The Toba super-eruption: Micro-scale traces of a global-scale climate event?

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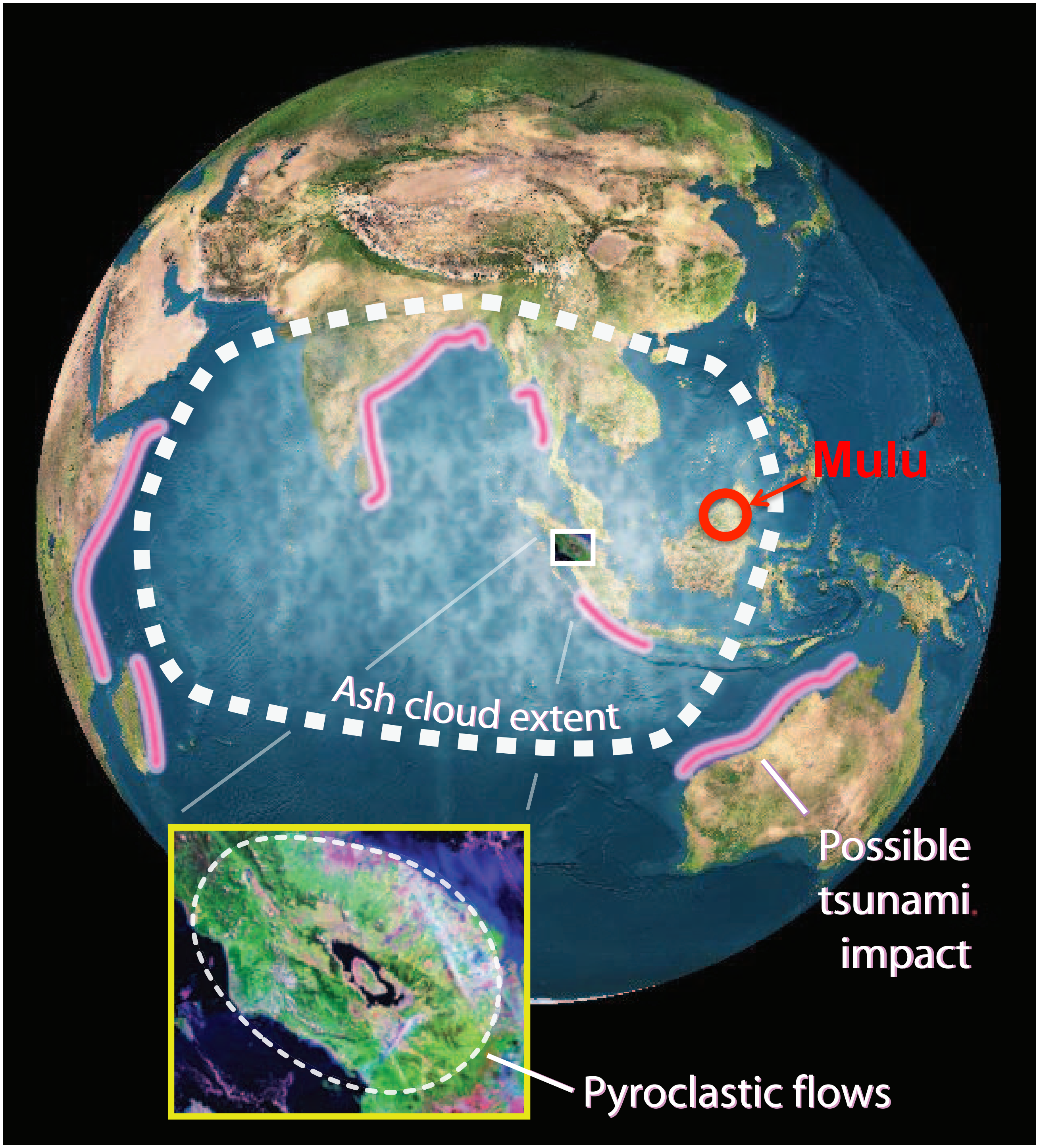


The Toba super-eruption:

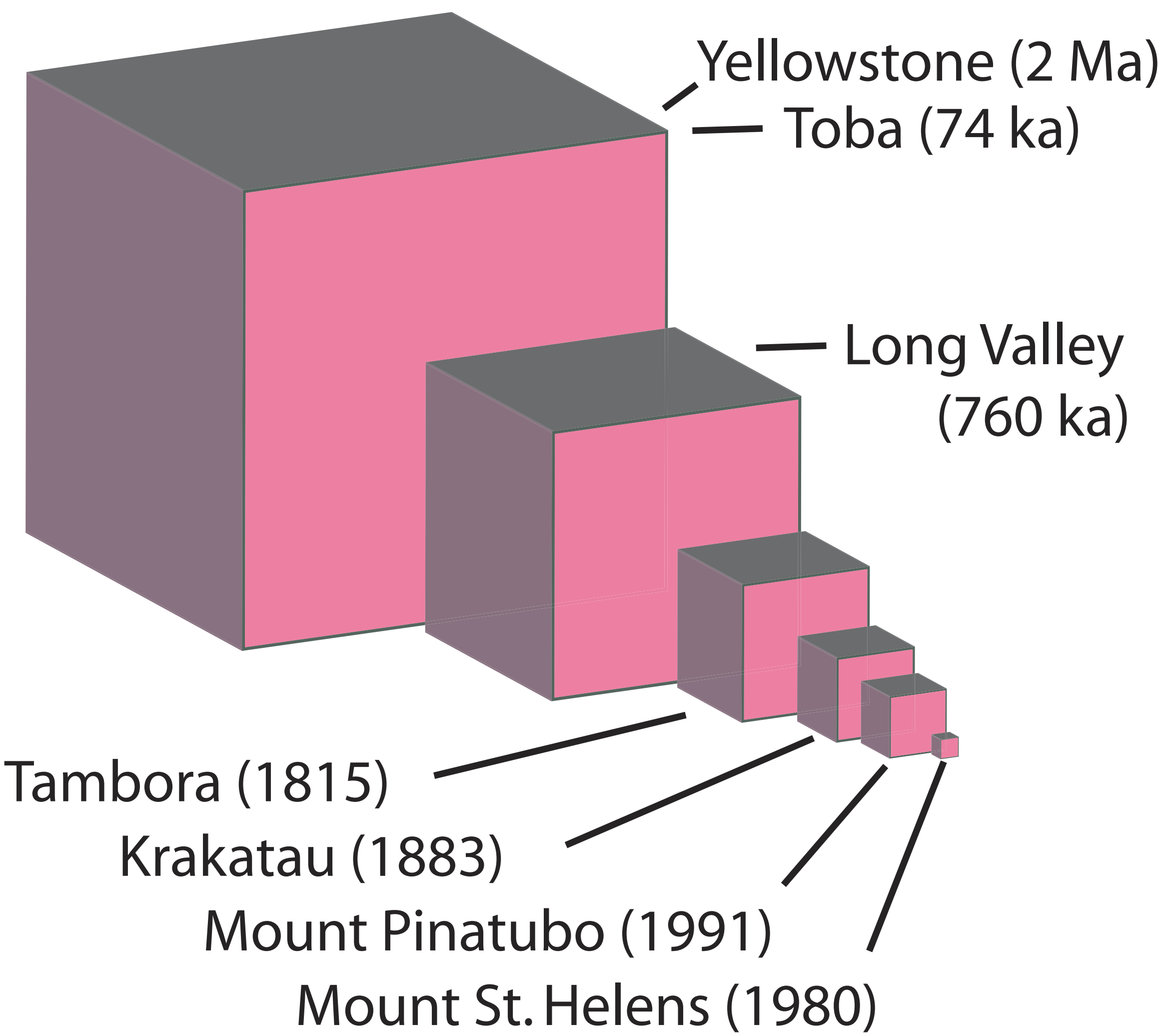
73.88 ± 0.6 kybp (Storey et al., 2012)

~3,000km^3 DRE

VEI of 8

Miller and Wark, 2008

Relative eruption magnitudes



Miller and Wark, 2008

Did Toba play a role in an observed “bottleneck” in human mitochondrial genetic diversity?

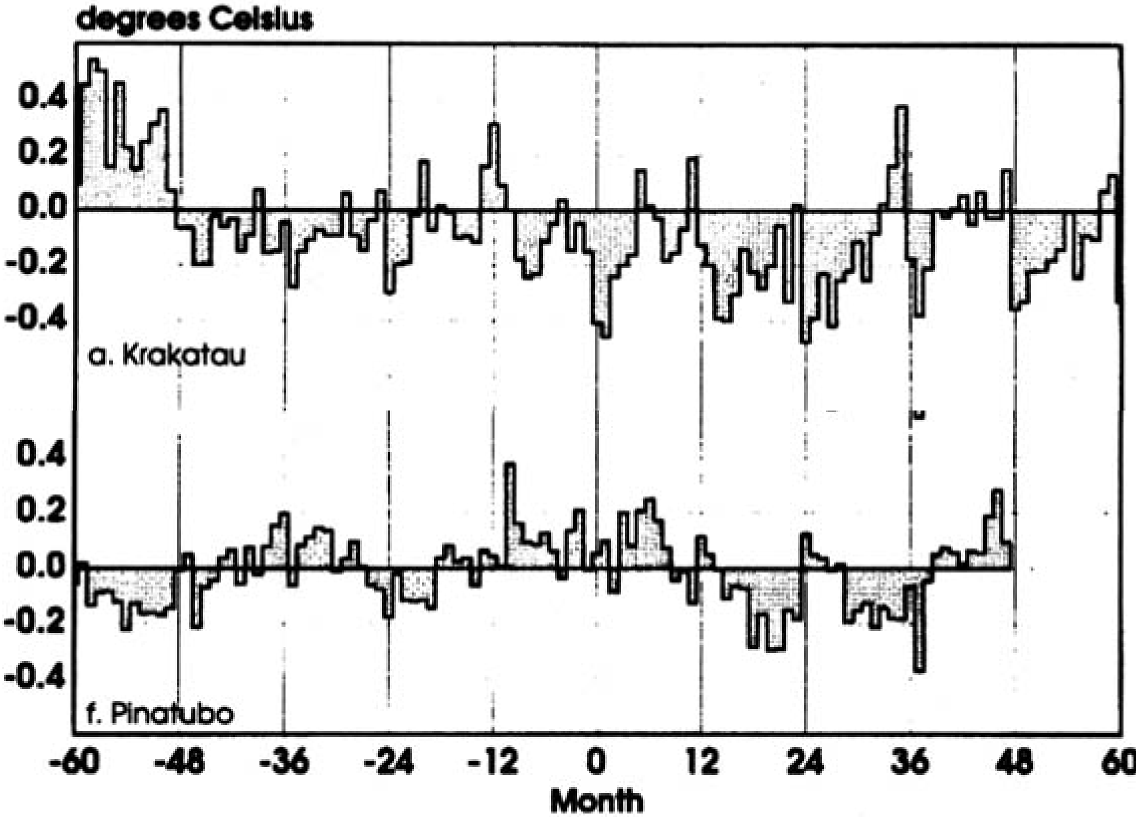
Maybe. [Ambrose 1998]

No. [Petraglia et al., 2007]

see review by Williams et al., 2012

H. floresiensis

Volcanoes impact global climate: Instrumental data

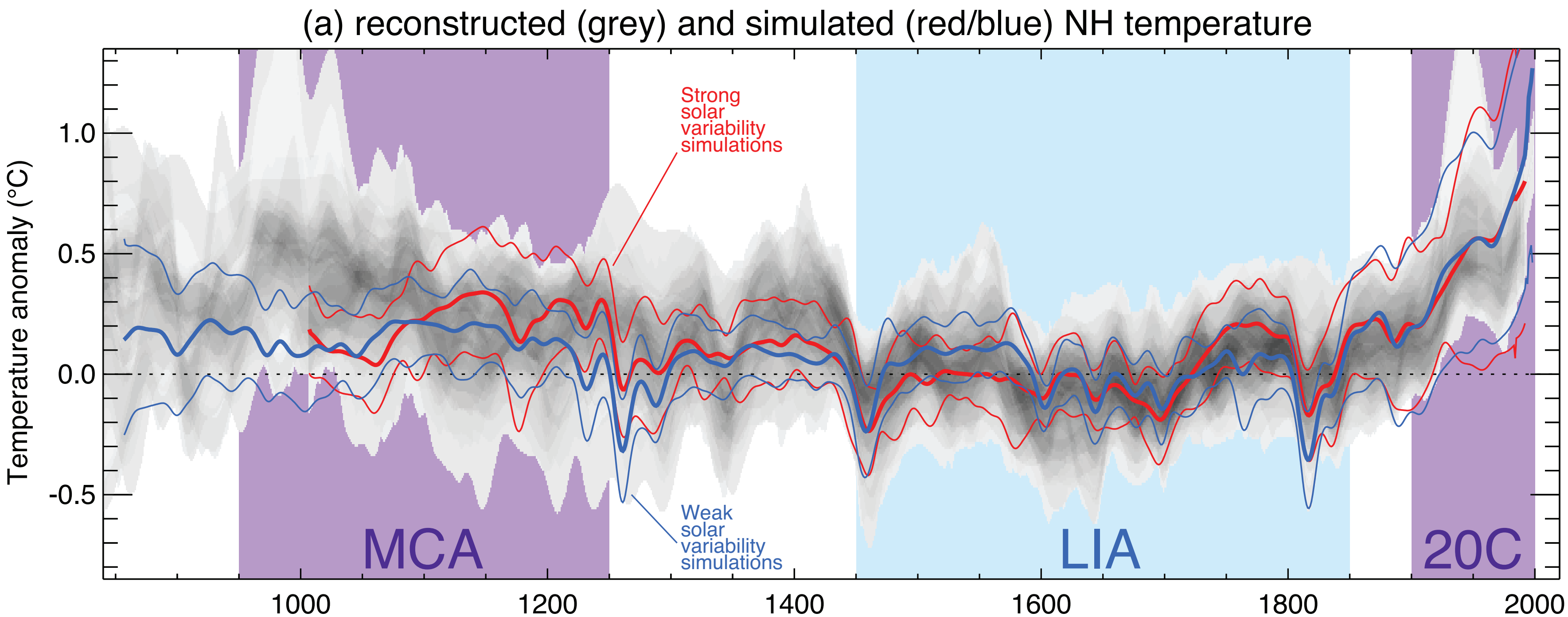


100x smaller than Toba

300x smaller than Toba

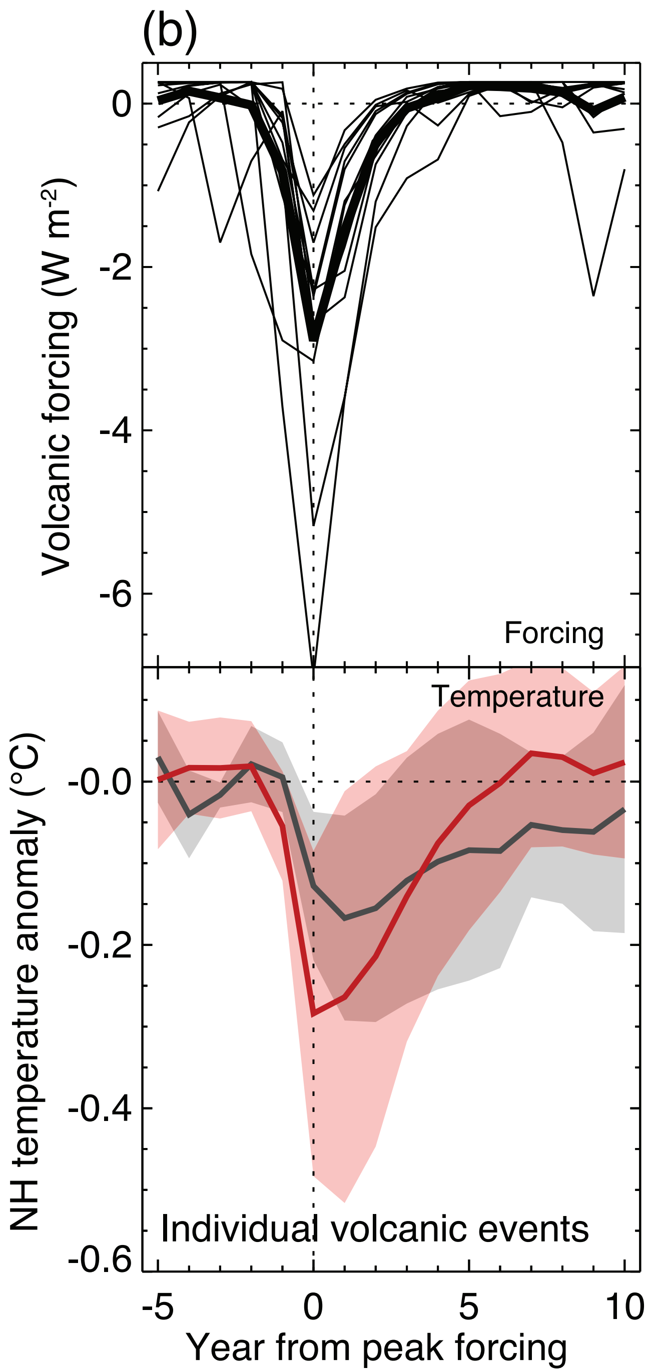
Kelly et al., 1996

Volcanoes impact global climate: Paleoclimate data



IPCC, 2013

data-model comparison provides critical constraint on **climate sensitivity**: temperature response to change in radiative forcing



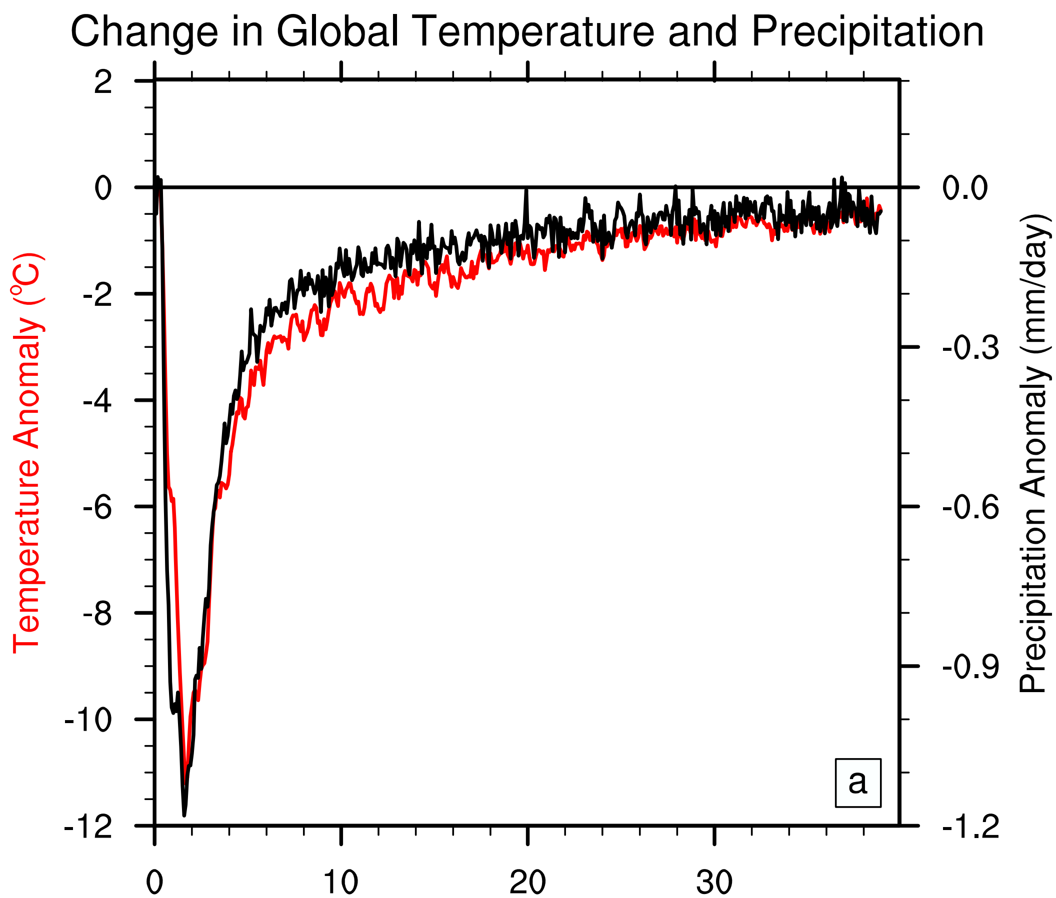
Volcanoes impact global climate, but how much?

Fact: models tend to cool more than paleoclimate data suggest

problem with model?
(Timmreck et al., 2010)

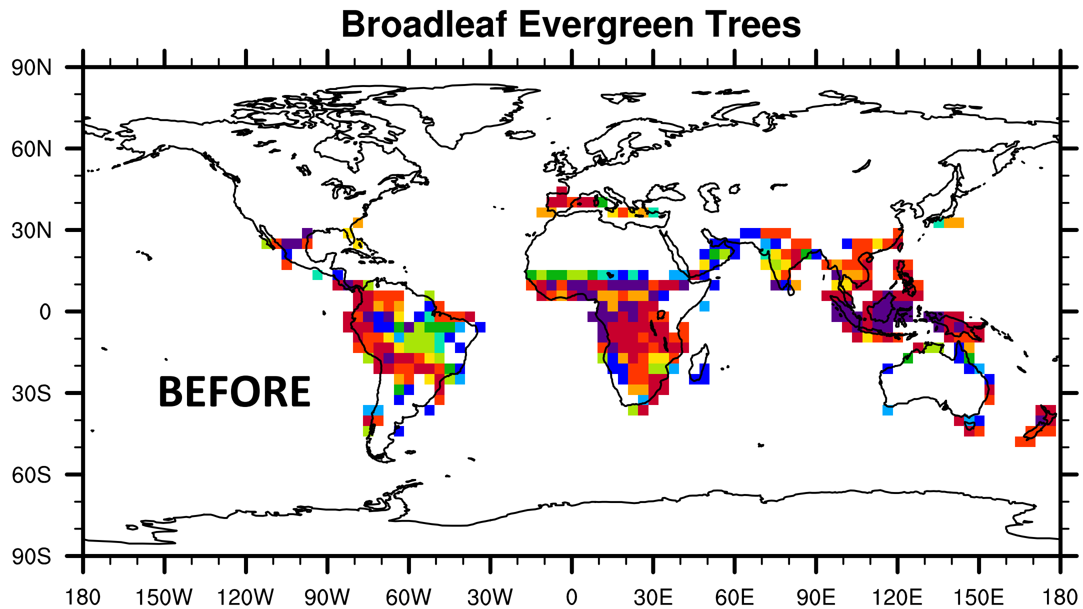
or data?
(Mann et al., 2012, 2013; Anchukaitis et al., 2012)

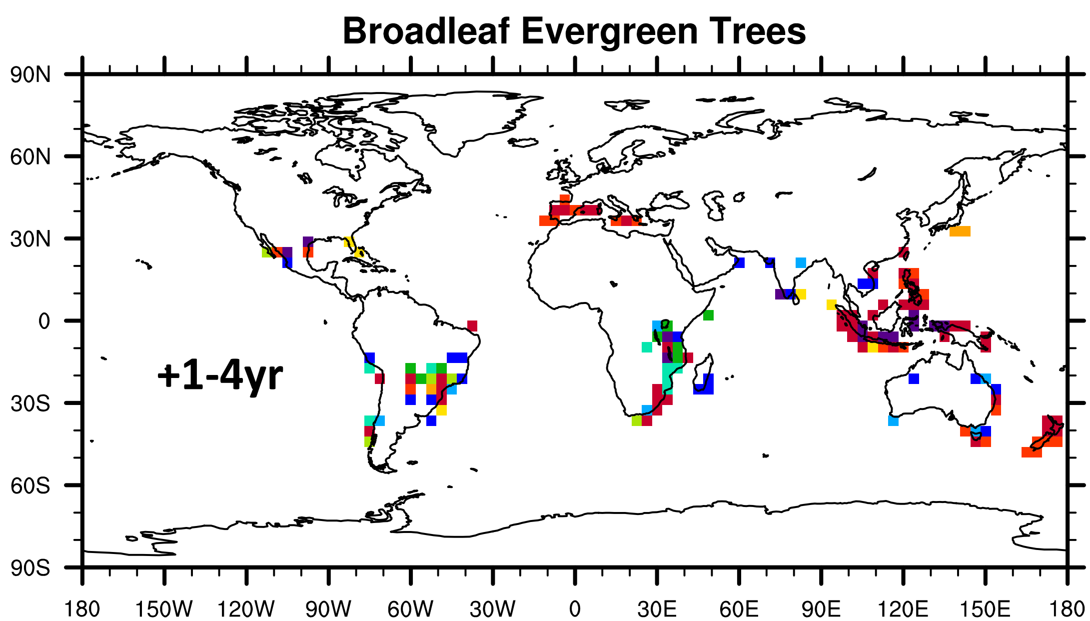
Modeling Toba's effects in CCSM3



Robock et al., 2009

dire effects in first 10yrs
dissipate in ~30yrs



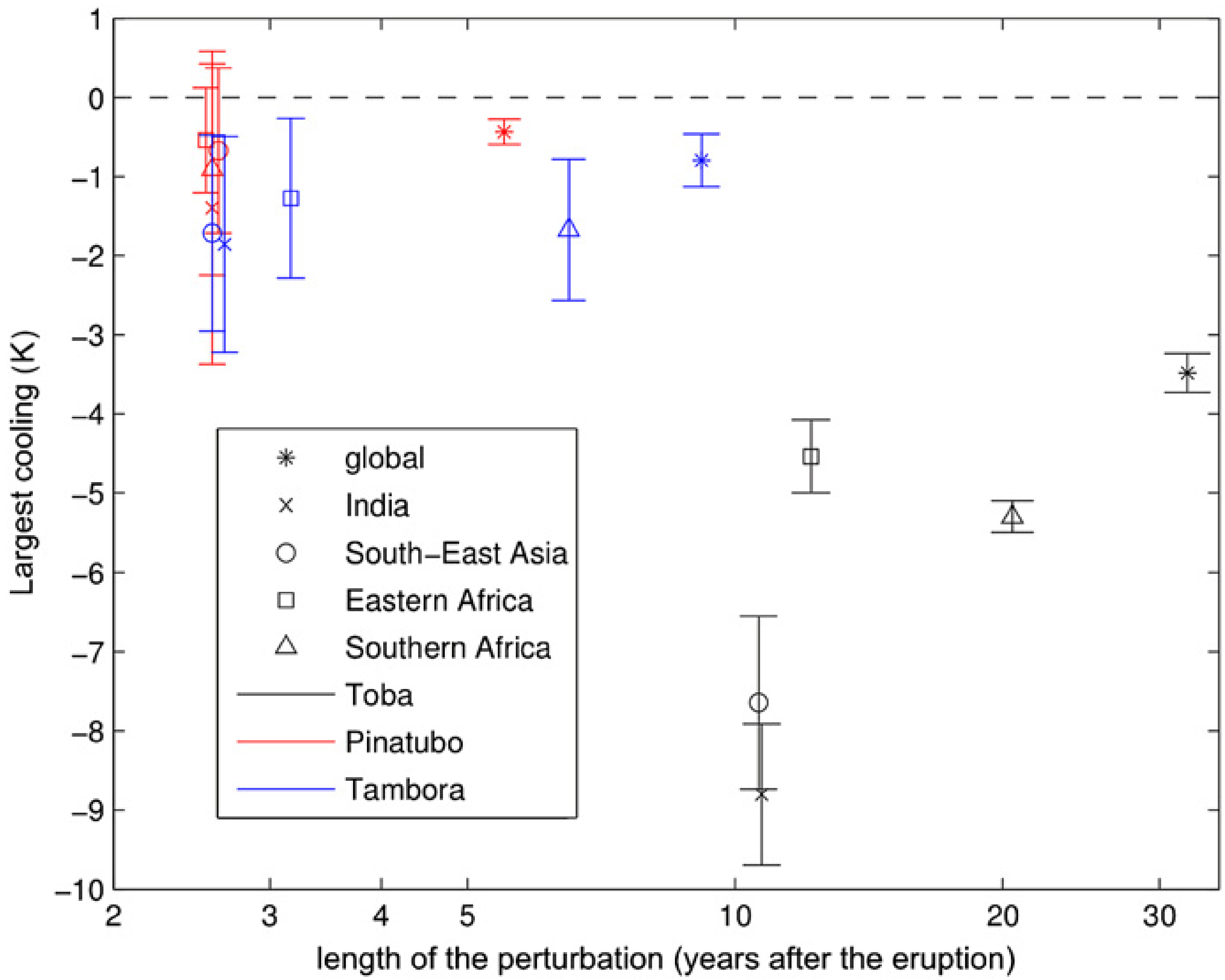


Robock et al., 2009

missing memory in snow/ice or vegetation?

need to look regionally? and at $\delta^{18}O_R$

Modeling Toba's effects in MPI-ESM

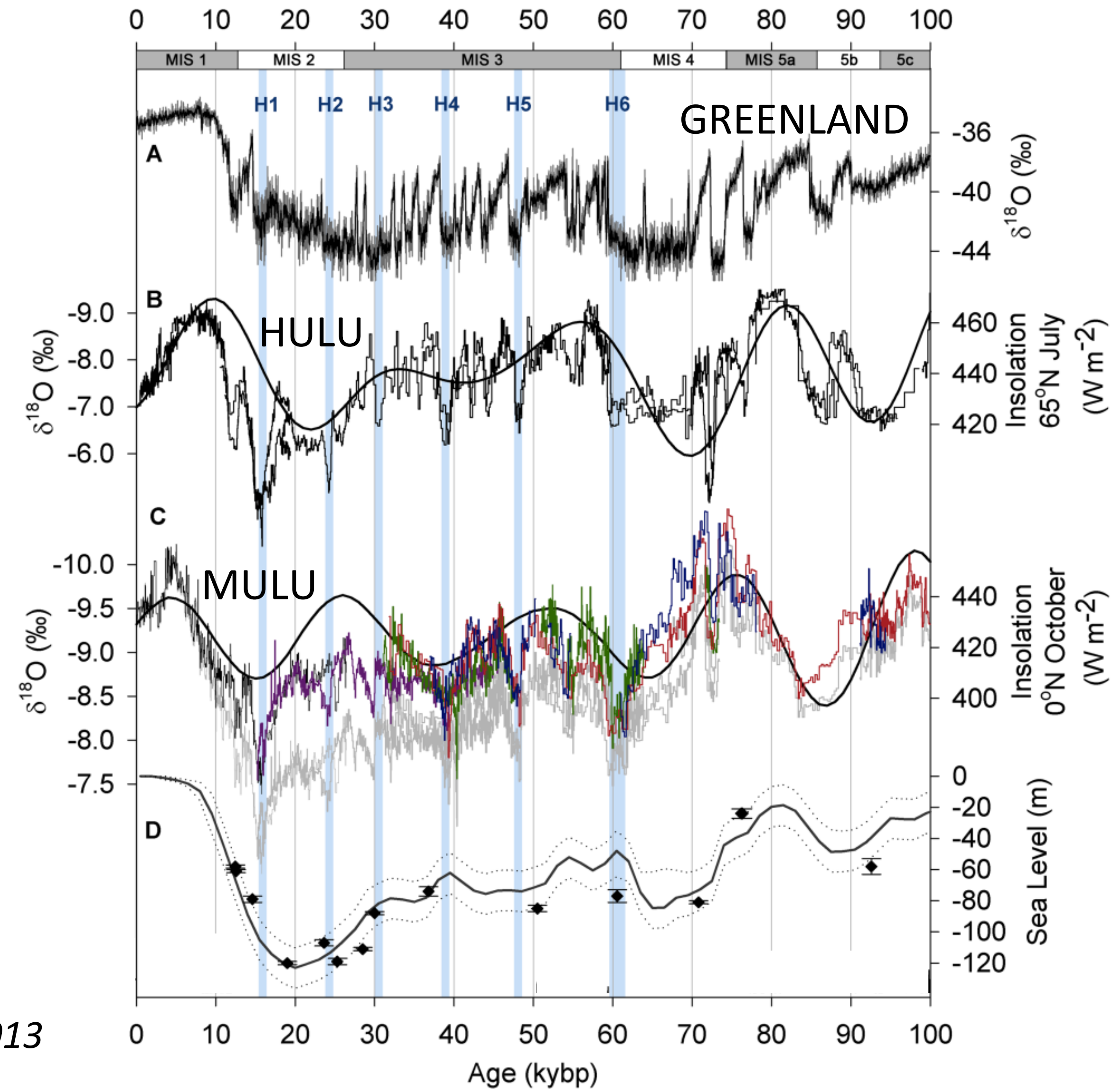


Timmreck et al., 2012

Borneo stalagmites as records of regional climate and environmental history

stalagmite oxygen isotope records reproducible

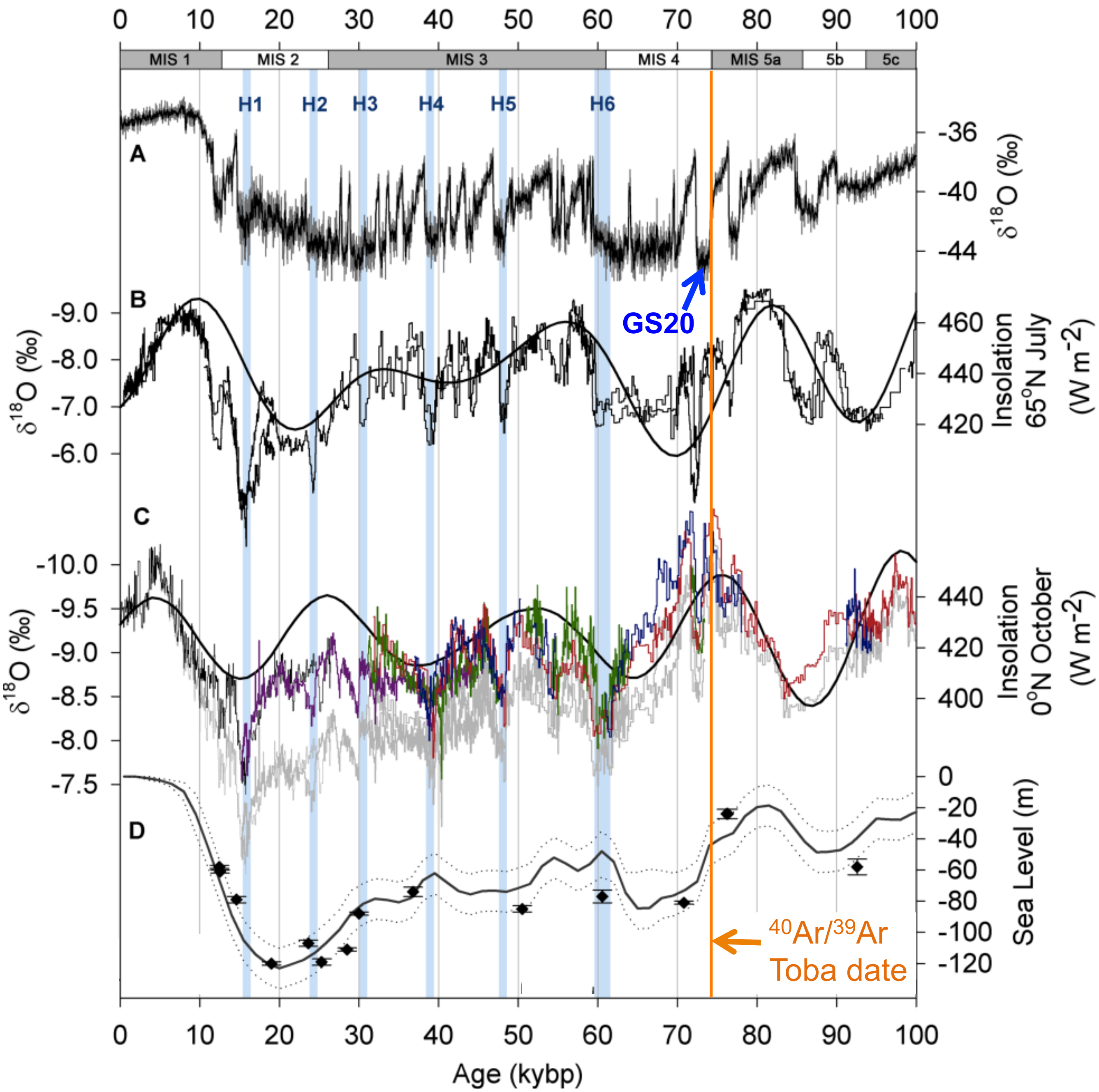
reveal large millennial-scale excursions (Heinrich events)



Carolin et al., Science 2013

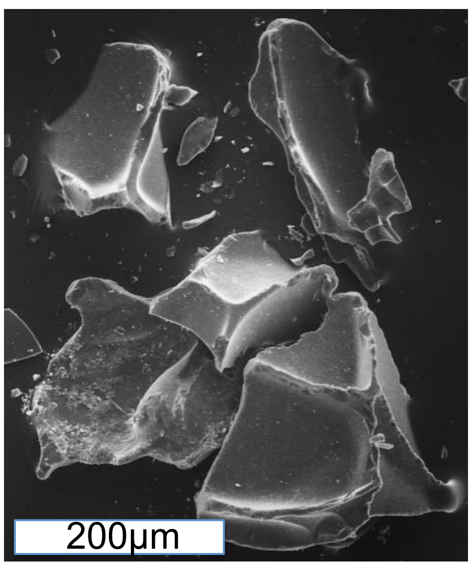
largest anomaly
associated with
Toba super-eruption

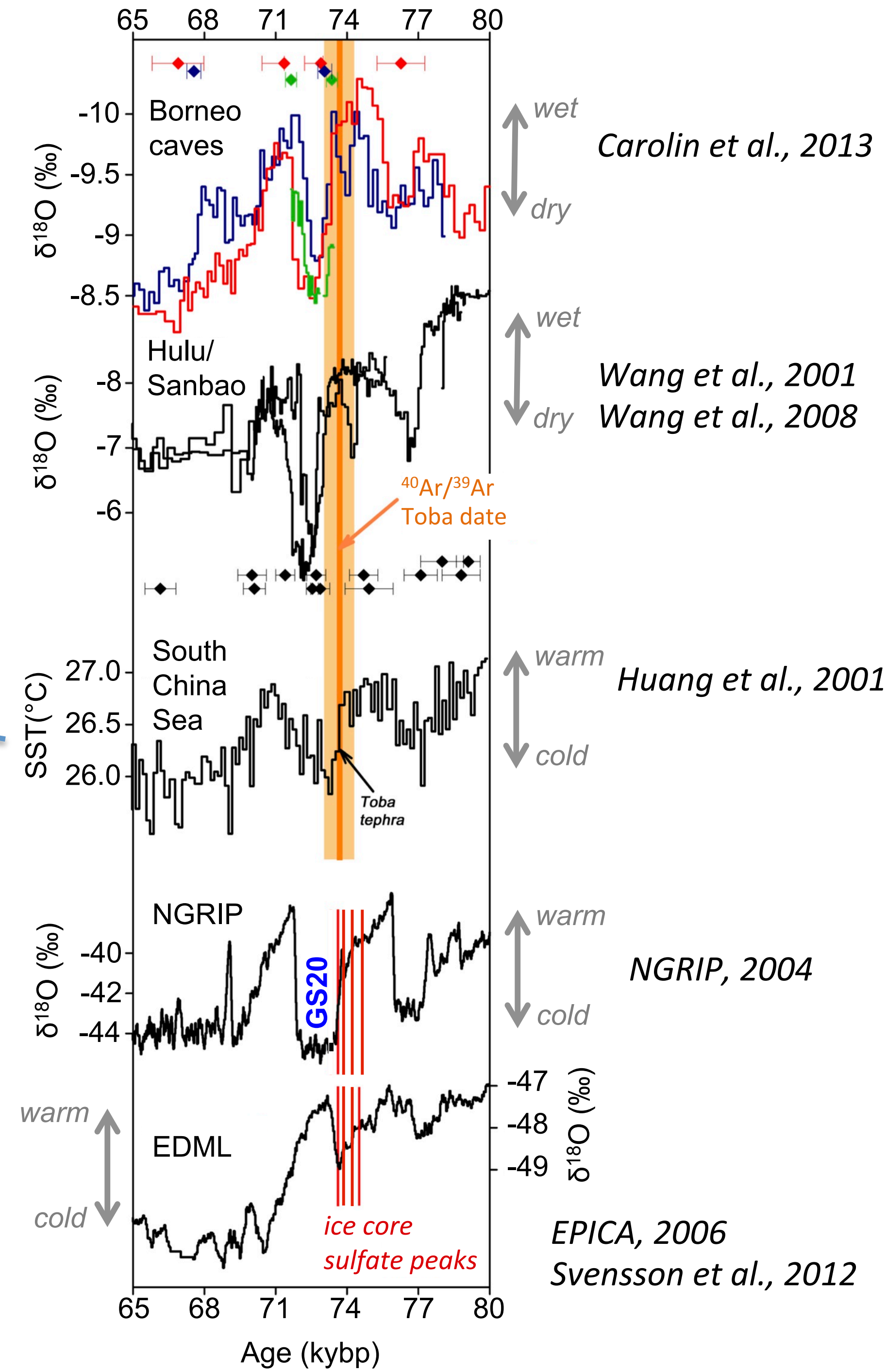
also captured as
out-sized event
in Hulu stalagmite
oxygen isotopes



A closer look

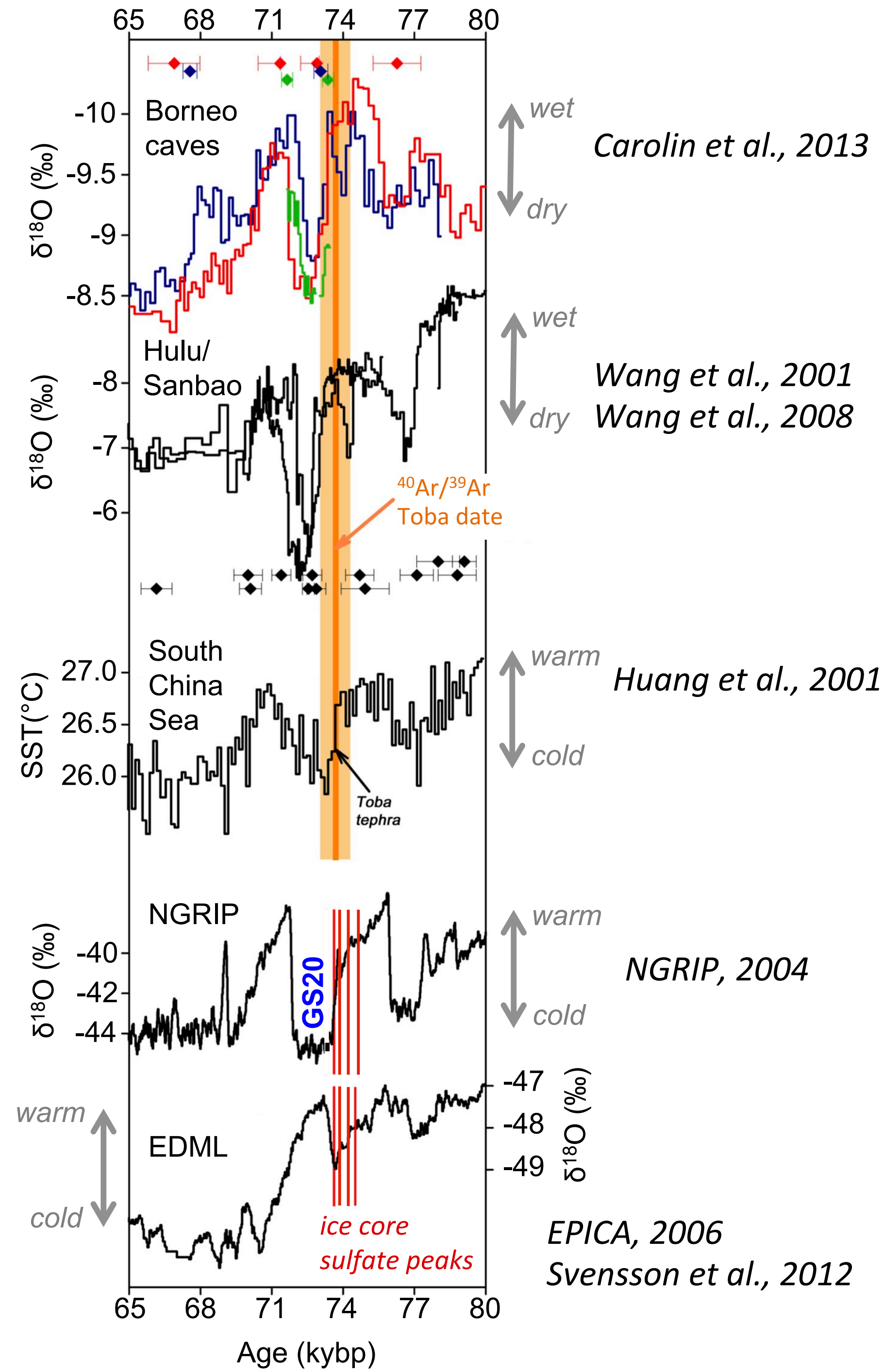
ash layer in South China Sea corresponds to initiation of cooler reconstructed SST





A closer look

multiple sulfate peaks in
Antarctic ice core tied
to sulfate peaks in Greenland
→ relationship to Toba
eruption(s)?



Research questions:

1) How many times did Toba erupt ~74,000yrs ago? And with what relative sizes?

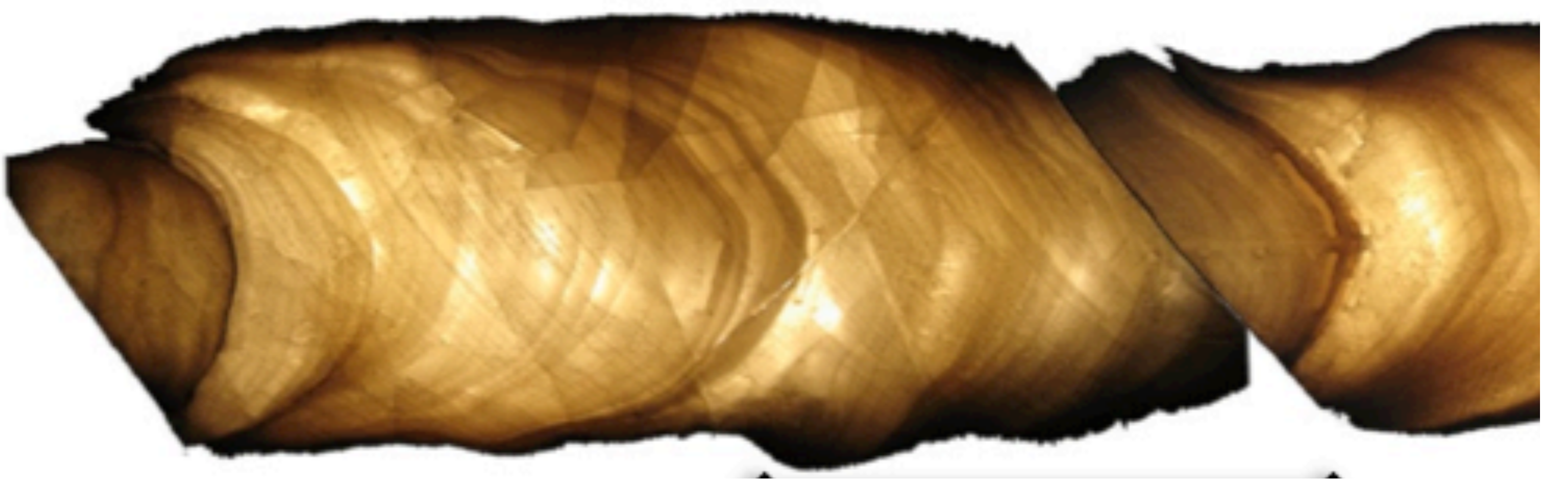
2) What were the regional climate impacts of the eruption(s)?

3) Did the Toba-related climate effects in Borneo occur before, during, or after the initiation of pronounced regional drying?

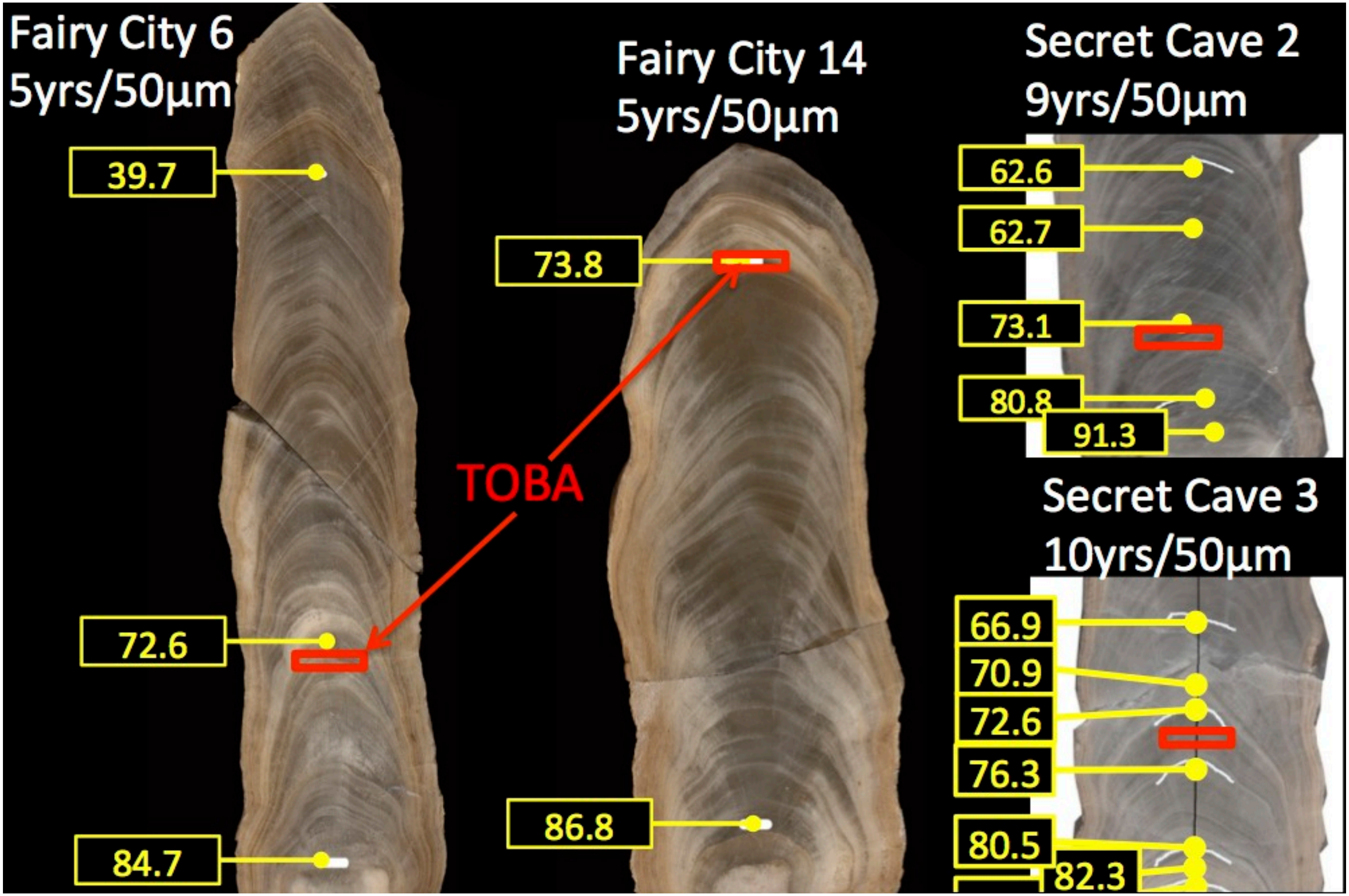
Approach:

Find the volcanic markers in the Borneo stalagmites.

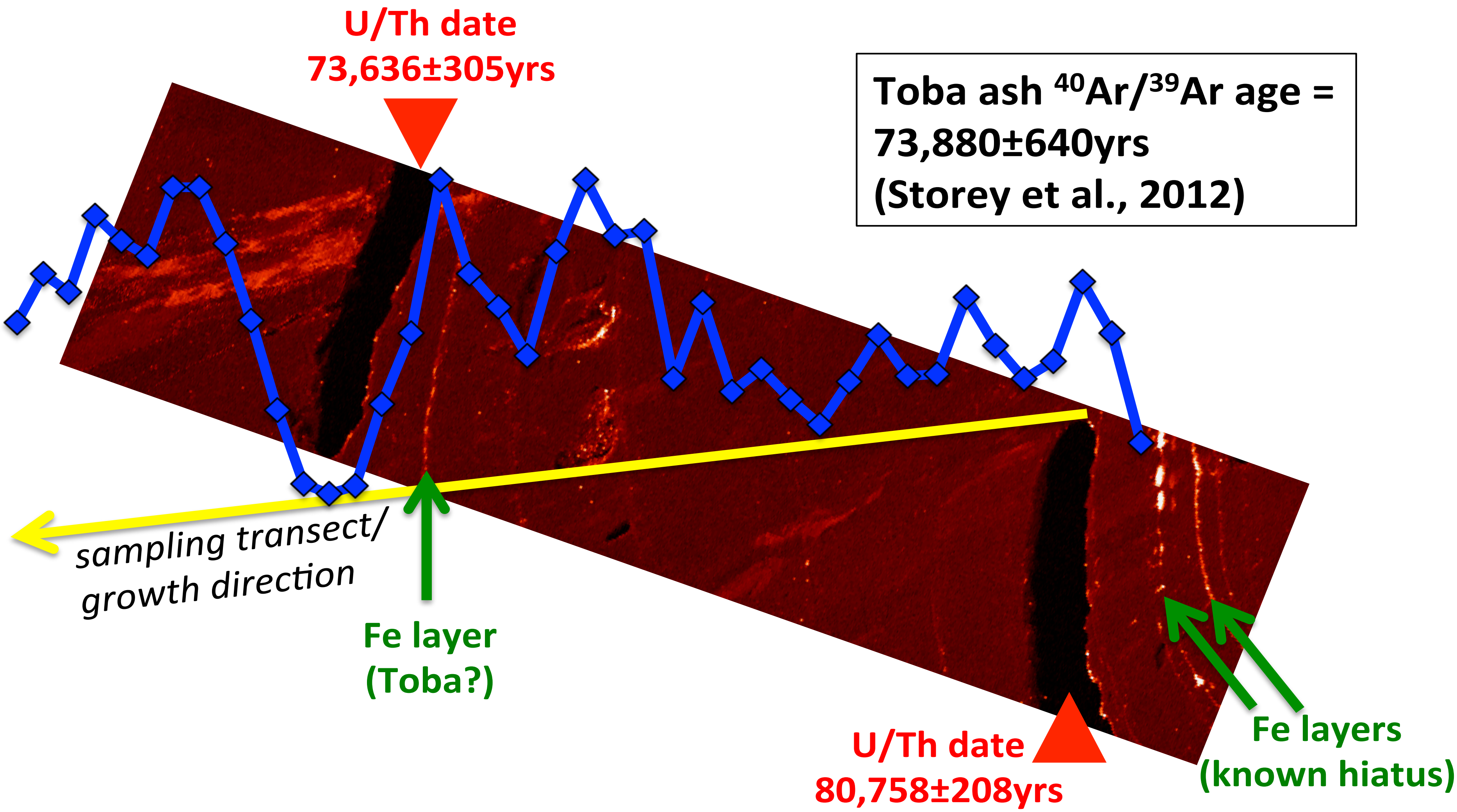
Compare to oxygen isotope-based climate record in same stalagmites.



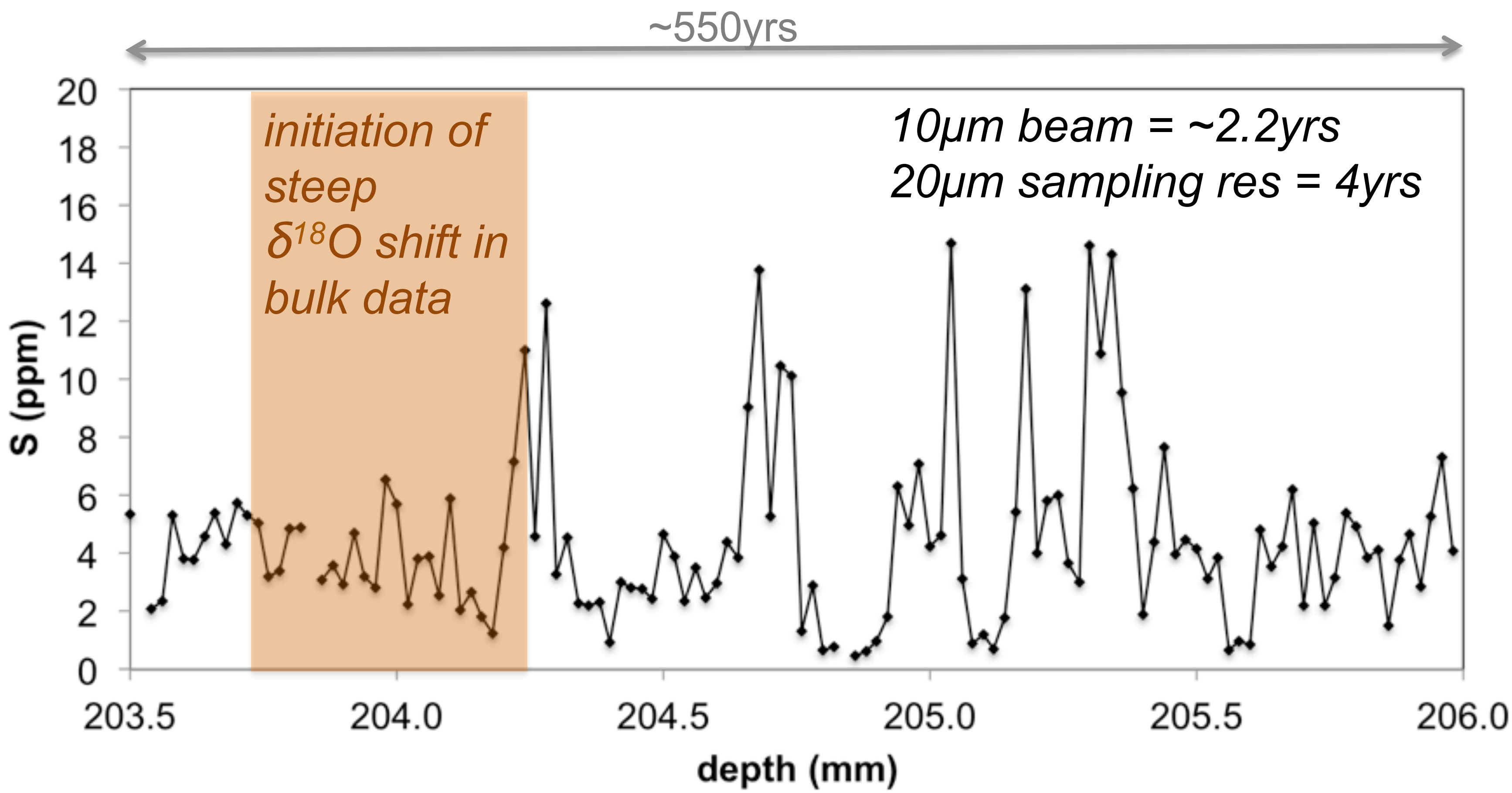
Available stalagmites



Preliminary synchrotron Fe data



Preliminary SIMS Sulfur profile

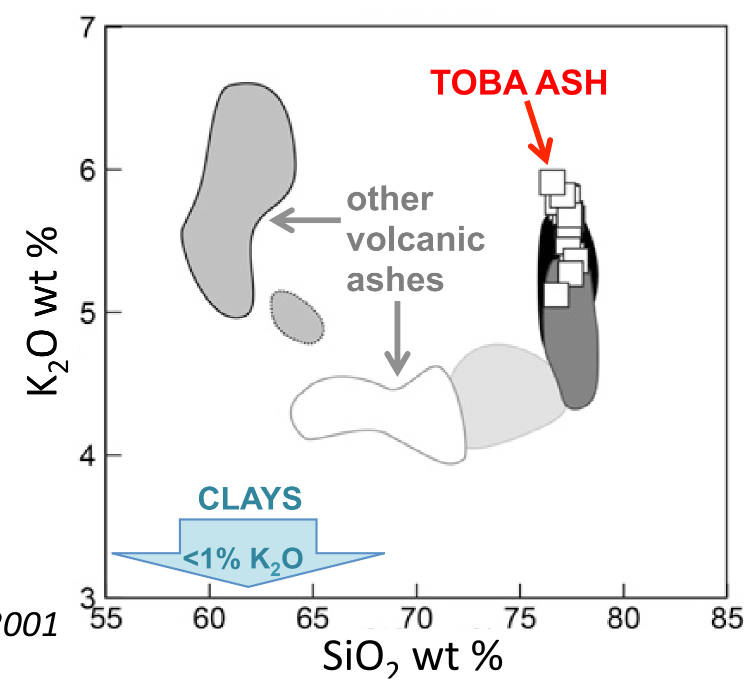


data from Stacy Carolin

Next steps:

Geochemically fingerprint
i) Toba ash
ii) Mulu clays

Compare to synchrotron/SIMS scans across Toba horizon (Fe, Si, S, Br, K, Al)
*see review by Frisia et al., 2012



Lane et al., 2013
Mermut and Cano, 2001