HOW WARM IS THE SOUTH POLE?

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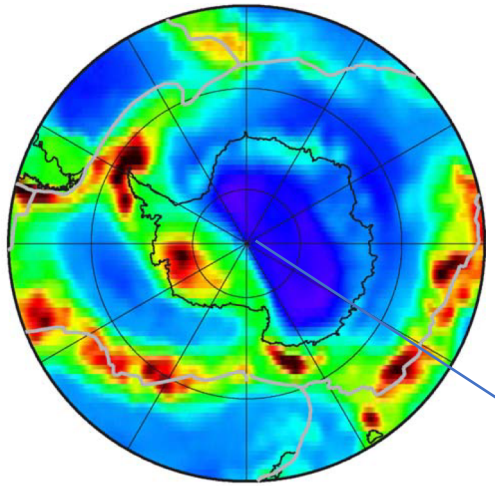
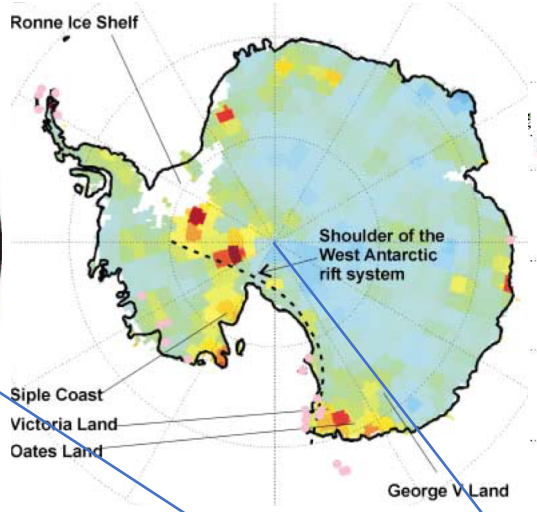
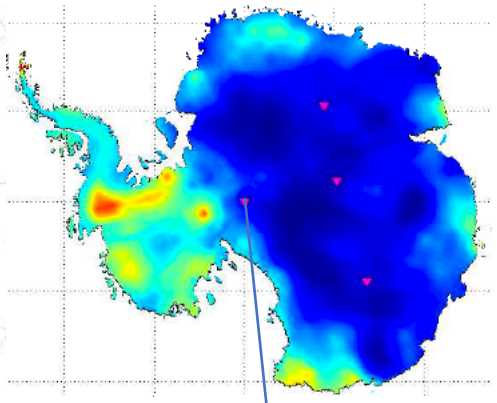
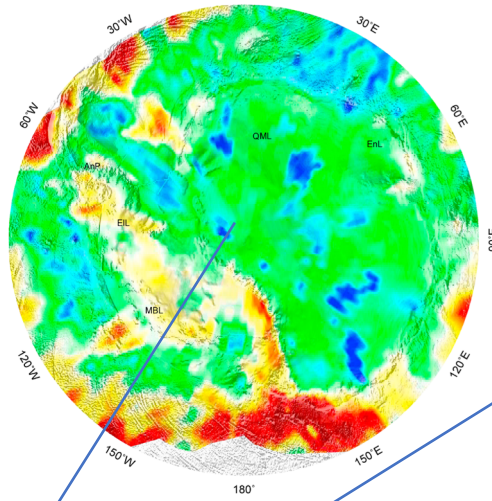
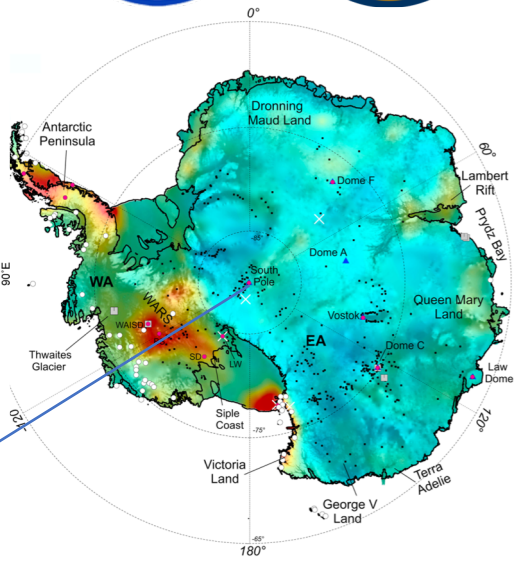
Large scale GHF estimations

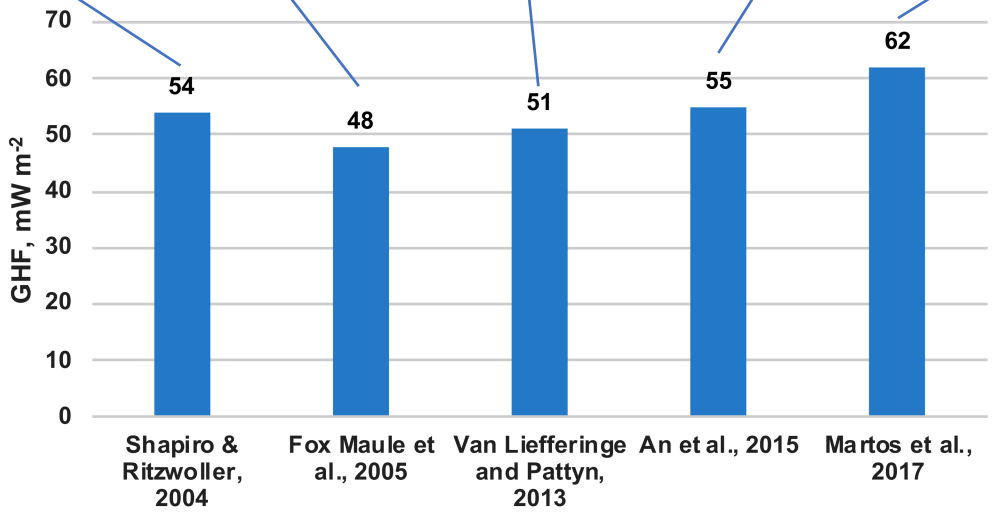










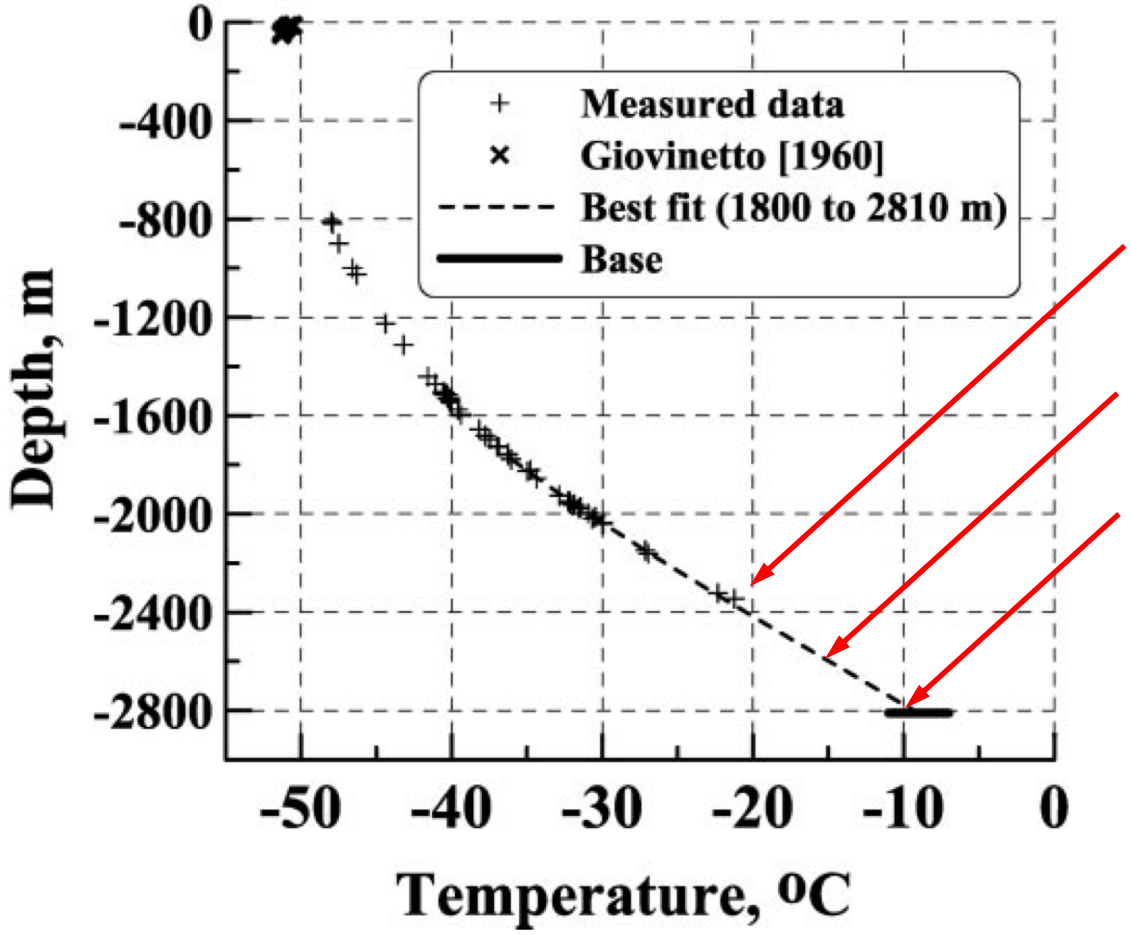


First pre-estimation

Temperature profile for glacial ice at the South Pole: Implications for life in a nearby subglacial lake

P. Buford Price*†, Oleg V. Nagornov‡, Ryan Bay*, Dmitry Chirkin*, Yudong He§, Predrag Miocinovic*, Austin Richards¶, Kurt Woschnagg*, Bruce Koci‖, and Victor Zagorodnov**

PNAS | June 11, 2002 | vol. 99 | no. 12



- **GHF was estimated to 61±1 mW m^{-2}**

Ignoring the deepest points

Assumption of linear temperature distribution in the bottom part

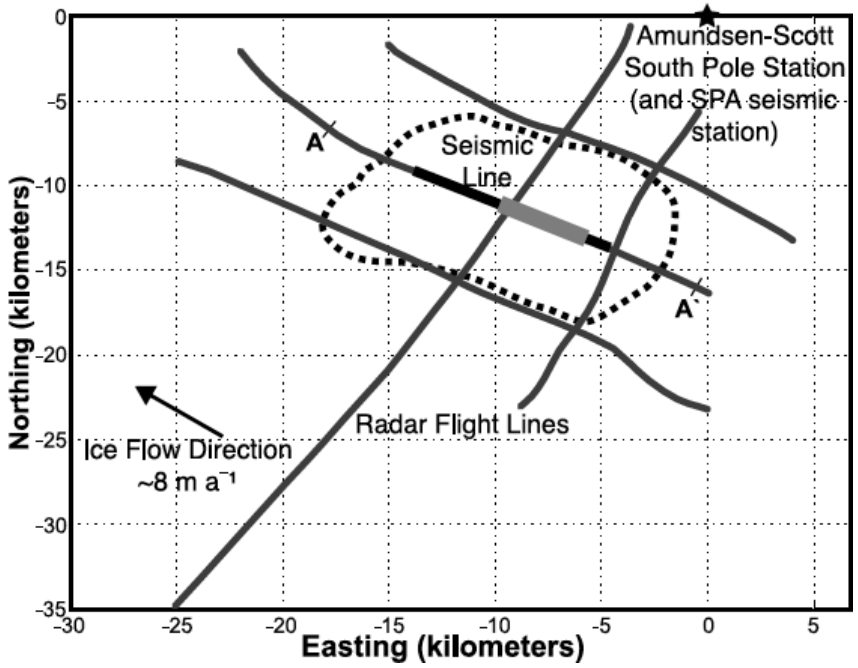
Temperature at the bedrock interface is well below the PMT -9±0.7 °C

Subglacial Lake near South Pole

Seismic detection of a subglacial lake near the South Pole, Antarctica

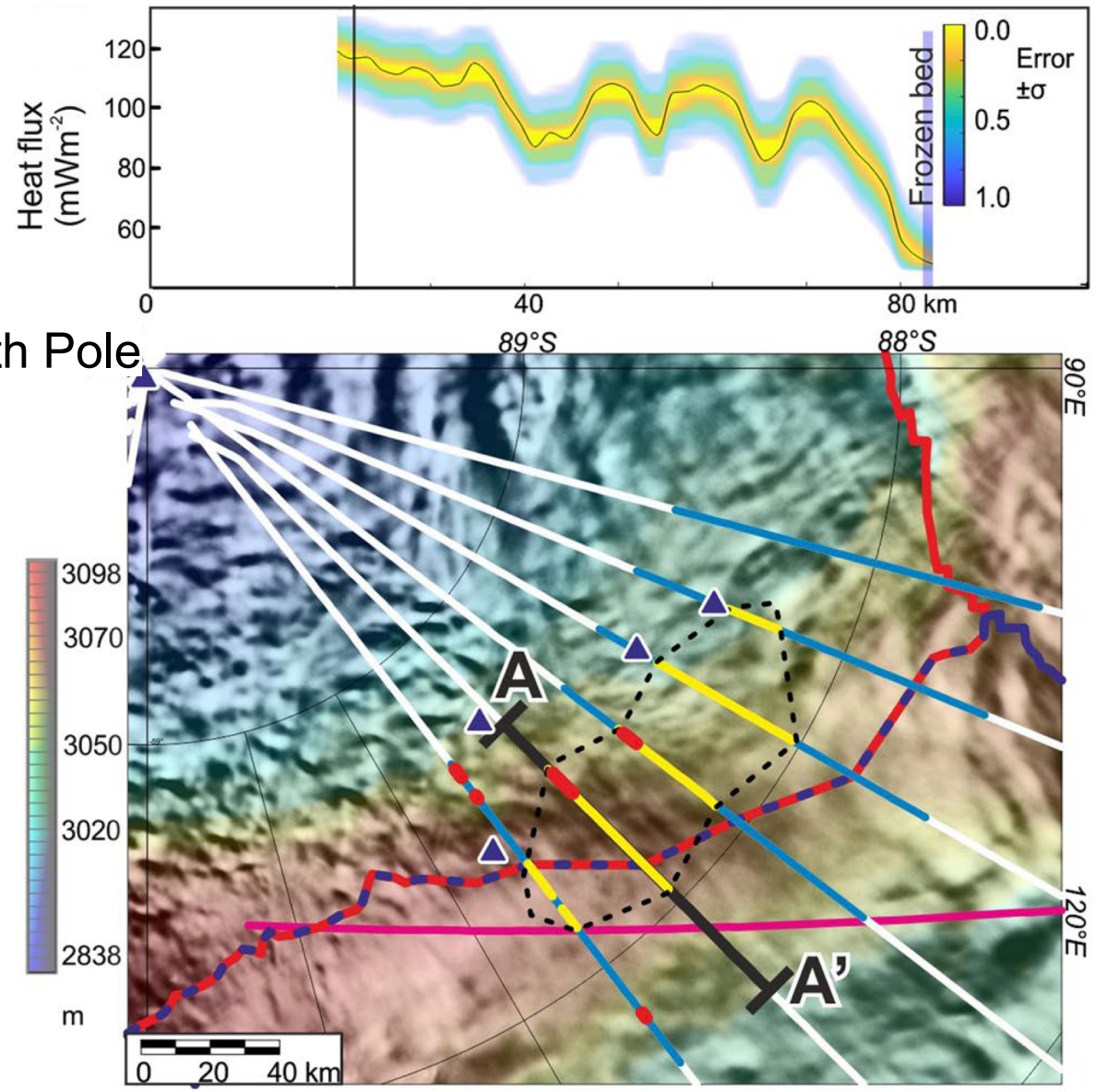
L. E. Peters,[1] S. Anandakrishnan,[1] C. W. Holland,[2] H. J. Horgan,[1] D. D. Blankenship,[3] and D. E. Voigt[1]

GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L23501, doi:10.1029/2008GL035704, 2008



- Detection of subglacial lake ~10 km north-easterly from the South Pole suggests high GHF in this area.
- This lake is at least 4.2 km wide and up to 32±10 m deep.
- Budd et al. (1984) pointed out that the presence of basal meltwater beneath most of the Antarctic ice sheet requires GHF ≥ 80 mW m^{-2} .

Upstream of South Pole



Anomalously high geothermal flux near the South Pole

T. A. Jordan[1], C. Martin[1], F. Ferraccioli[1], K. Matsuoka[2], H. Corr[1], R. Forsberg[3], A. Olesen[3] & M. Siegert[4]

SCIENTIFIC REPORTS | (2018) 8:16785

- **Analyzing of ice-penetrating radar data upstream of South Pole revealed area with extremely high GHF of 120±20 mW m^{-2}, double the values expected for this cratonic sector of East Antarctica.**

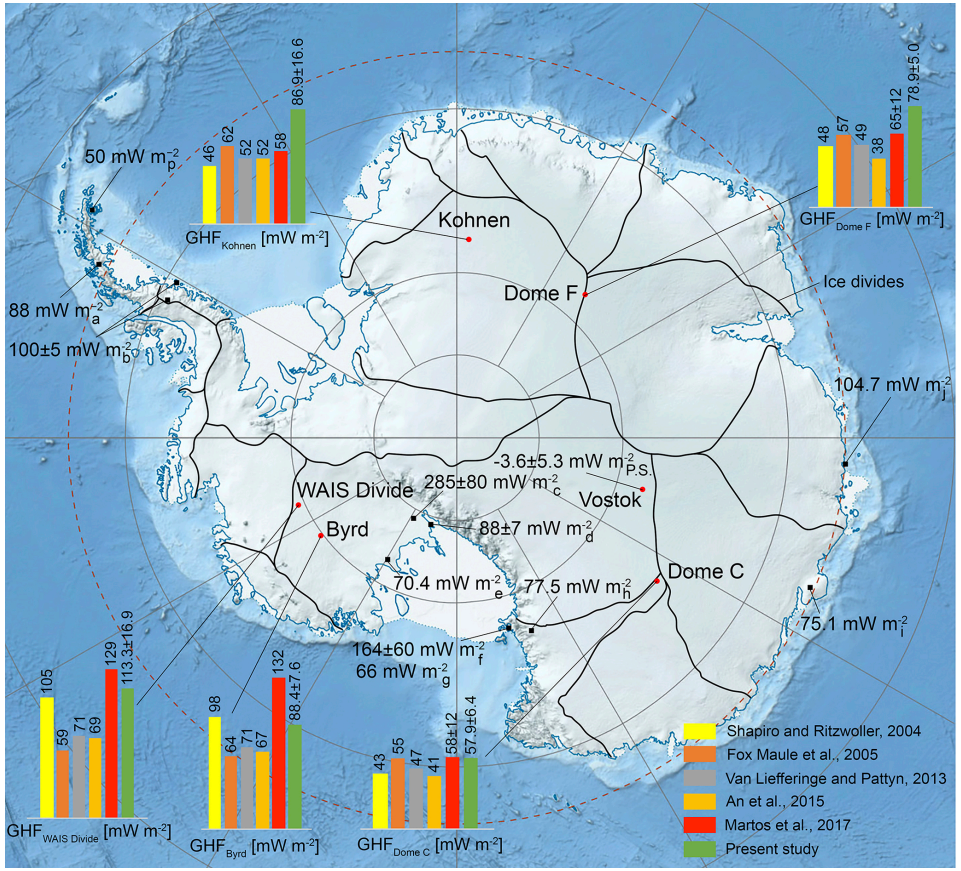
GHF estimation model

Geothermal heat flux from measured temperature profiles in deep ice boreholes in Antarctica

Pavel Talalay[1], Yazhou Li[1], Laurent Augustin[2], Gary D. Clow[3], Jialin Hong[1], Eric Lefebvre[4], Alexey Markov[1], Hideaki Motoyama[5], and Catherine Ritz[4]

The Cryosphere Open Access EGU

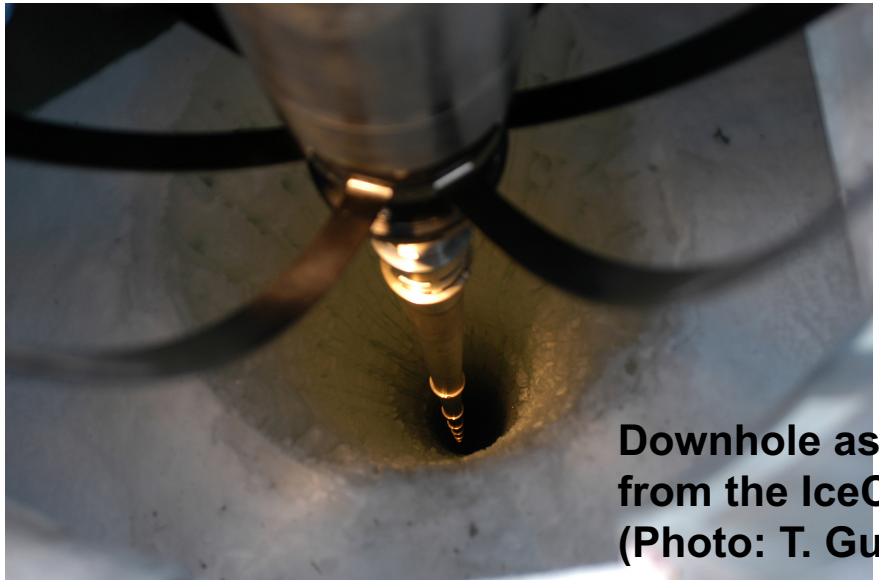
- Steady-state heat flow modeling
- Horizontal advection and horizontal heat conduction are assumed to be minimal
- Common genetic algorithm is used to find the optimal solution of temperature fitting



Initial drill site and ice sheet parameters

Drill site and ice sheet parameters	
Coordinates	90°S; 139°16′E
Years drilled (AMANDA & IceCube)	1993-2011
Surface elevation (m a.s.l.)	2800
Drilled depth (m)	2500
Ice thickness according with radar survey (m)	2810
Snow accumulation at surface (cm ice a^{-1})	8.15
Mean surface snow temperature (°C)	-51.4

View of the AMANDA drilling site, 1993-1994 (Photo: R. Morse)



Downhole assembly retrieving from the IceCube hole (Photo: T. Gustafsson)

Uncertainties from form factor *m*

$$\left(\frac{z}{H}\right)^{m+1}$$

m **is an adjustable form factor that accounts for the variation in vertical velocity**

$$0 < m < 1$$

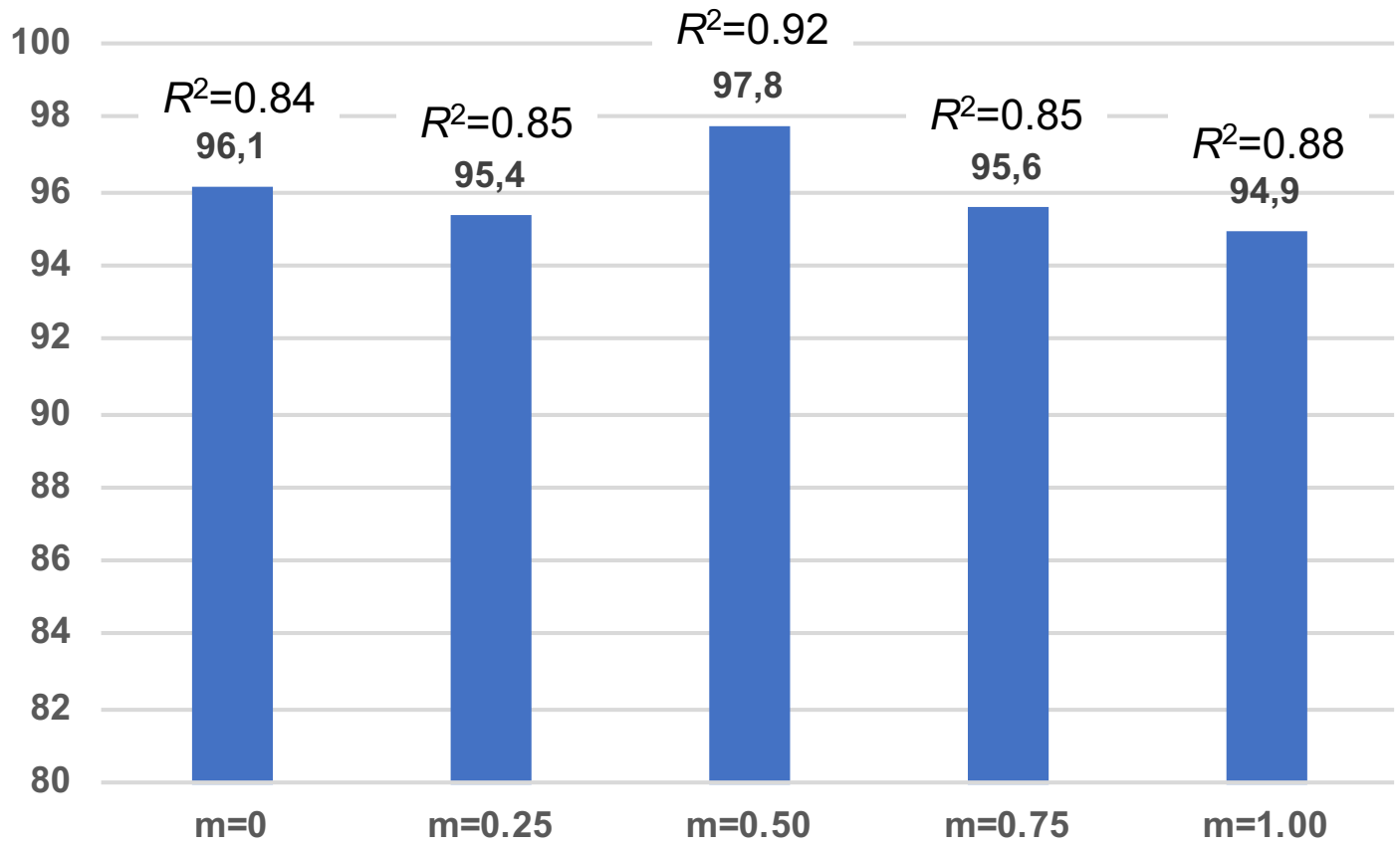
- **Classically, vertical velocity depends linearly on *z/H* and *m* = 0.**
- **However, at an ice divide, the downward flow of ice is slower for the same depth than at locations away from the divide. Therefore, Raymond (1983) suggested the use of *m* = 1.0 for deformation in the vicinity of ice divides.**

- **Thus, we examine the form factor *m* at five levels:**

0, 0.25, 0.50, 0.75, and 1.00.

GHF [mW m^{-2}]

- **The best value for the form factor *m* is selected on the basis of the nonlinear correlation analysis between modeled and measured age scales.**



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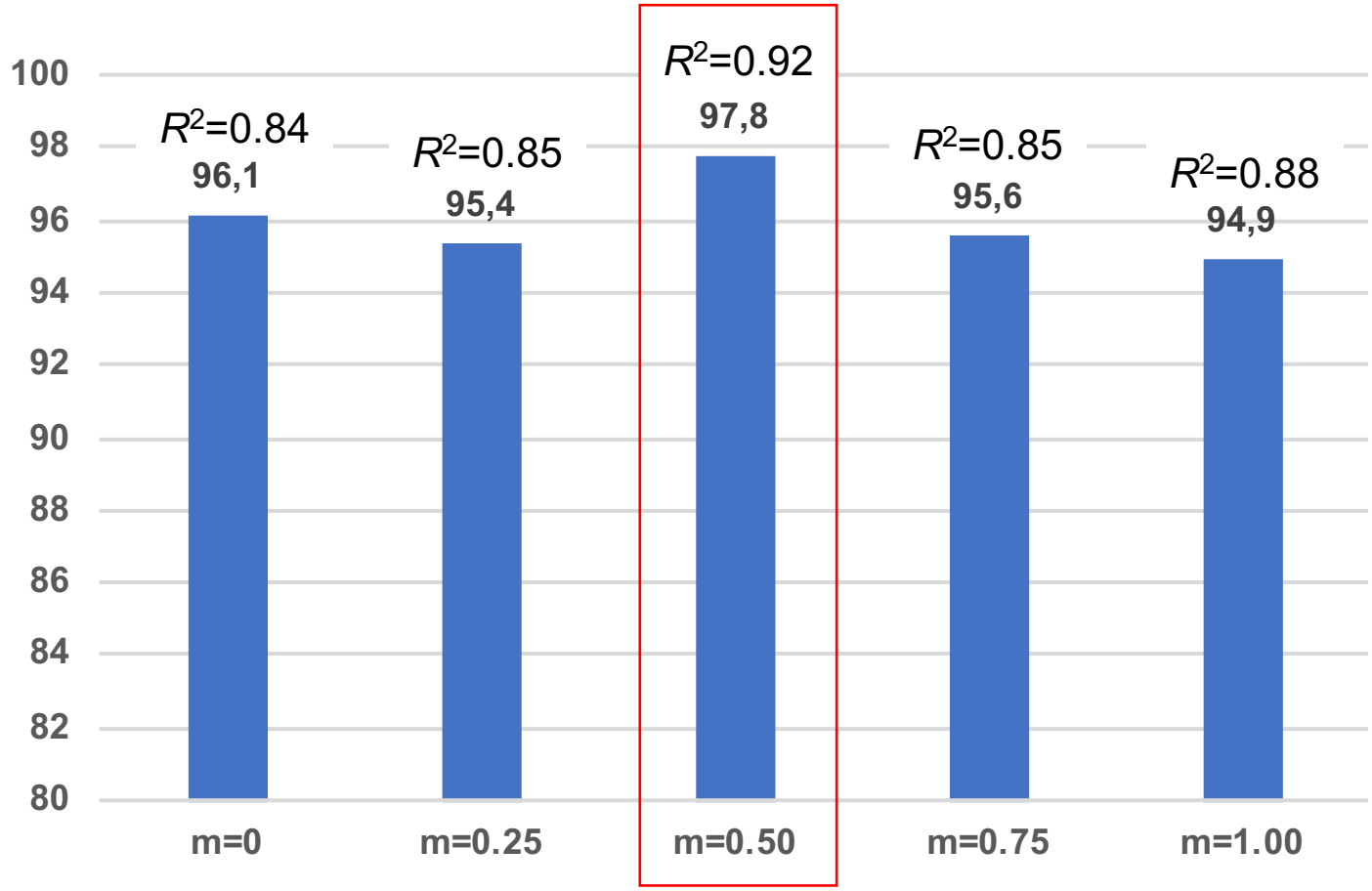
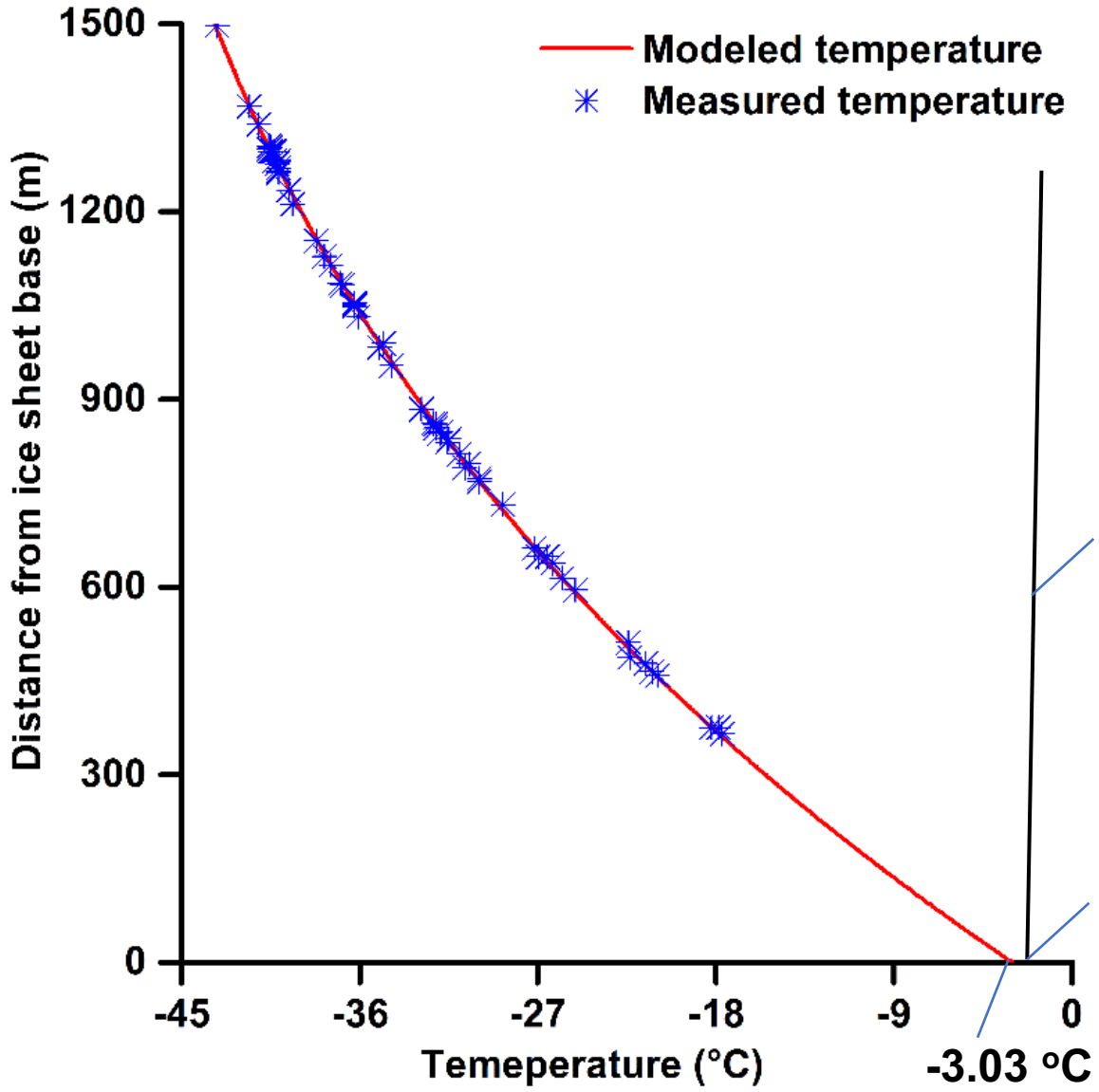


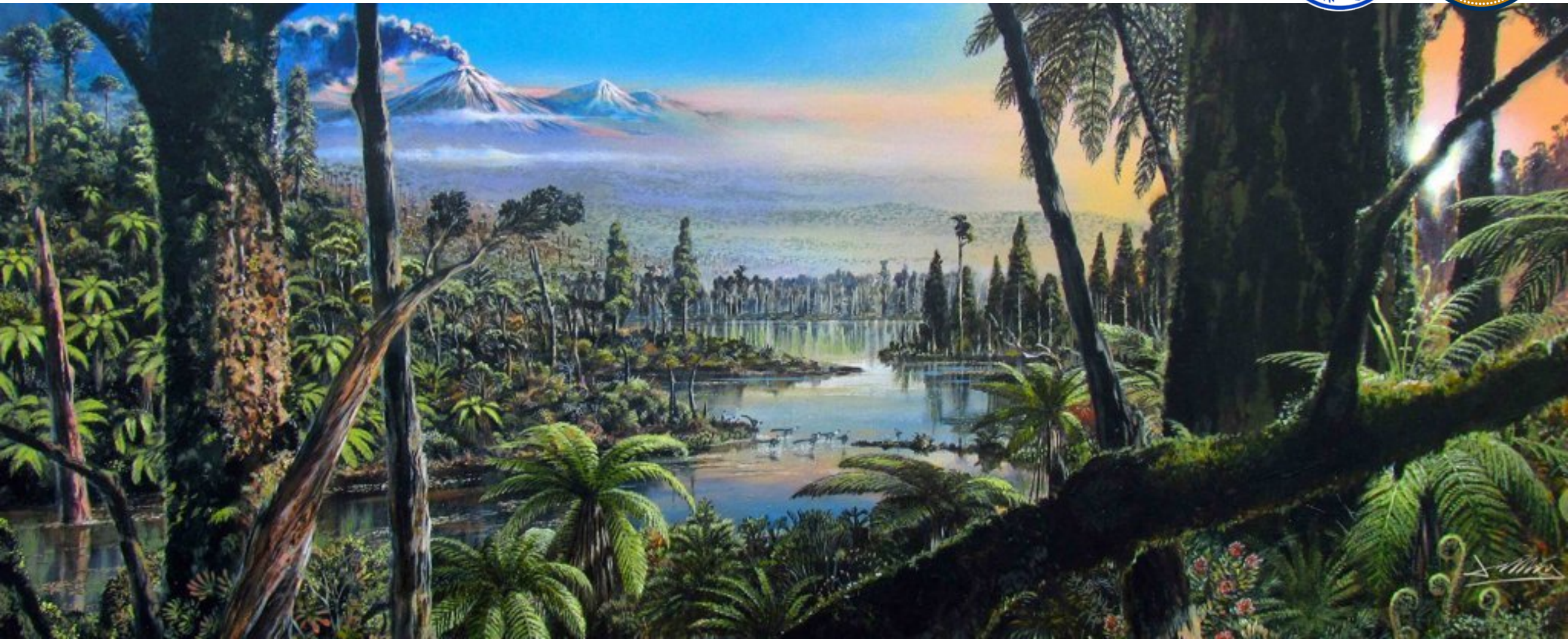
Estimated temperature at the base



PMT under the assumption of a Clausius–Clapeyron slope of 0.0742 K/MPa

-1.86 °C

Thanks for your attention



https://www.sciencealert.com/discovery-of-ancient-rainforest-in-antarctica-is-a-grim-warning-of-earth-s-future

South Polar region ~90 million years ago