

Global Climate Change – the Long View

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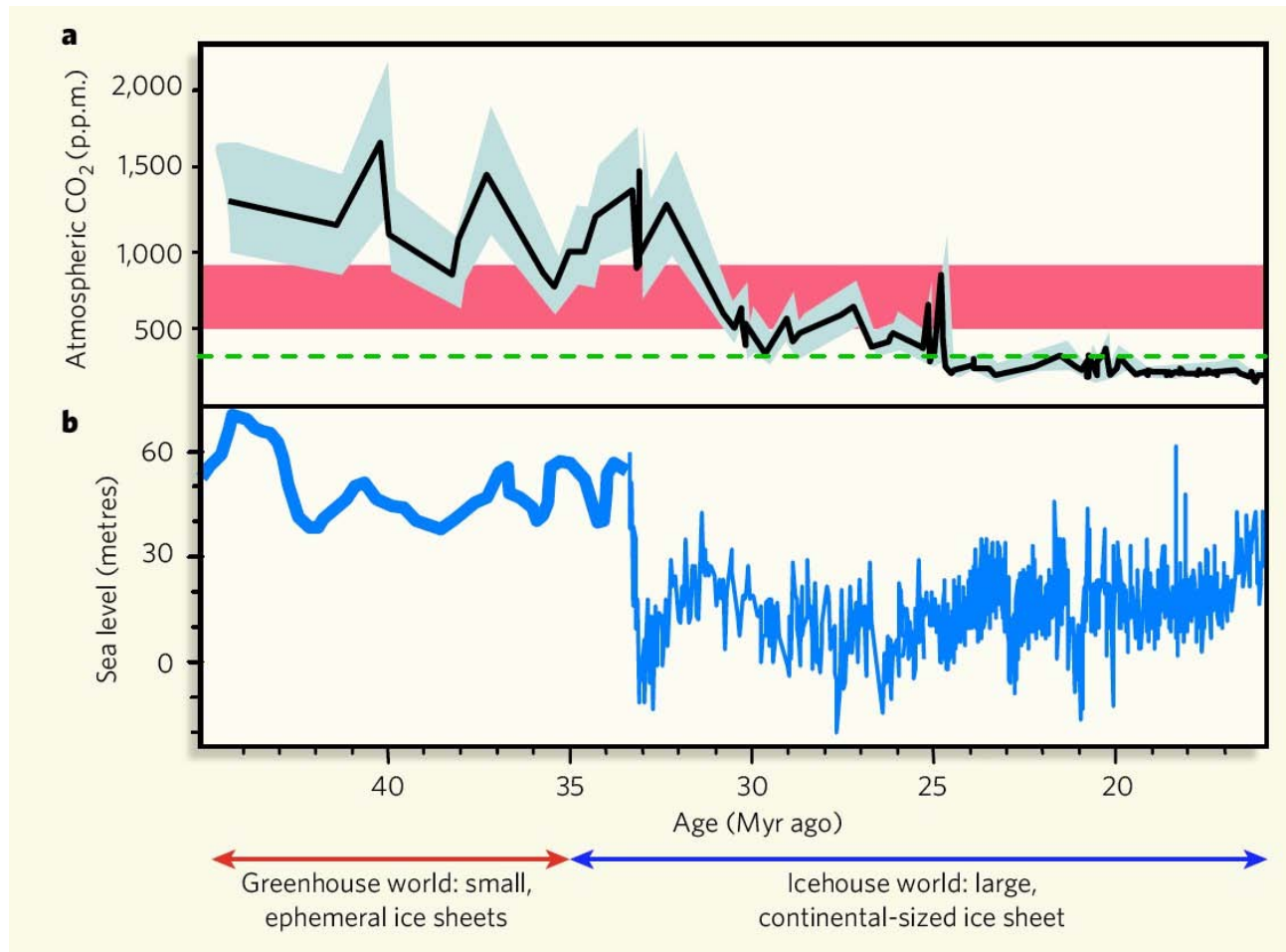
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MAX-PLANCK-GESELLSCHAFT

Switch from greenhouse to icehouse 33 million years ago



Why?

S. F. Pekar (2008) When did the icehouse cometh? Nature N&V 455, 602-603..

Continental Drift

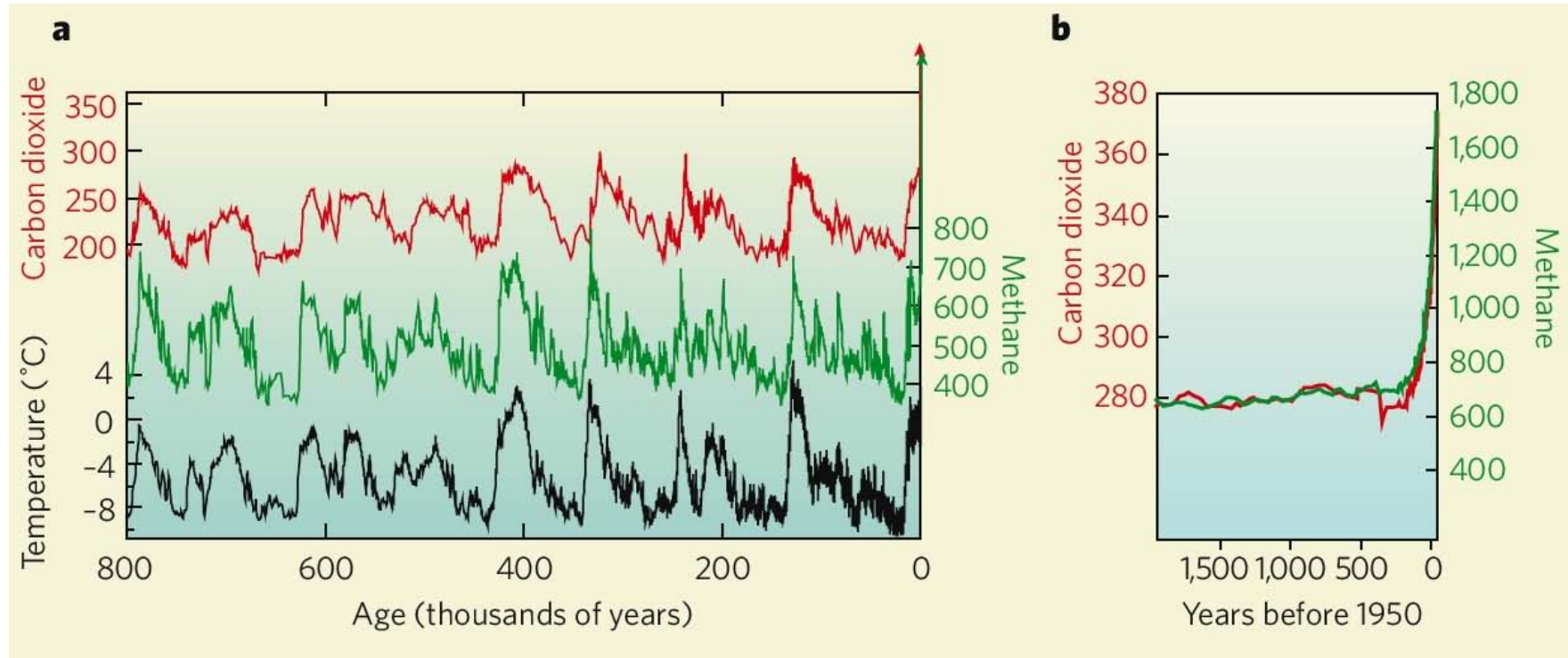


A large land mass
(Antarctica) drifts toward the
South Pole:

- ✓ Permanent ice shield builds.
- ✓ Sea level drops
- ✓ Earth cools

All together now:

Temperature, CO₂ & methane during the Ice Ages

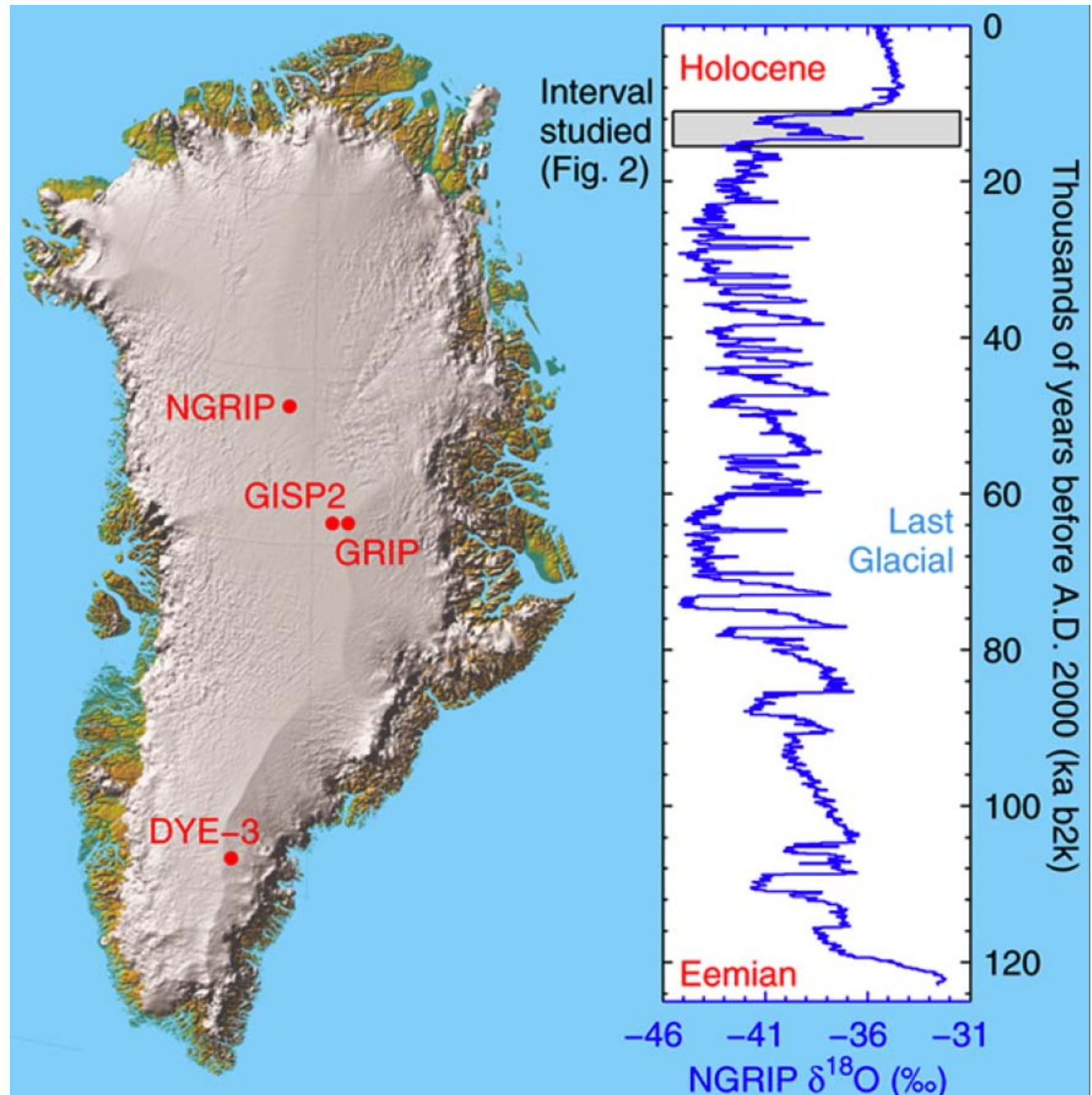


E. Brook, Palaeoclimate: Windows on the greenhouse. Nature 453, 291-292 (2008)

The last Ice Age

Very rapid climate changes except for the last 10,000 years:

Stable climate is the exception, not the rule



Steffensen et al., High-resolution Greenland ice core data show abrupt climate change happens in a few years. Science 321

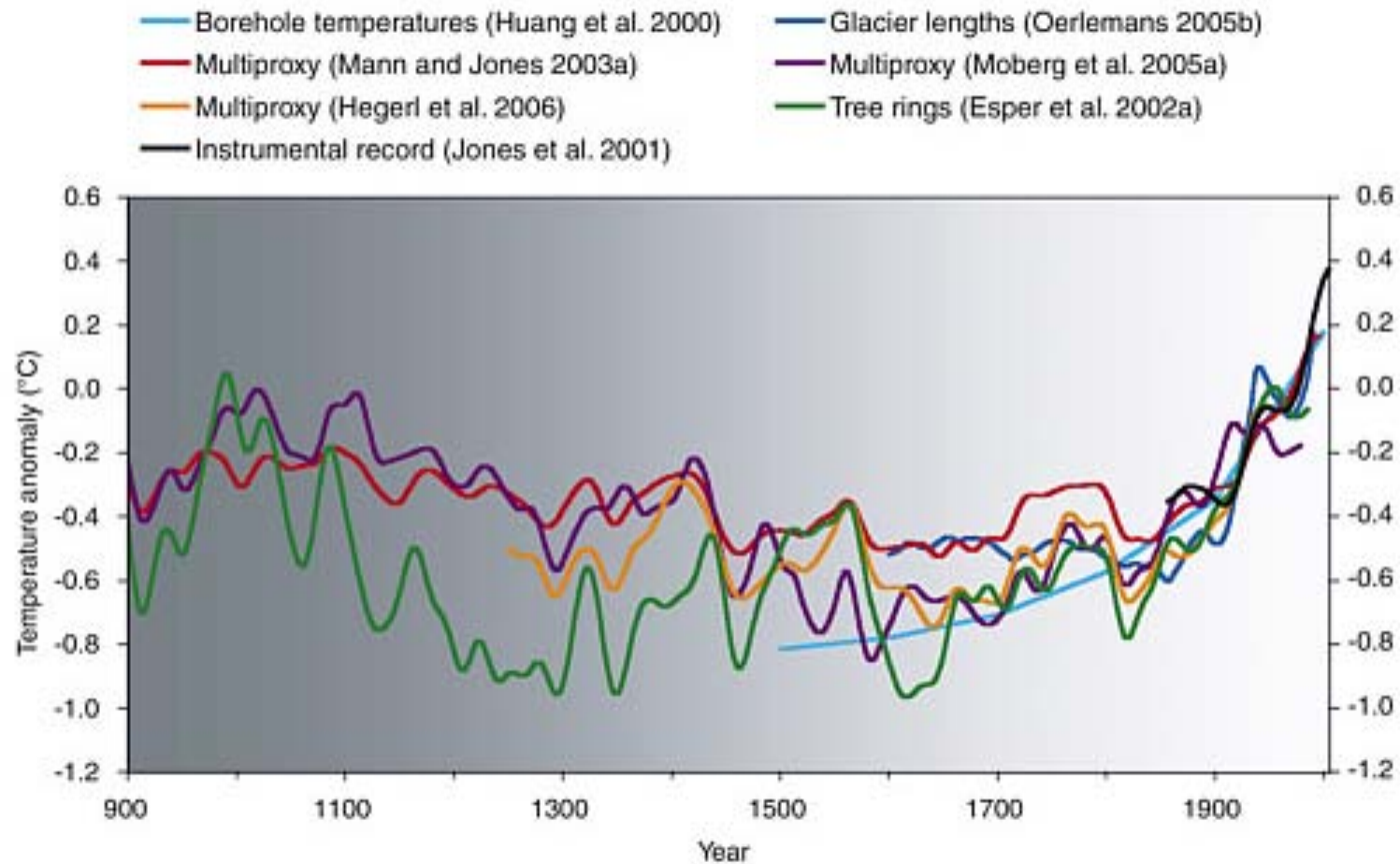
Recent Climate Change: Threatened by the Hockey Stick?



Quite possibly?

Do we really want to find out???

Temperature reconstructions over the last 2000 Years

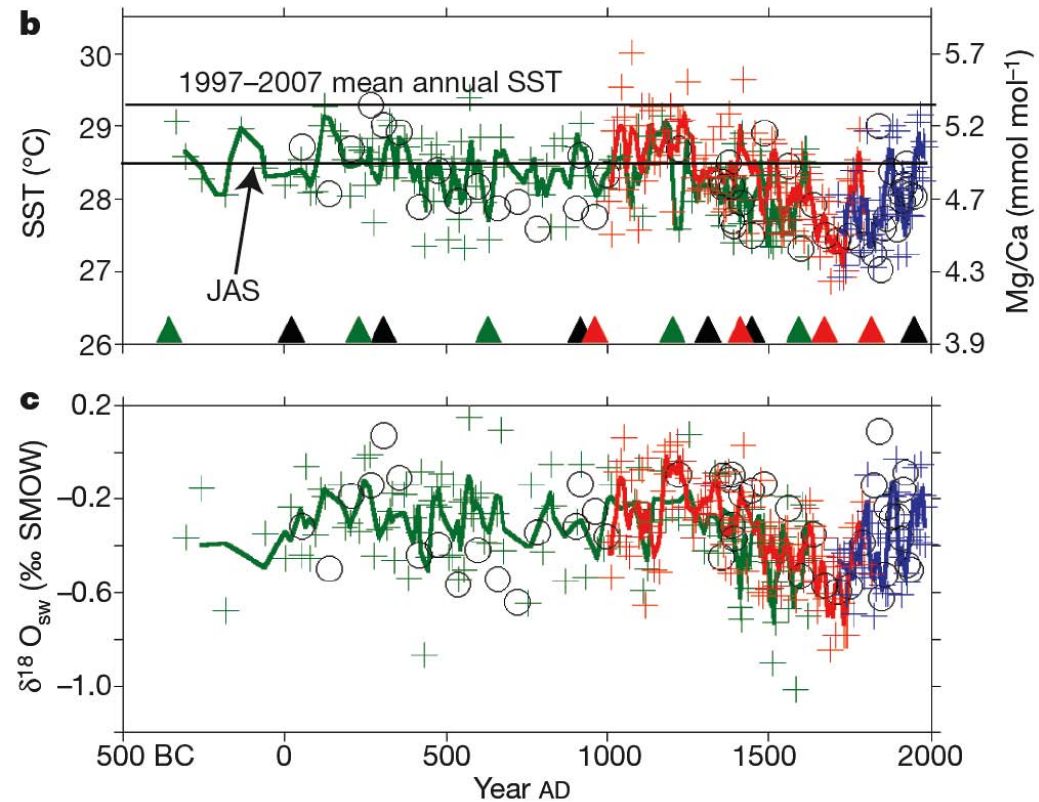


National Research Council (2006) Surface Temperature Reconstructions for the Last 2000 Years. Board on Atmospheric Sciences and Climate.

Maybe no hockey stick in tropical sea surface temperatures?

Was medieval warm period (900 to 1200 AD) warmer than present?

“Proxy” data from deep sea cores seem to indicate that this is the case, but are all affected by uncertainties

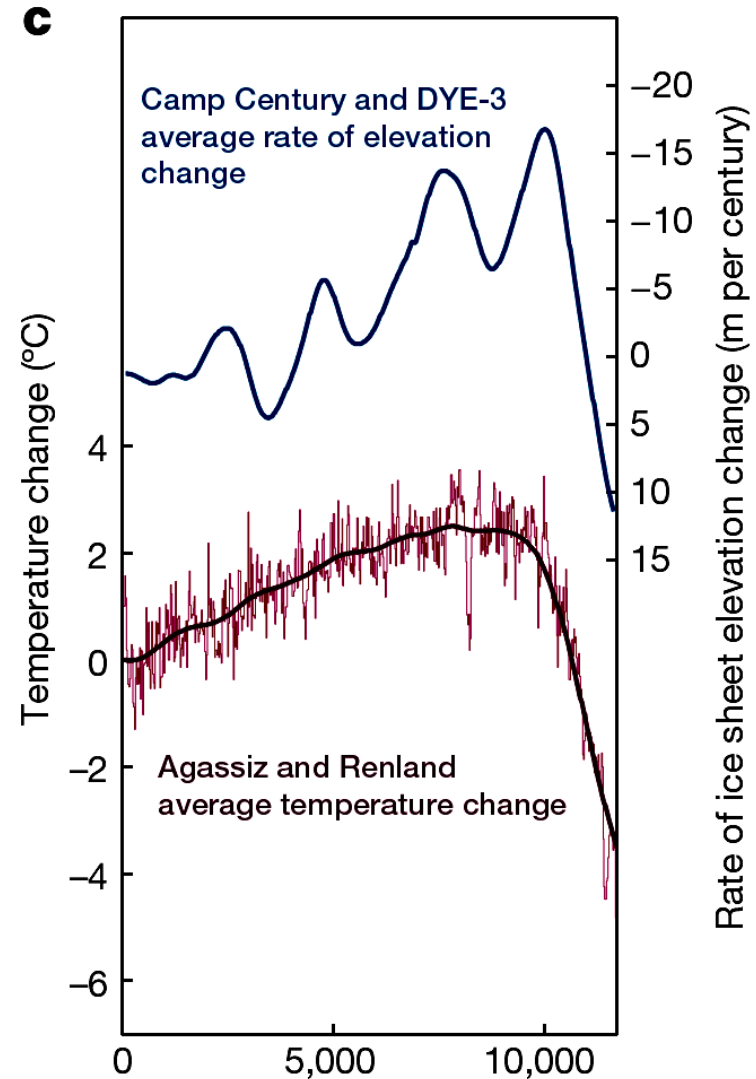
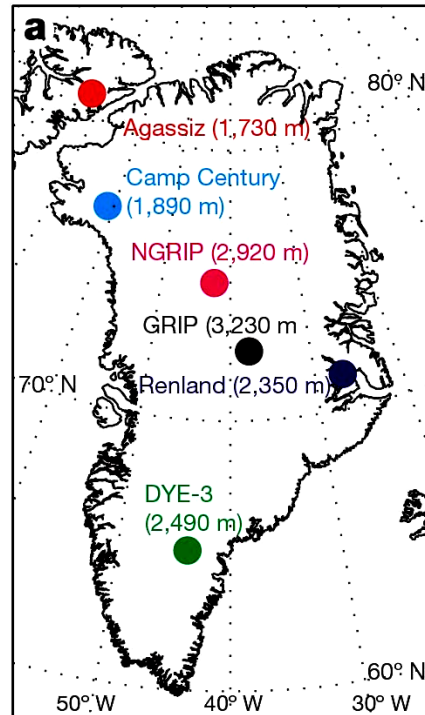


Oppo et al., 2,000-year-long temperature and hydrology reconstructions from the Indo-Pacific warm Pool. *Nature* 450, 1114-1116 (2009).

Arctic Temperature Record

Greenland ice temperatures were 2 degrees higher 8000 years ago.

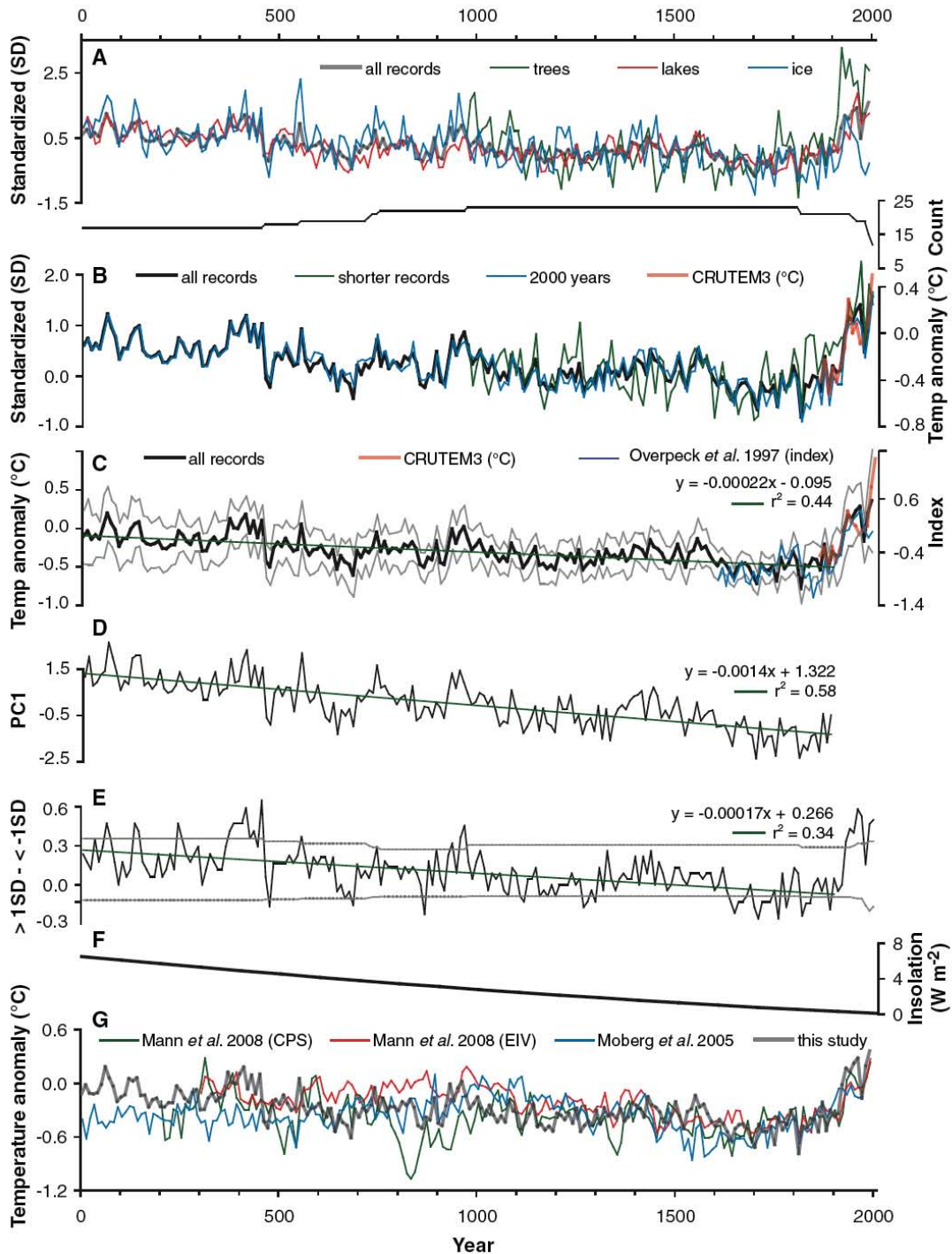
But note: Recent 1-2 degree “uptick”



Vinther et al., Holocene thinning of the Greenland ice sheet. *Nature* 461, 385-388 (2009).

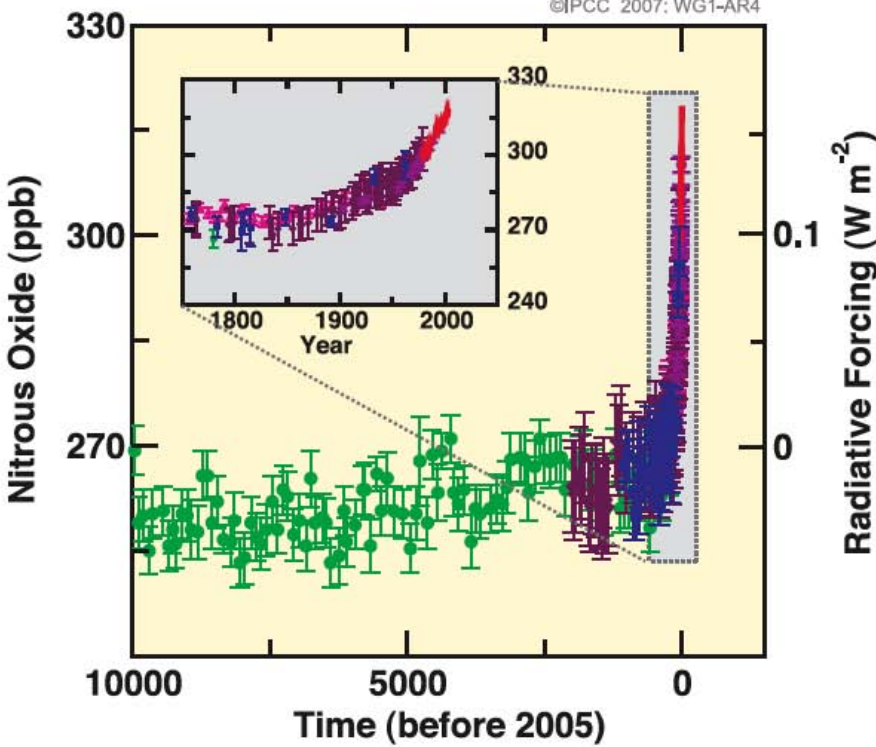
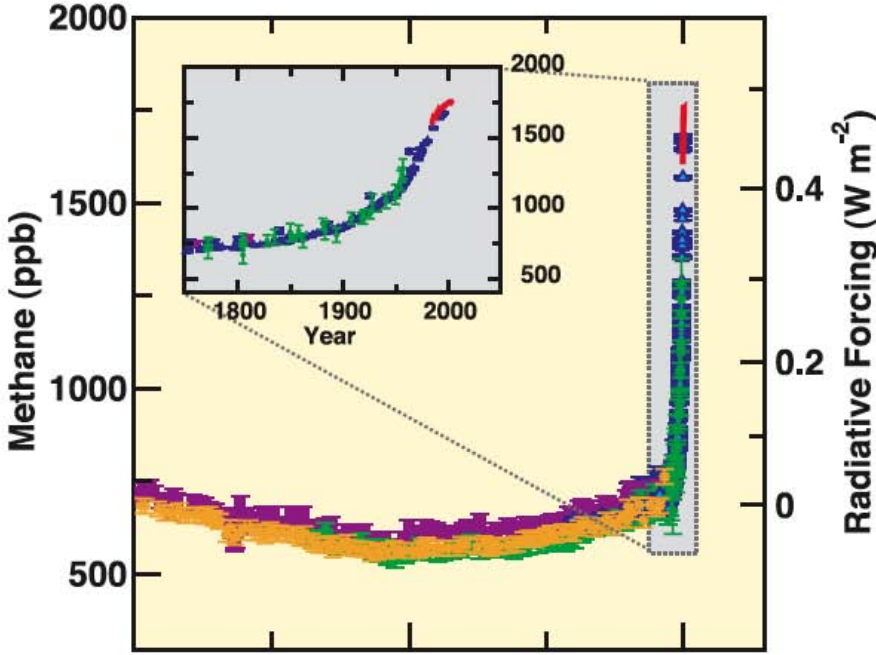
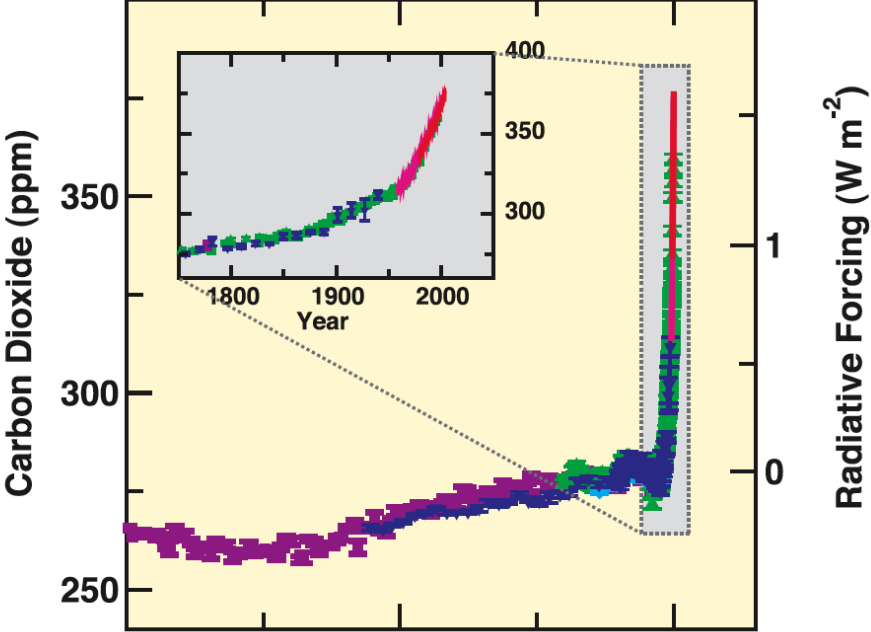
2000-Year Climate Proxy Records From the Arctic:

Overall slow cooling but recent warming



Kaufman et al. (2009) Science, 325, 1236-1239.

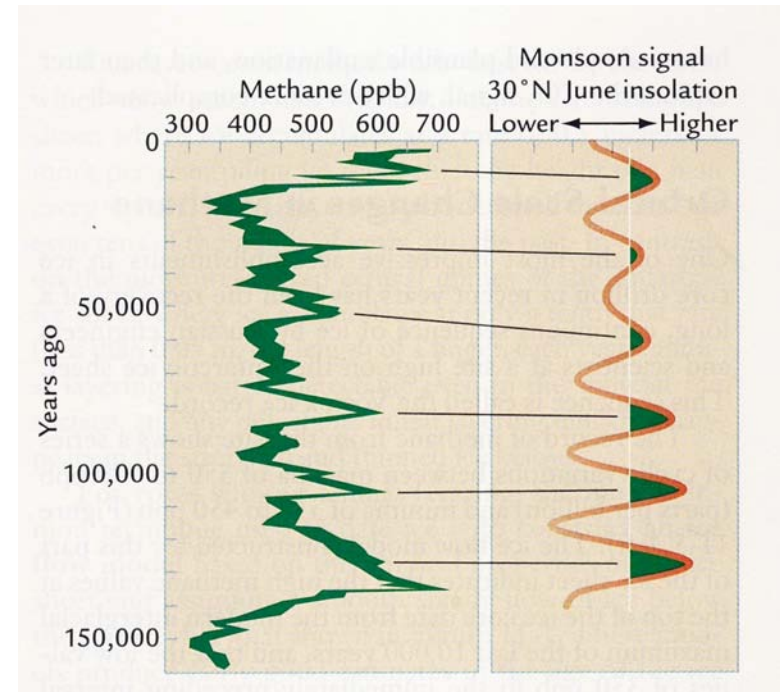
CO₂, Methane, Nitrous Oxide during the last 10000 years



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What about Methane?

- Fluctuates naturally with climate, driven by vegetation and summer insolation
- Recent anthropogenic input serious, because it is about 60 times more powerful as greenhouse agent than CO₂.
- Therefore burning methane to carbon dioxide, instead of releasing it into the atmosphere, *is actually highly beneficial to the total greenhouse gas budget.*



From: W.F. Ruddiman, Earth's Climate: Past and Future. Freeman & Co., 2001.

Conclusions

- Climate change is geologically normal, not exceptional
- Climate has been more stable during the past 10 000 years than during the previous 100 000 yrs
- There has been dramatic warming during the past 150 years
- Human causes of this warming, although disputed by some, are probable
- We are presently conducting a highly dangerous experiment with CO₂.
- Nevertheless, burning of methane, a vastly more powerful greenhouse gas than CO₂, is actually beneficial to the total greenhouse gas budget.