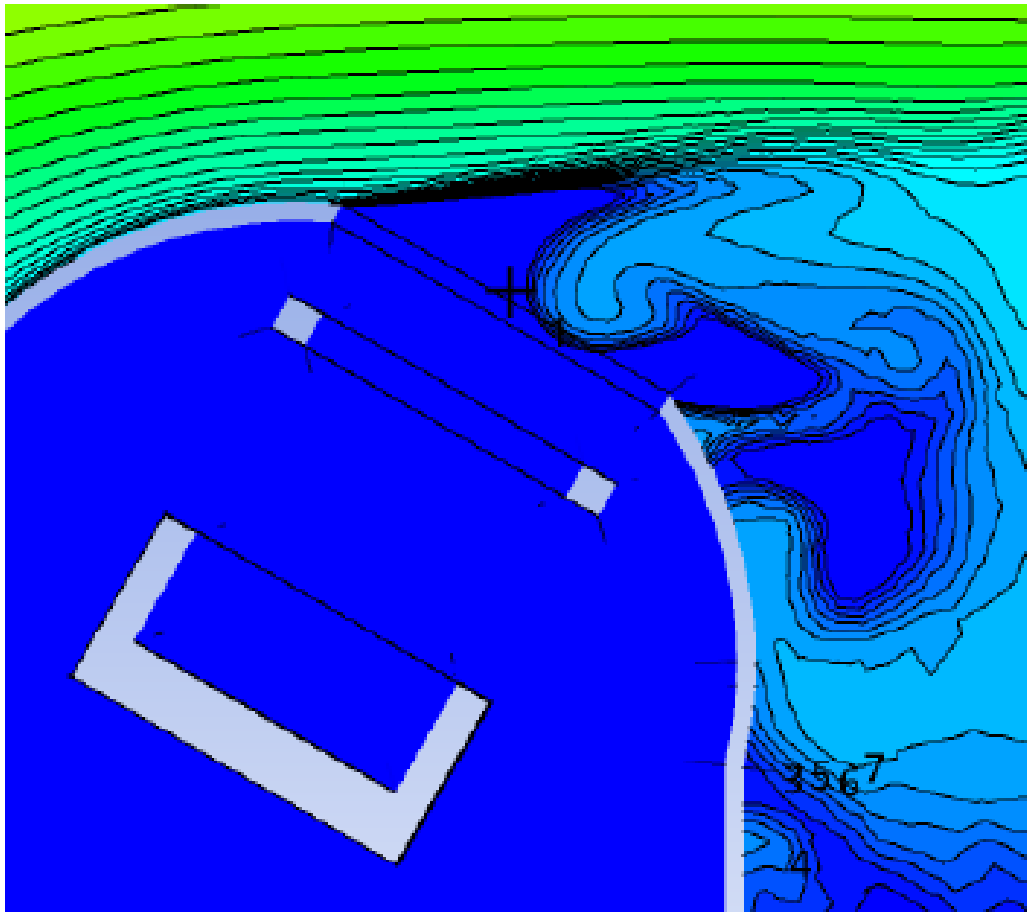


Figure 8.10. Snapshot, 8.6 seconds after beginning of transient calculations, of temperature distribution (with contour interval 0.05°). The air flow from the floor of the enclosure was set to 1° colder than the temperature just outside and upstream of the dome aperture. Note, by reference to figure 10, that this was close to the time when the seeing disturbance was at its worst.

A set of transient calculations was also run with the supply temperature to the dome offset by −1°C from the temperature of the outside air just above the aperture. Figure 8.10 shows the temperature contours at a time when the seeing disturbance was at its worst and figure 8.11 is a plot of the rms ray deviations (in milli arcsec) v time. The worst values here are substantially worse than was budgeted for this degradation.

Figure 8.12 is another plot of the irregularity v time but expressed as wavefront error (nm) rather than ray deviation. Figures 8.13 and 14 are plots of the wavefront error across the diameters in the P and Q planes respectively, indicating that the errors have low spatial frequency and can be

PLATO, a collaboration between China, Australia, USA and UK.

Image: CHINARE

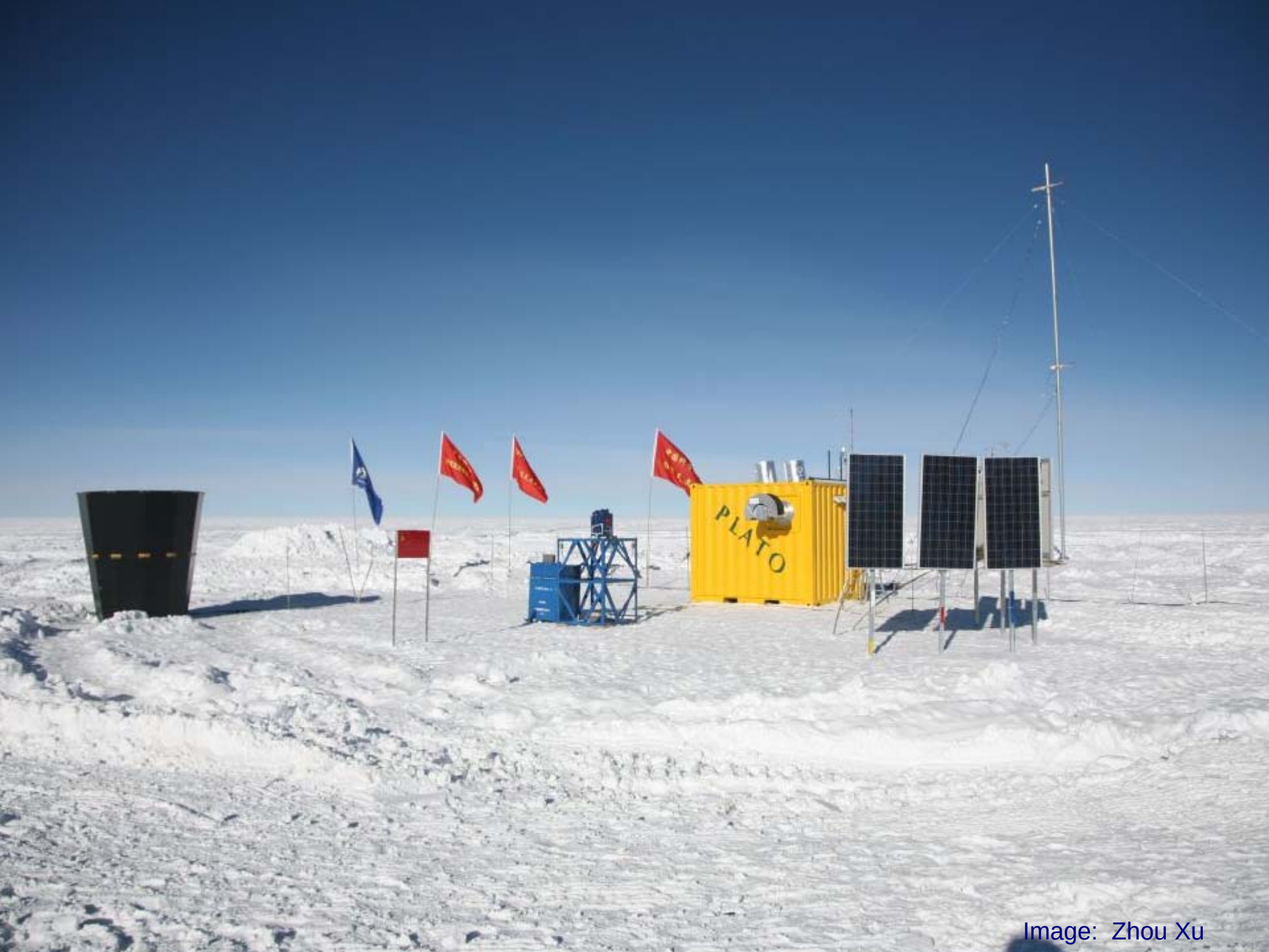


Image: Zhou Xu

One year later…

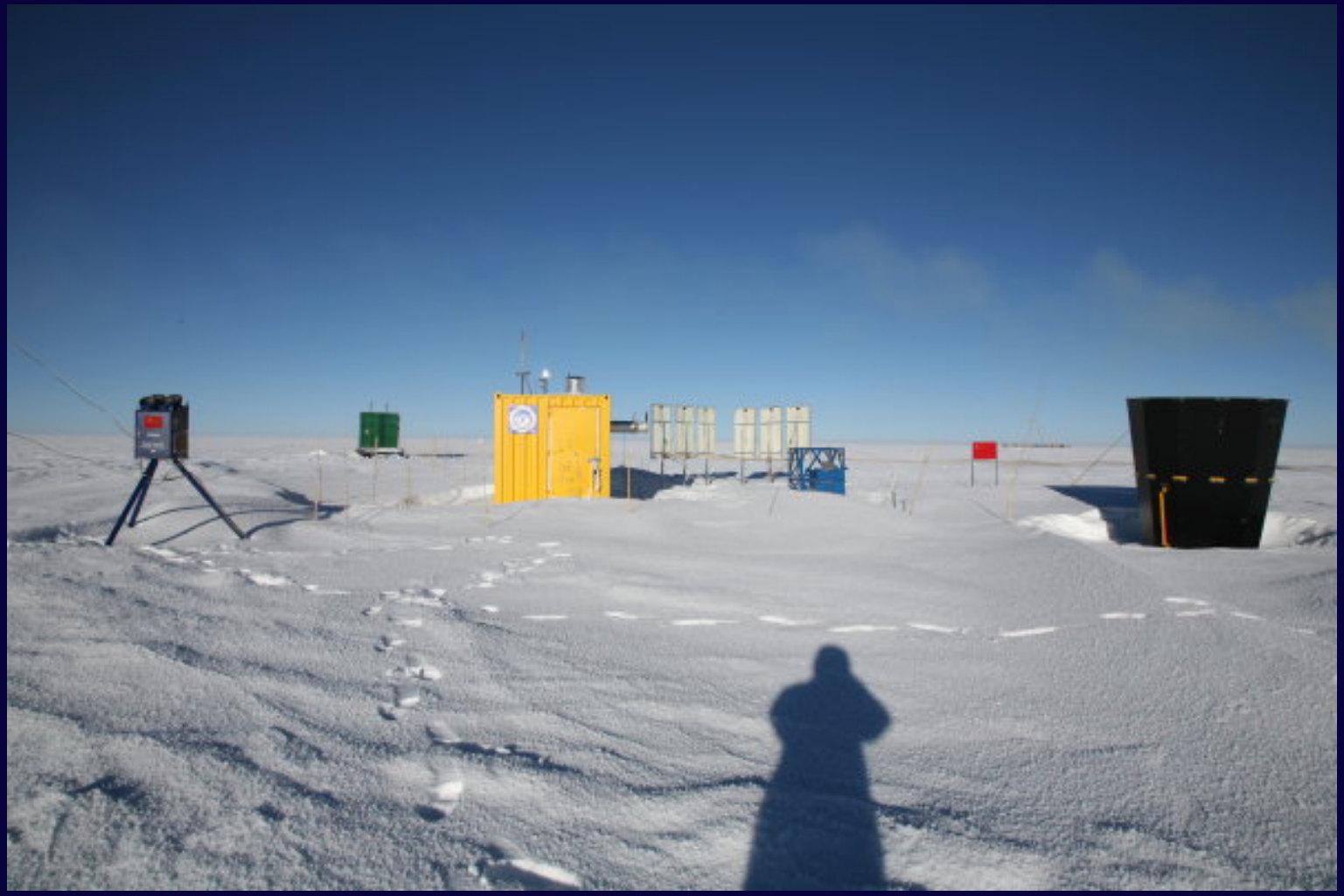


Image: Xuefei Gong

A few days later…

Image: Xuefei Gong

Astronomy & Astrophysics from Antarctica

a new SCAR Scientific Research Program

Image: David A. Hardy

Scientific Committee on Antarctic Research

Astronomy & Astrophysics from Antarctica (AAA)

Proposal to establish the AAA Scientific Research Programme

VERSION: 18 June 2008

Expected Duration: 2008 – 2012

Estimated SCAR funding: $US60,000

Astronomy & Astrophysics from Antarctica

Scientific Research Programme

Broadly stated, the objectives of *Astronomy & Astrophysics from Antarctica* are to coordinate astronomical activities in Antarctica in a way that ensures the best possible outcomes from international investment in Antarctic astronomy, and maximizes the opportunities for productive interaction with other disciplines.

Astronomy & Astrophysics from Antarctica

Scientific Research Programme

Four “Themes”

A. Site testing, validation and data archiving.
B. Arctic site testing.
C. Science goals.
D. Major new facilities.

Astronomy & Astrophysics from Antarctica

Scientific Research Programme

The following Steering Committee has been approved:

- Michael Andersen (Denmark)
- Philip Anderson (United Kingdom)
- Michael Burton (Australia)
- Xiangqun Cui (China)
- Nicolas Epchtein (France)
- Takashi Ichikawa (Japan)
- Albrecht Karle (USA)
- James Lloyd (USA)
- Silvia Masi (Italy)
- John Storey (Australia – Proposed Chief Officer)
- Lifan Wang (China/USA)

Upcoming IAU meeting

- *IAU XXVII General Assembly*, Rio de Janeiro, Brazil,3 - 14 August 2009.
  - Special Session 3, *"Astronomy in Antarctica"*
  - IAU Working Group on Antarctic Astronomy
  - *Second SCAR AAA SRP Planning Meeting.*

Summary

1. Their exist great opportunities for optical/IR astronomy.
2. There exist great opportunities for sub-mm astronomy.
3. It’s cold — get over it.
4. Deployment and operational costs are relatively modest.
5. However, communications bandwidth is limited and there are other challenges.

Image: Paolo Calisse


Thank you!
Image: John Storey