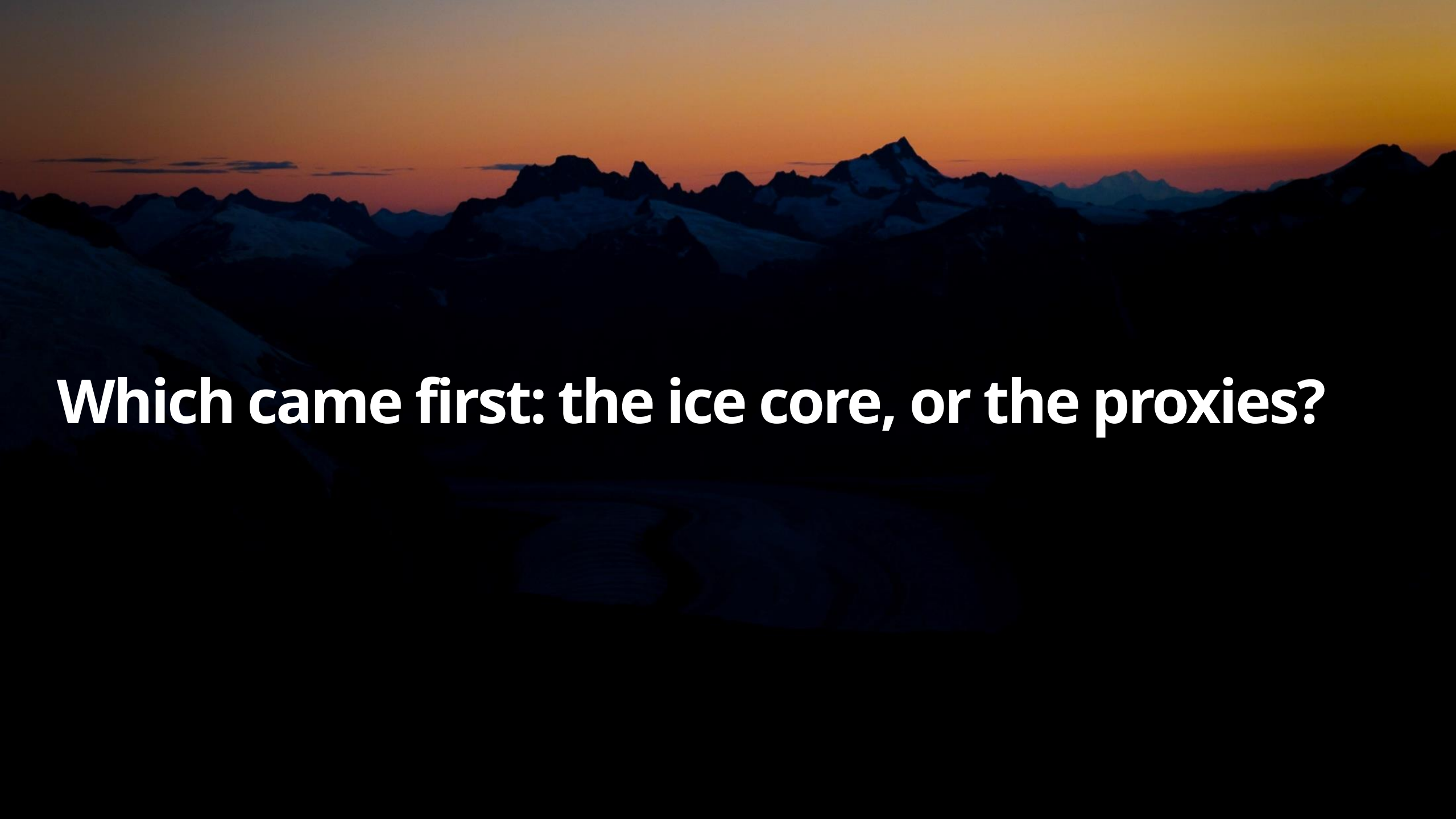

Which came first: the ice core, or the proxies?

The (main) proxy.

Stable isotopes in precipitation

By W. DANSGAARD, *Phys. Lab. II, H. C. Ørsted Institute, University of Copenhagen*

(Manuscript received April 28, 1964)

ABSTRACT

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$$\delta^{18}\mathrm{O} = \left(\frac{\left(\frac{^{18}\mathrm{O}}{^{16}\mathrm{O}}\right)_{sample}}{\left(\frac{^{18}\mathrm{O}}{^{16}\mathrm{O}}\right)_{standard}} - 1 \right) * 1000$$

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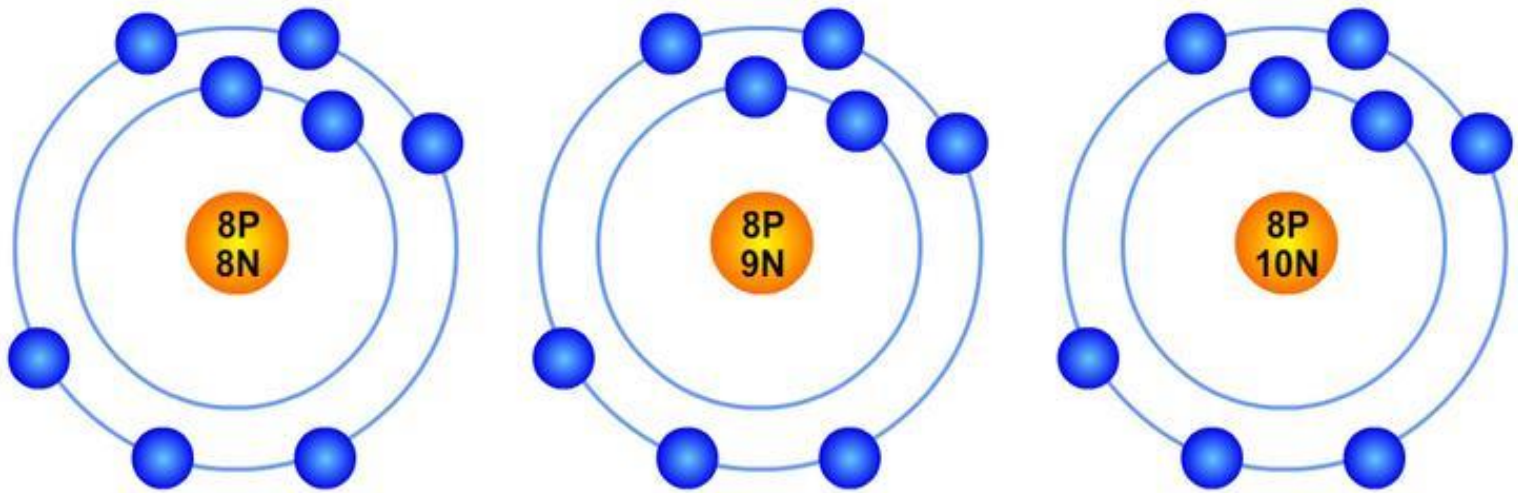
Oxygen Isotopes



^{16}O Isotope ^{17}O Isotope ^{18}O Isotope

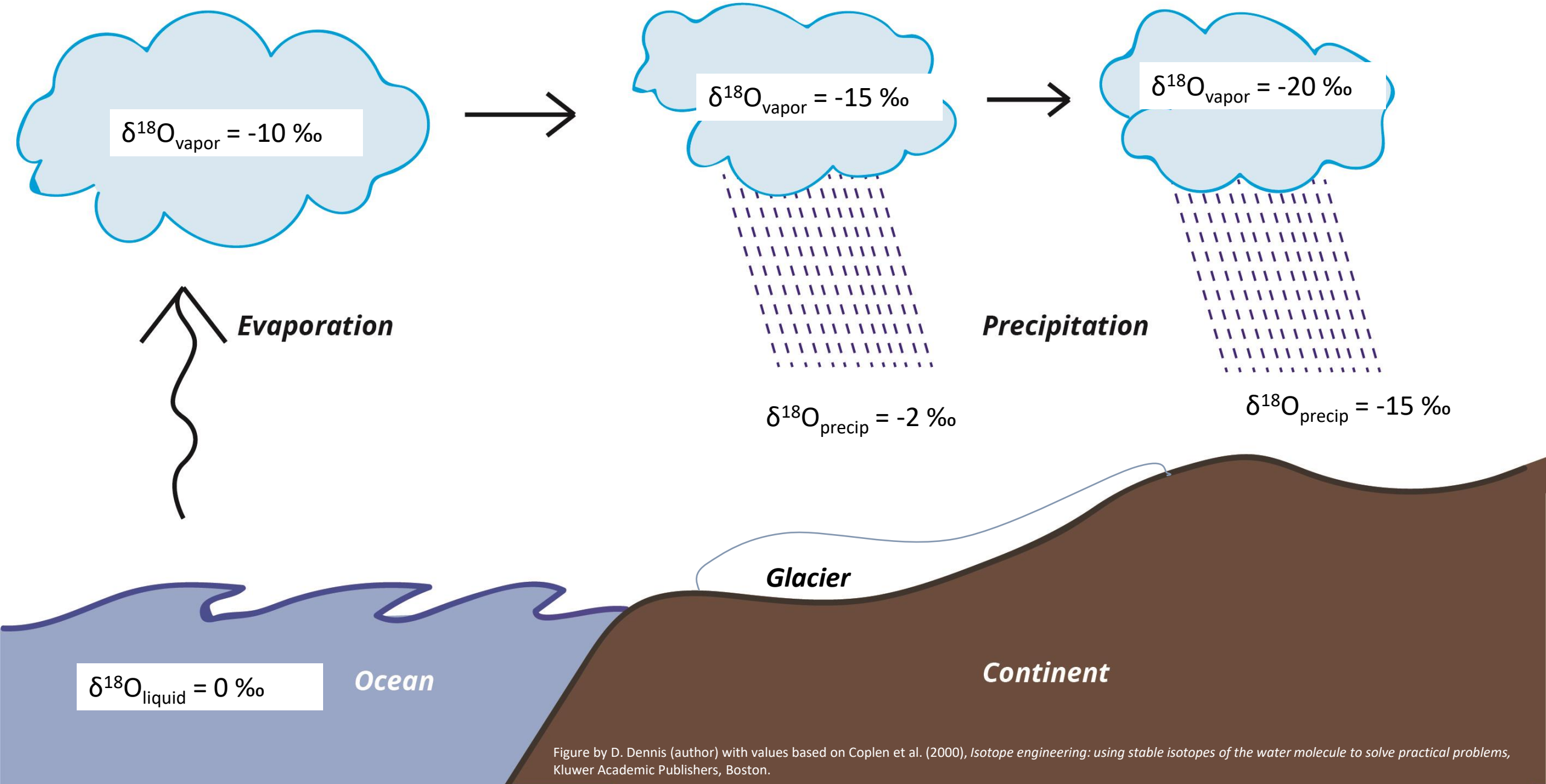


Figure by D. Dennis (author) with values based on Coplen et al. (2000), *Isotope engineering: using stable isotopes of the water molecule to solve practical problems,* Kluwer Academic Publishers, Boston.

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A measure of the relative abundance of both—and it changes based on certain climatological parameters, primarily humidity.

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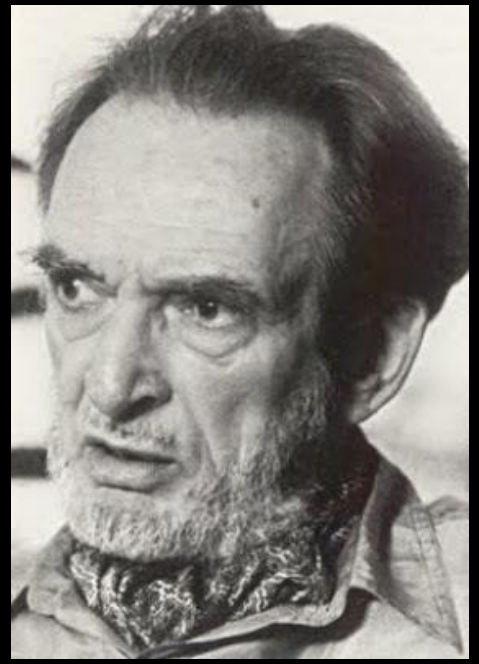
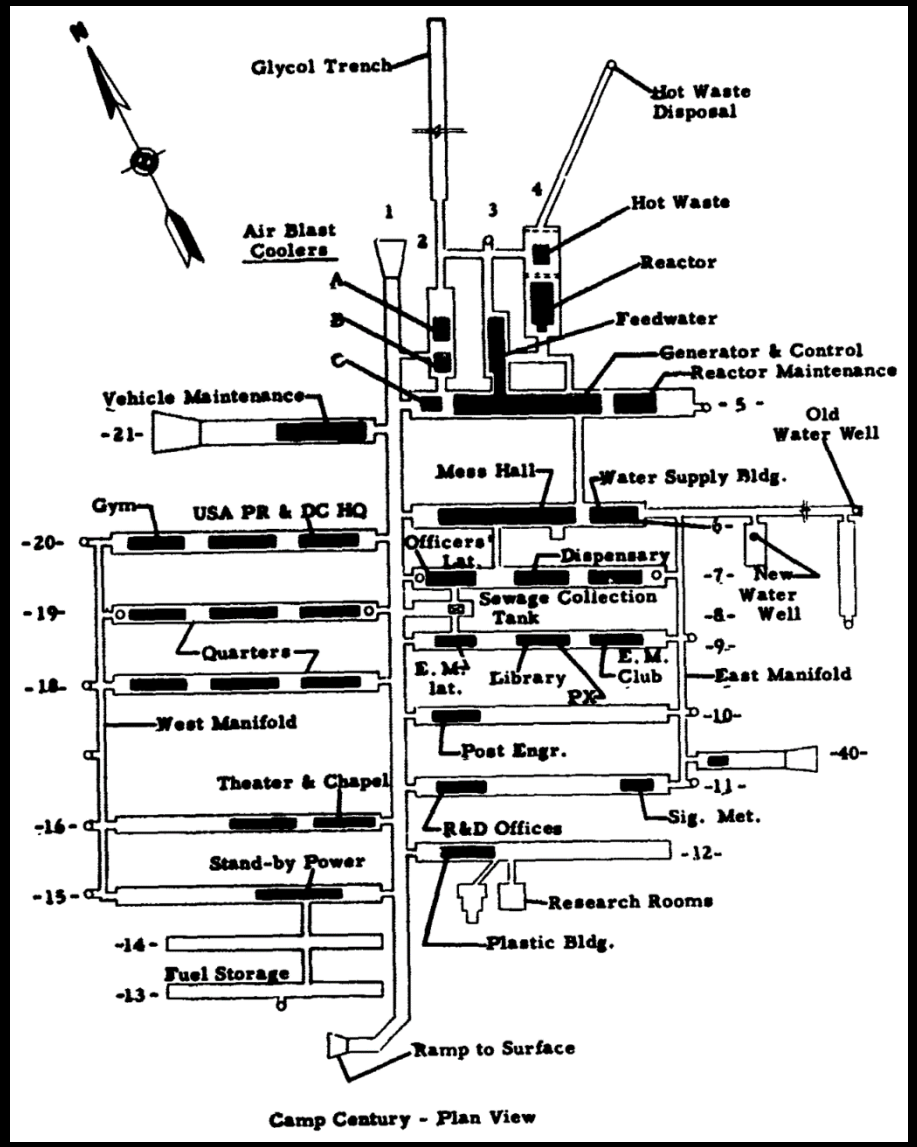
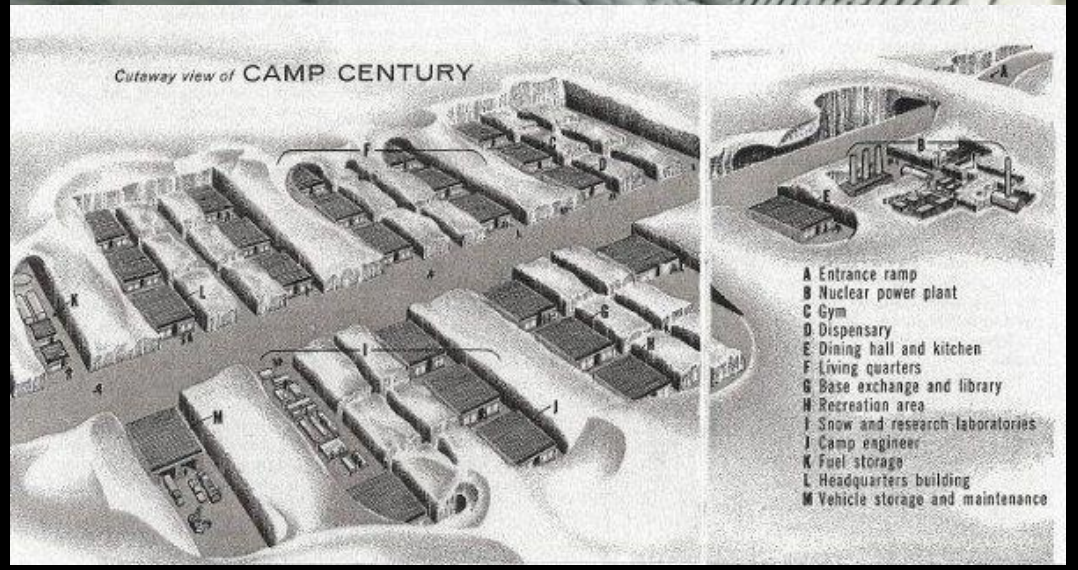
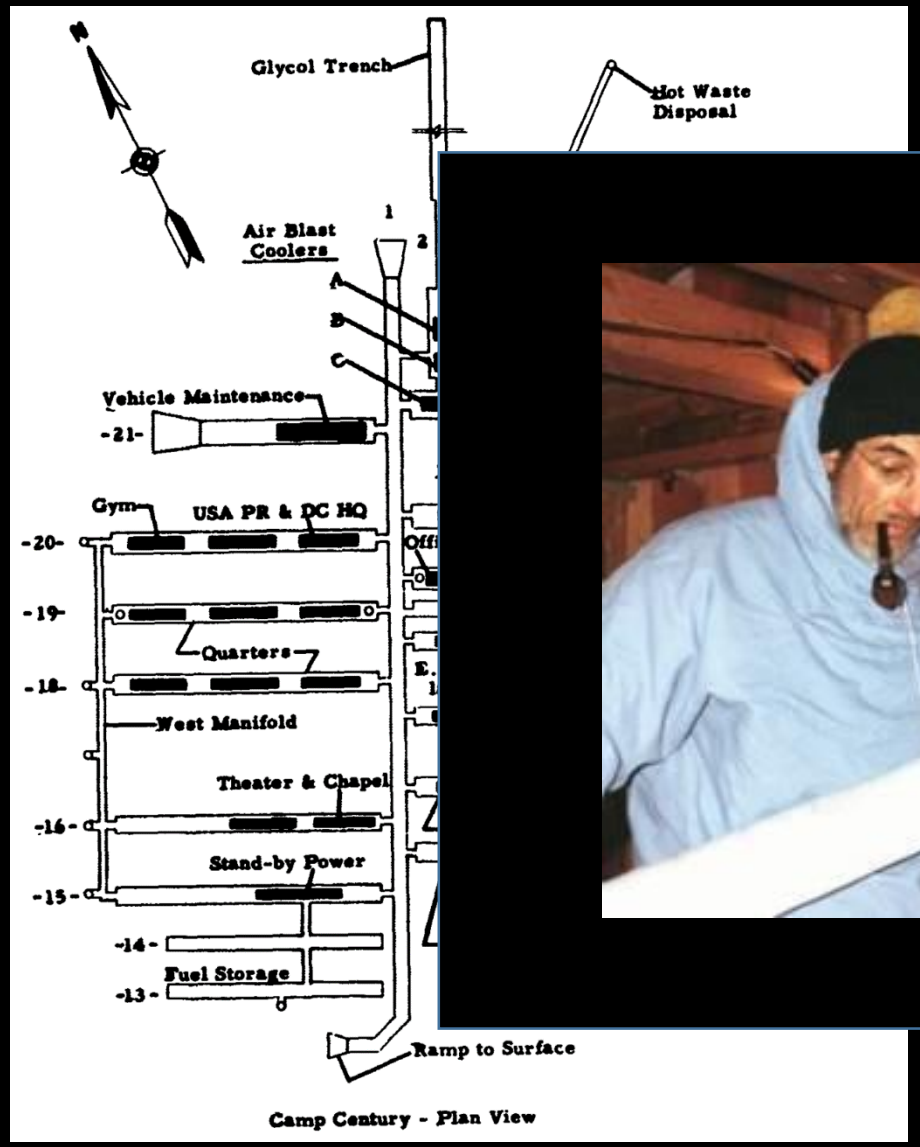




Camp Century - Plan View





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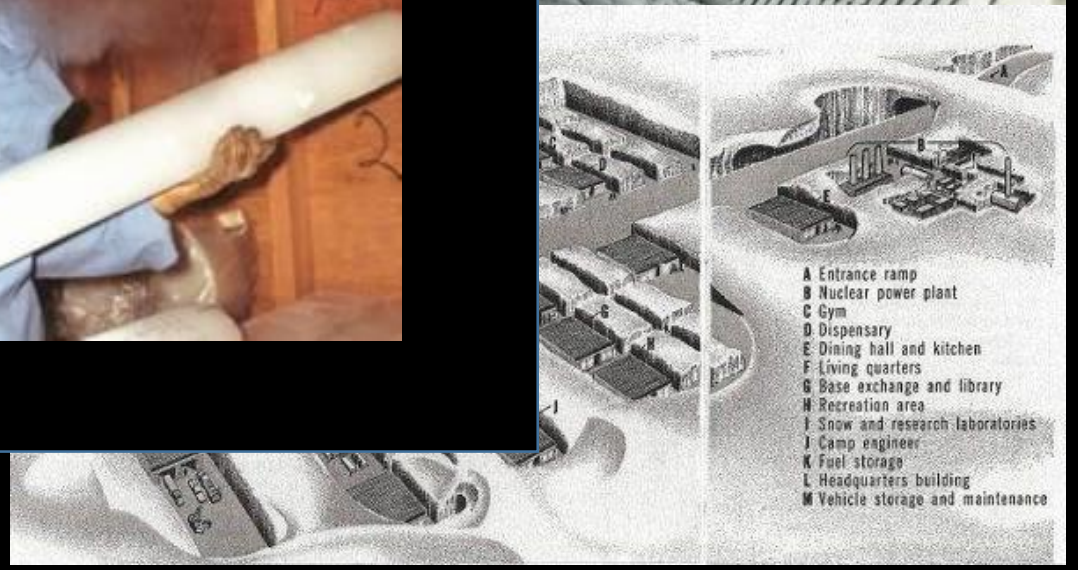
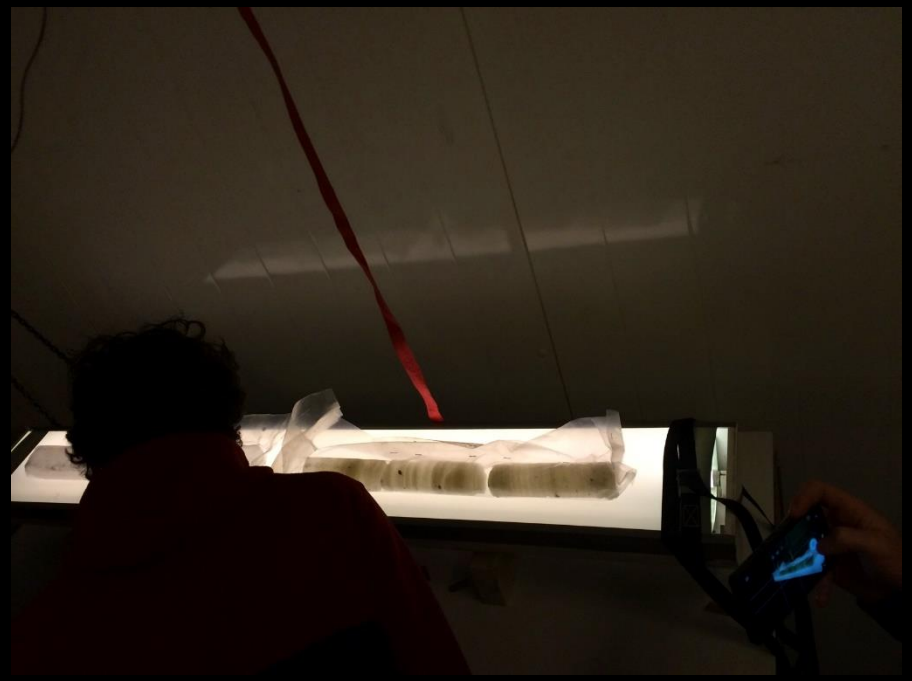
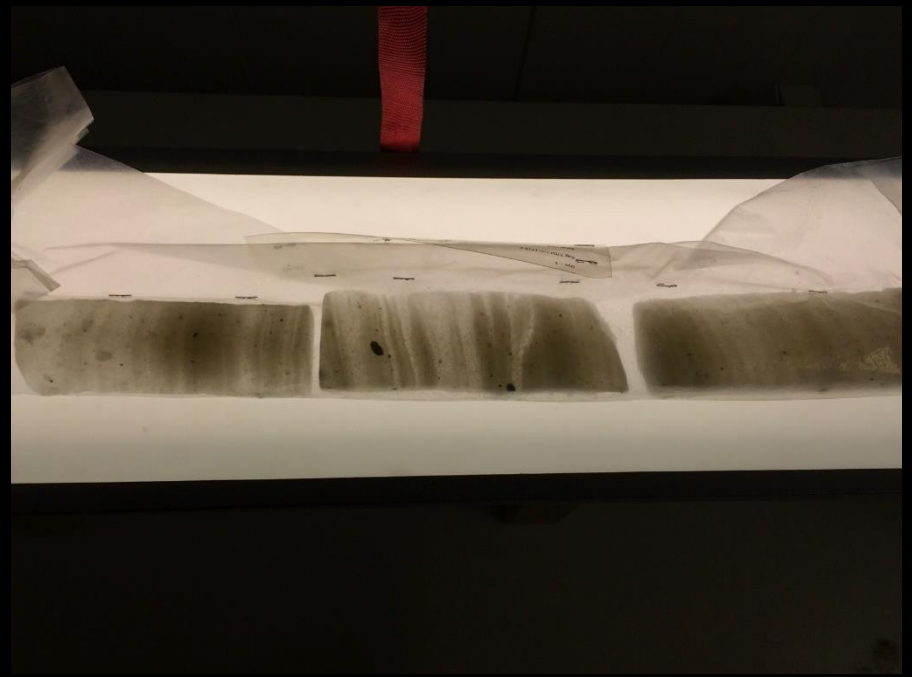


Ice core code words:

Jargon	Meaning
“a dry drill hole”	We didn’t pour toxic or disgusting chemicals (including jet fuel) down the hole while drilling thereby introducing possible contaminants to the record.
“hiatus features”	Years without ~~a Santa Claus~~ accumulation. (Gaps in the record).
“frozen to bed”	The glacier is frozen year-round and the isotope record is not altered by meltwater.
“layer thinning”	Compression-induced thinning of the annual layers that could be interpreted as reduced accumulation.
“meters water equivalent (w.e.)”	Standardization mechanism for accumulation that accounts for the density of the snow.





What is the sample resolution?

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A: 2.42 cm resolution for water isotopes; 2.61 cm resolution for dust.

This is reasonably-good resolution for a discretely-sampled core.

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What are the proxies?

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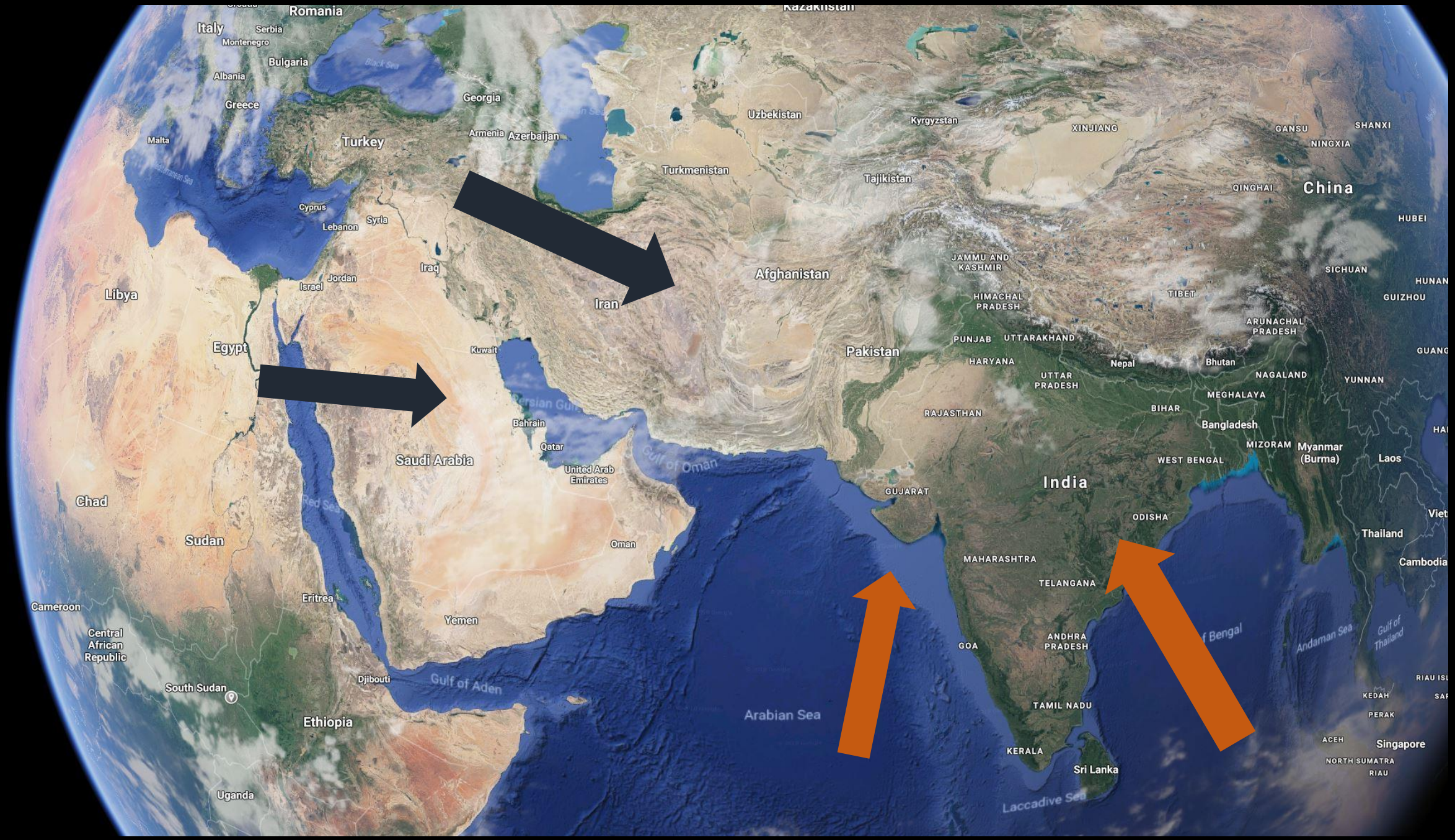
What are the proxies? What is *d* approximating?

A:

Compound/Material	Proxy for […]
$\delta^{18}O$	Temperature
D-excess (*d*)	Moisture source and monsoon presence/absence(?); amount of precipitation
dust aerosols	Drought (?)
additional aerosols (NO_3, Cl, Pb, etc.)	Moisture source (oceanic or not), anthropogenic emissions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TIBET
SICHUAN
HUNAN
GUIZHOU
ARUNACHAL PRADESH
PUNJAB
UTTARAKHAND
HARYANA
Pakistan
Nepal
Bhutan
UTTAR PRADESH
NAGALAND
YUNNAN
MEGHALAYA
RAJASTHAN
BIHAR
Bangladesh
MIZORAM
Myanmar (Burma)
Laos
WEST BENGAL
India
GUJARAT
ODISHA
Thailand
Cambodia
Bahrain
Qatar
United Arab Emirates
Saudi Arabia
Gulf of Oman
Red Sea
Oman
MAHARASHTRA
TELANGANA
ANDHRA PRADESH
GOA
Chad
Sudan
Eritrea
Yemen
Cameroon
Central African Republic
South Sudan
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Interpret the record at 1790 absent the written record.

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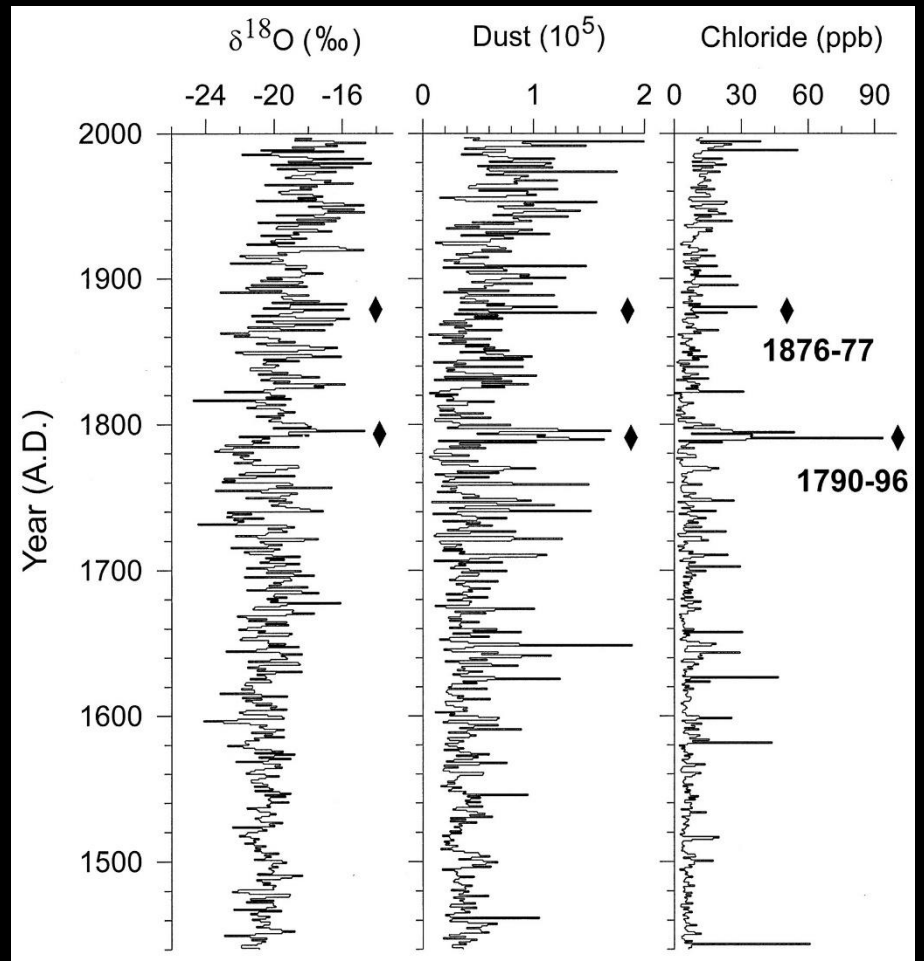

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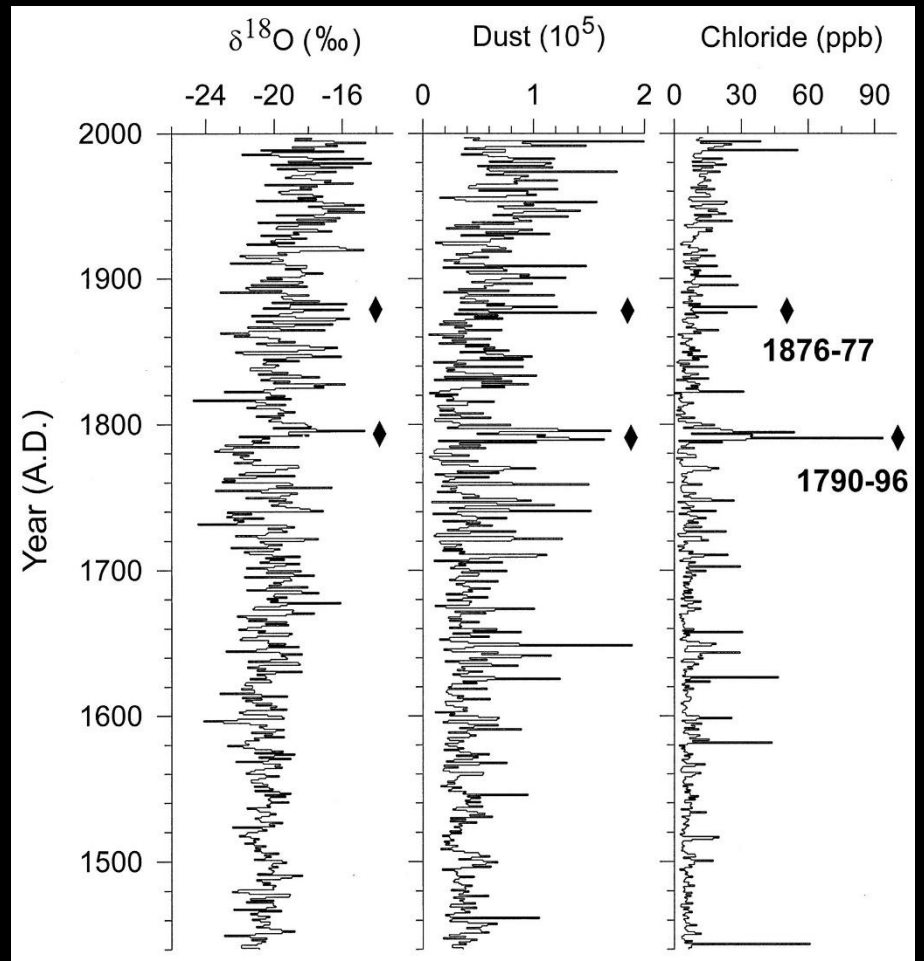

My thoughts:

The amount of dust in 1790 is at about the modern levels. As we are not presently in a drought, this could be a difficult interpretation without an understanding of the evolution of background aerosol concentrations. It's also notable that we don't see a decrease in d-excess or accumulation that year. So perhaps the monsoon was reduced, but what if there was some other climatological phenomenon that year that increased dustiness. It's important to think about all the factors affecting a proxy.

What is the link between *d*, accumulation, and the monsoon strength?

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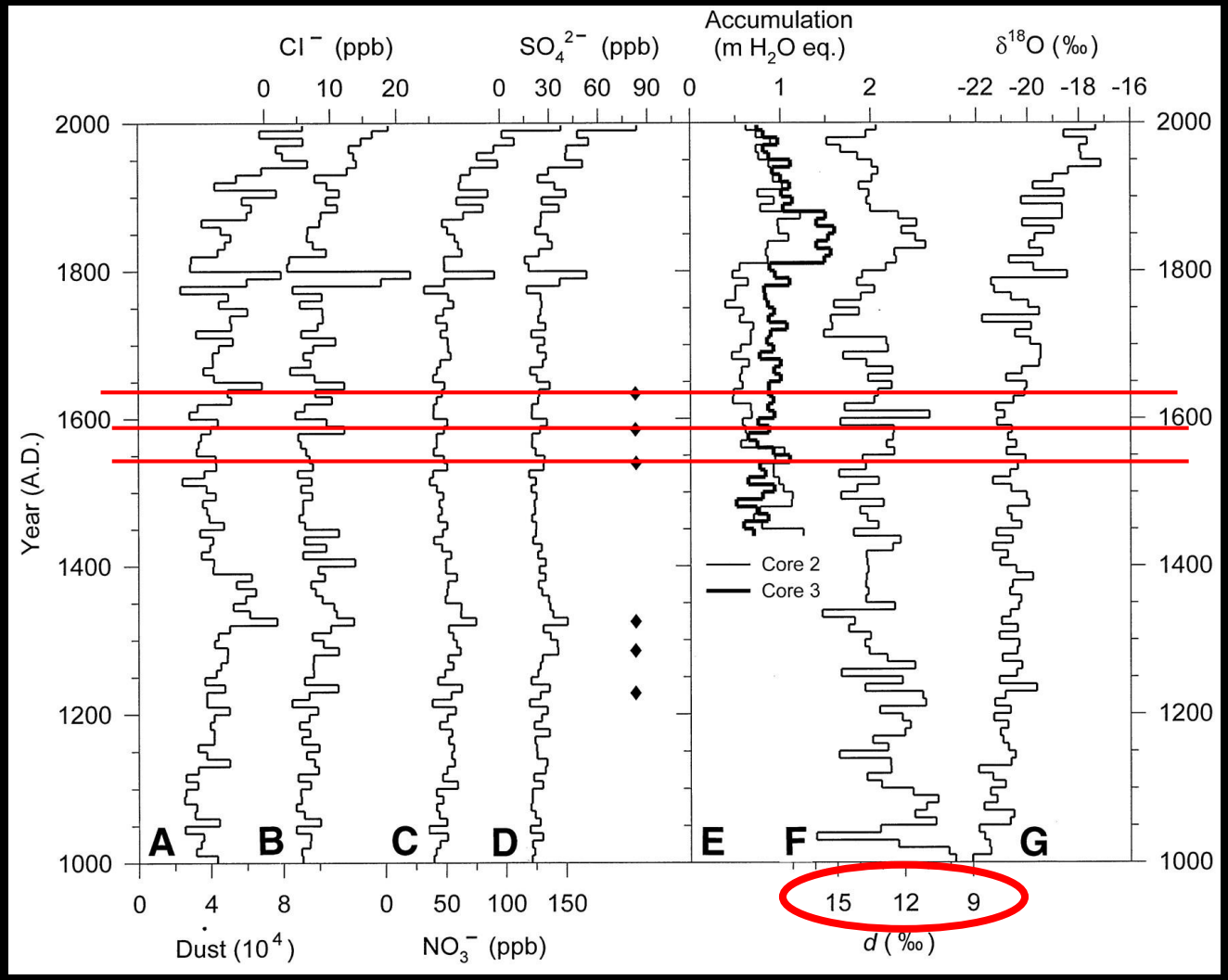
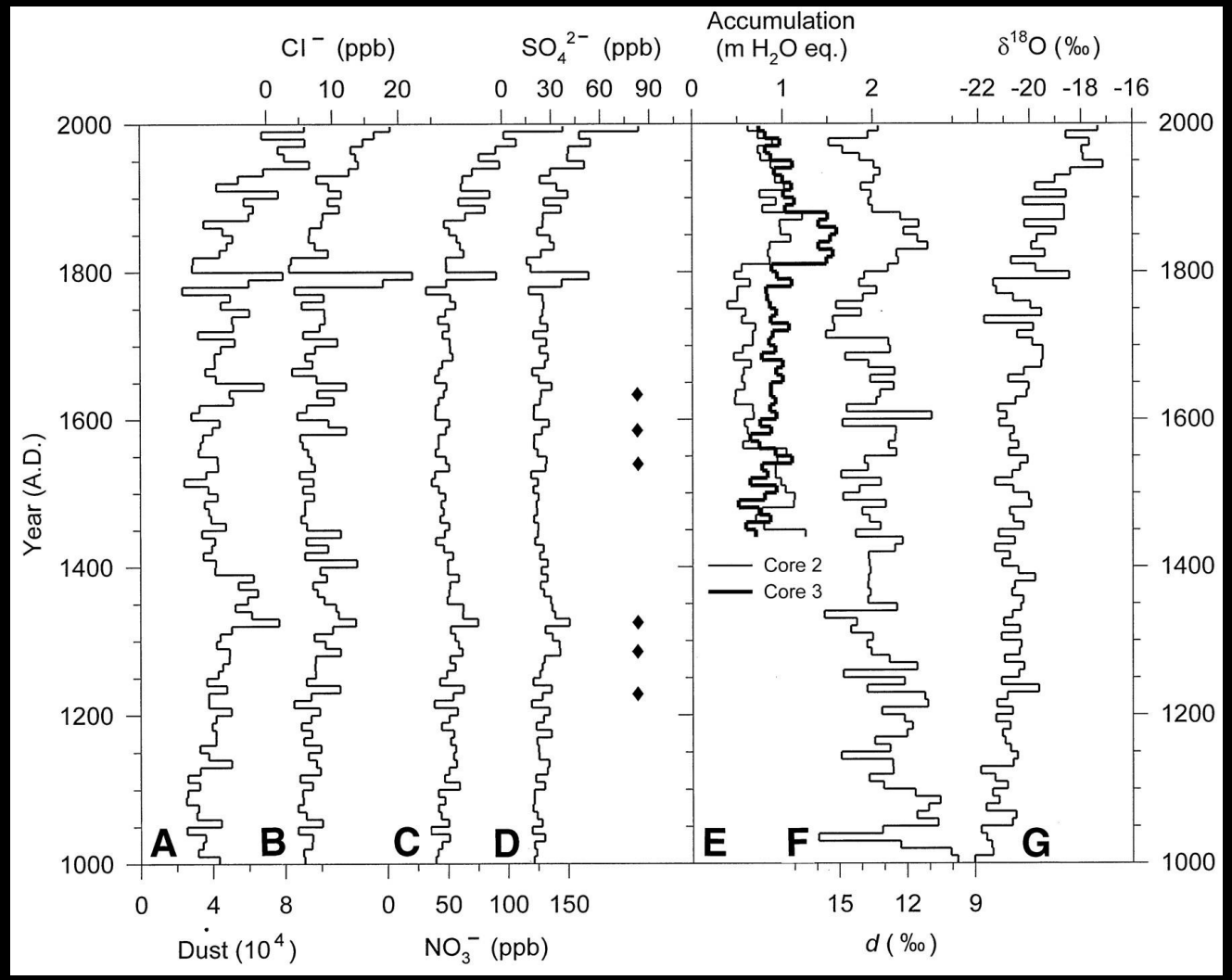
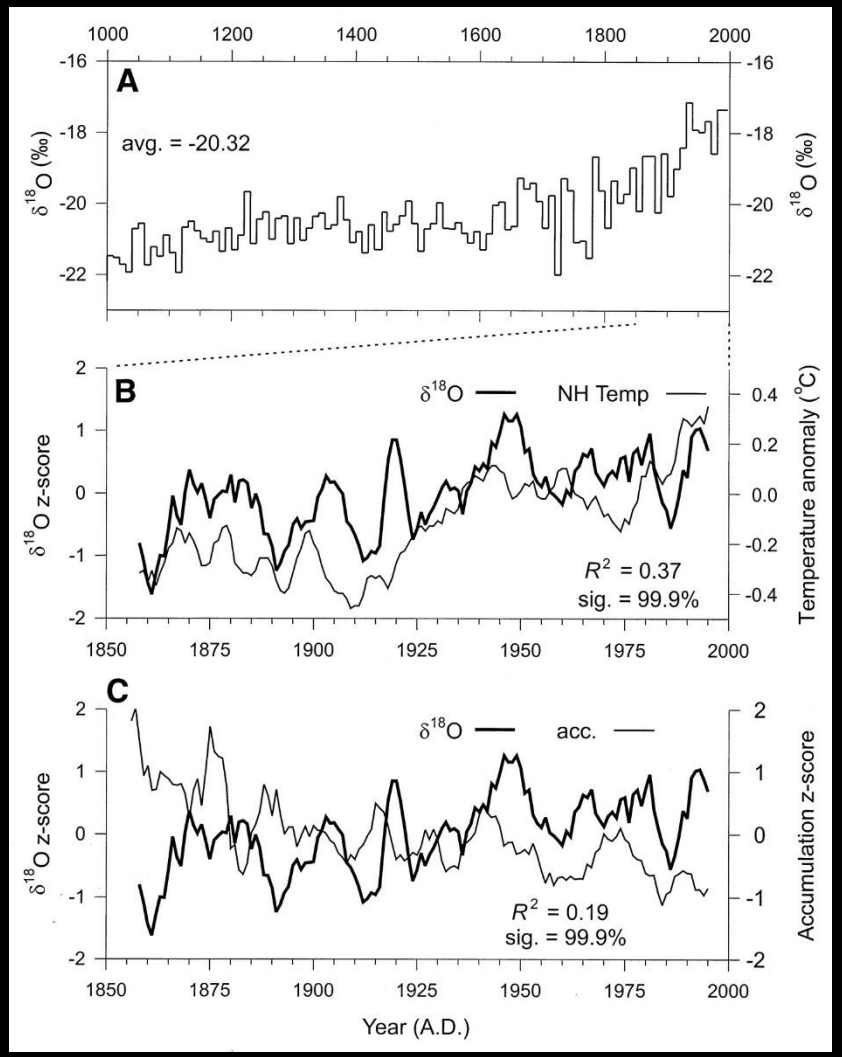
A: *d* decreases and accumulation increases, reflecting a stronger monsoon.



What can be said about the period from ~1850 – 2000 ?





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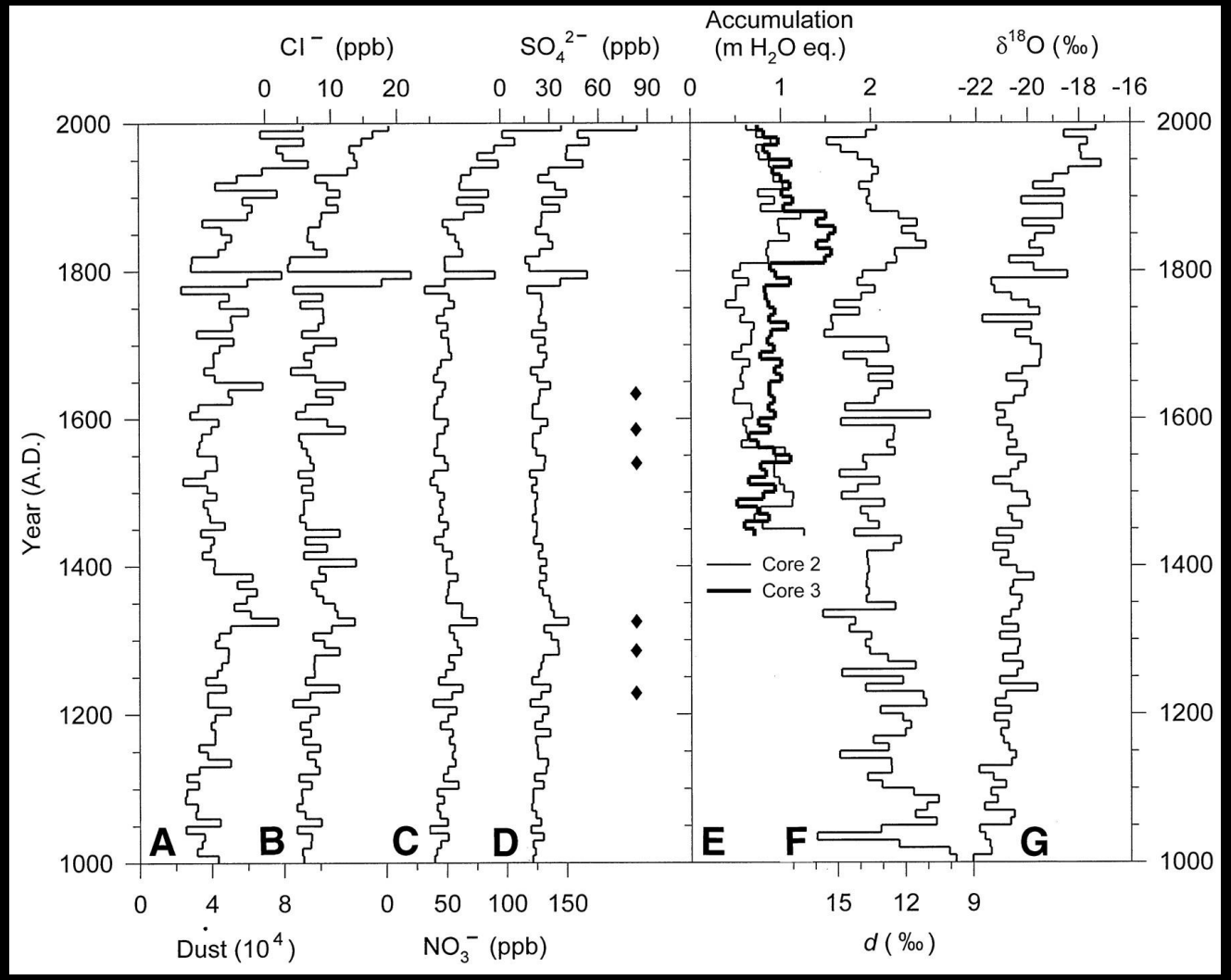

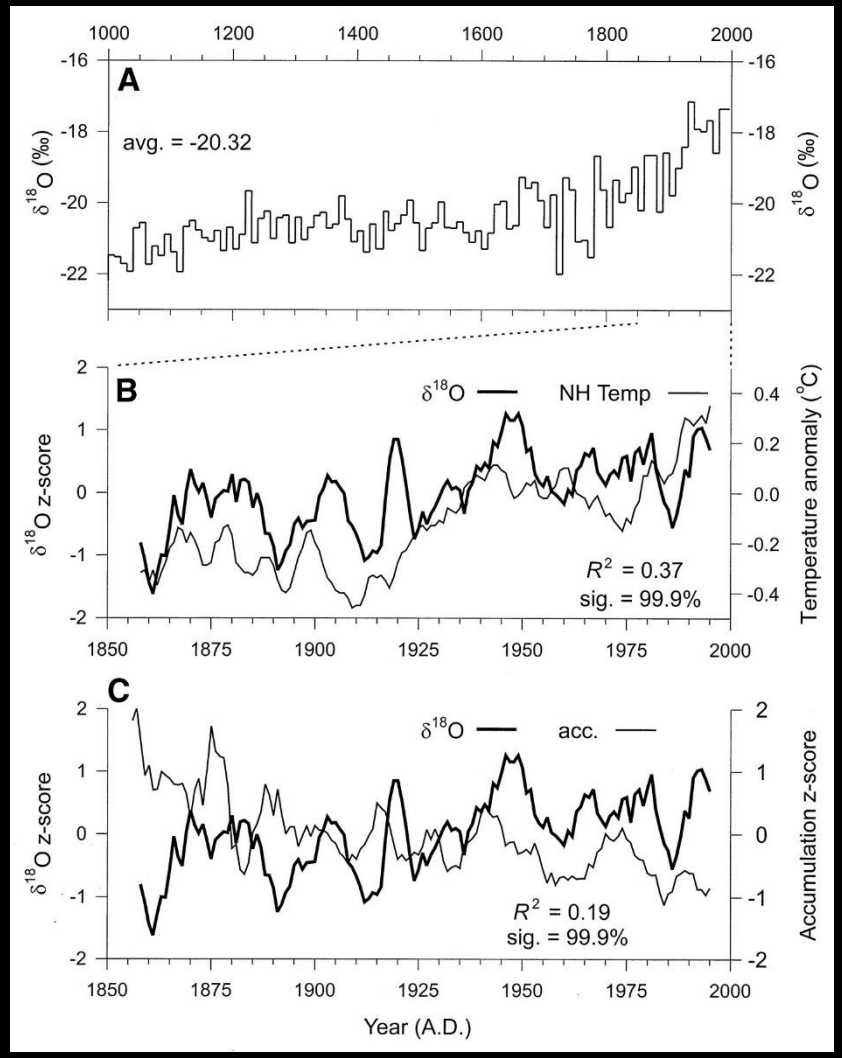

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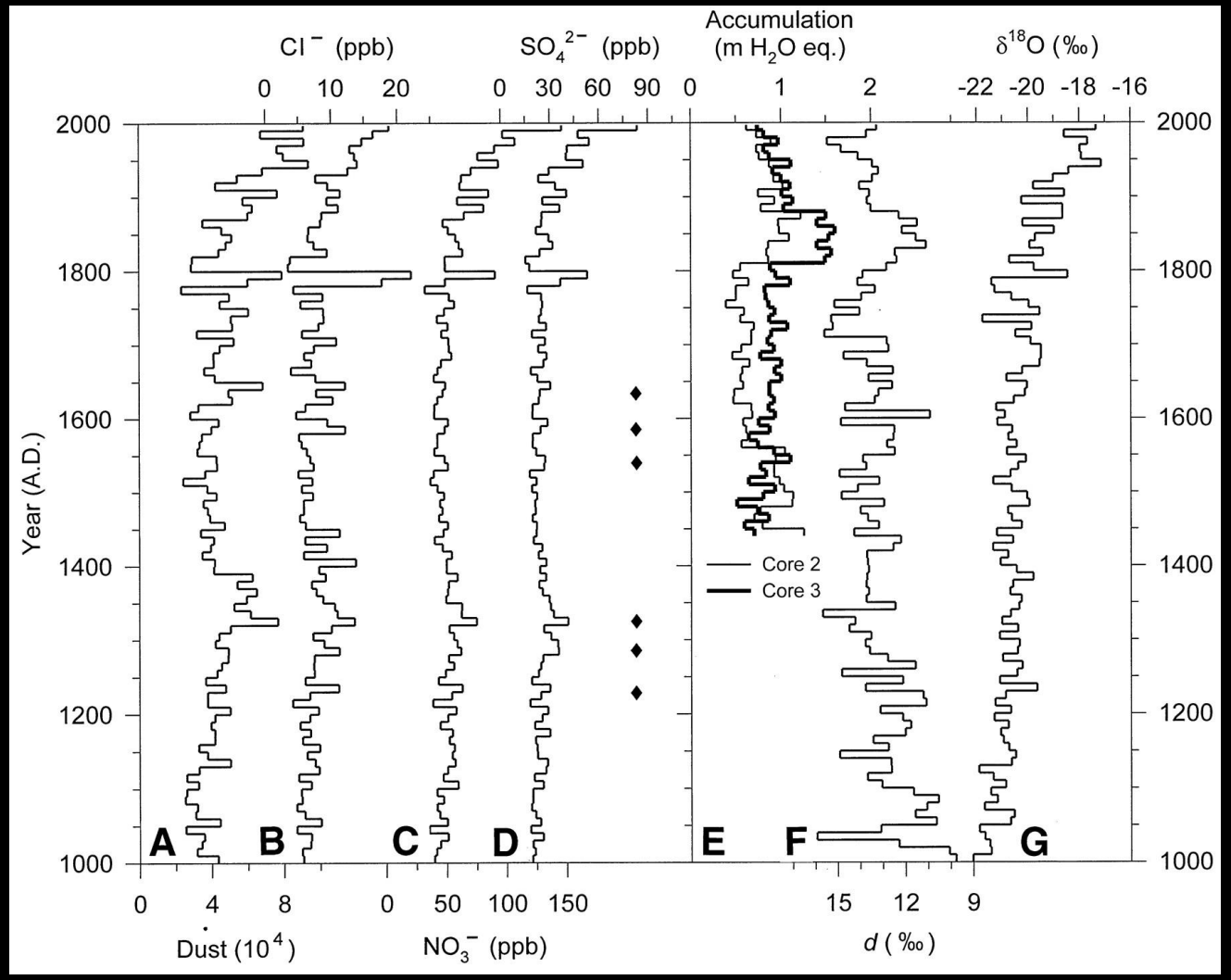
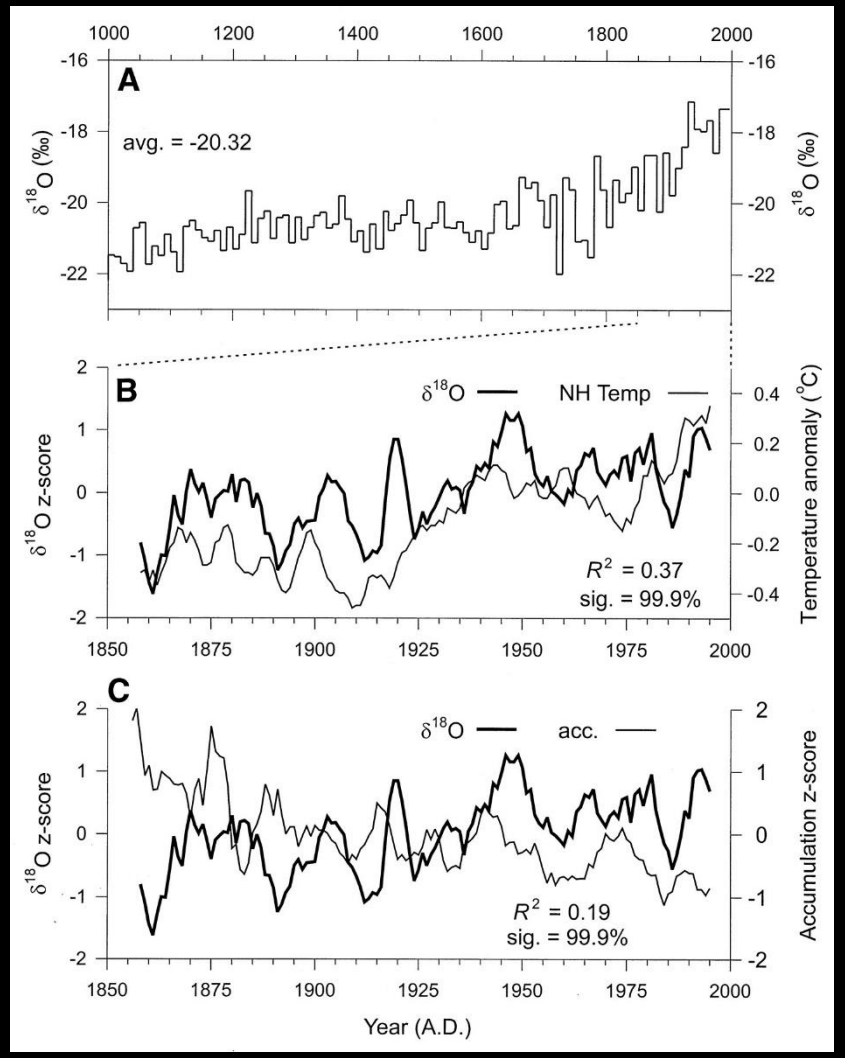
… I thought accumulation *increased* with a stronger monsoon. What gives?





Next paper...

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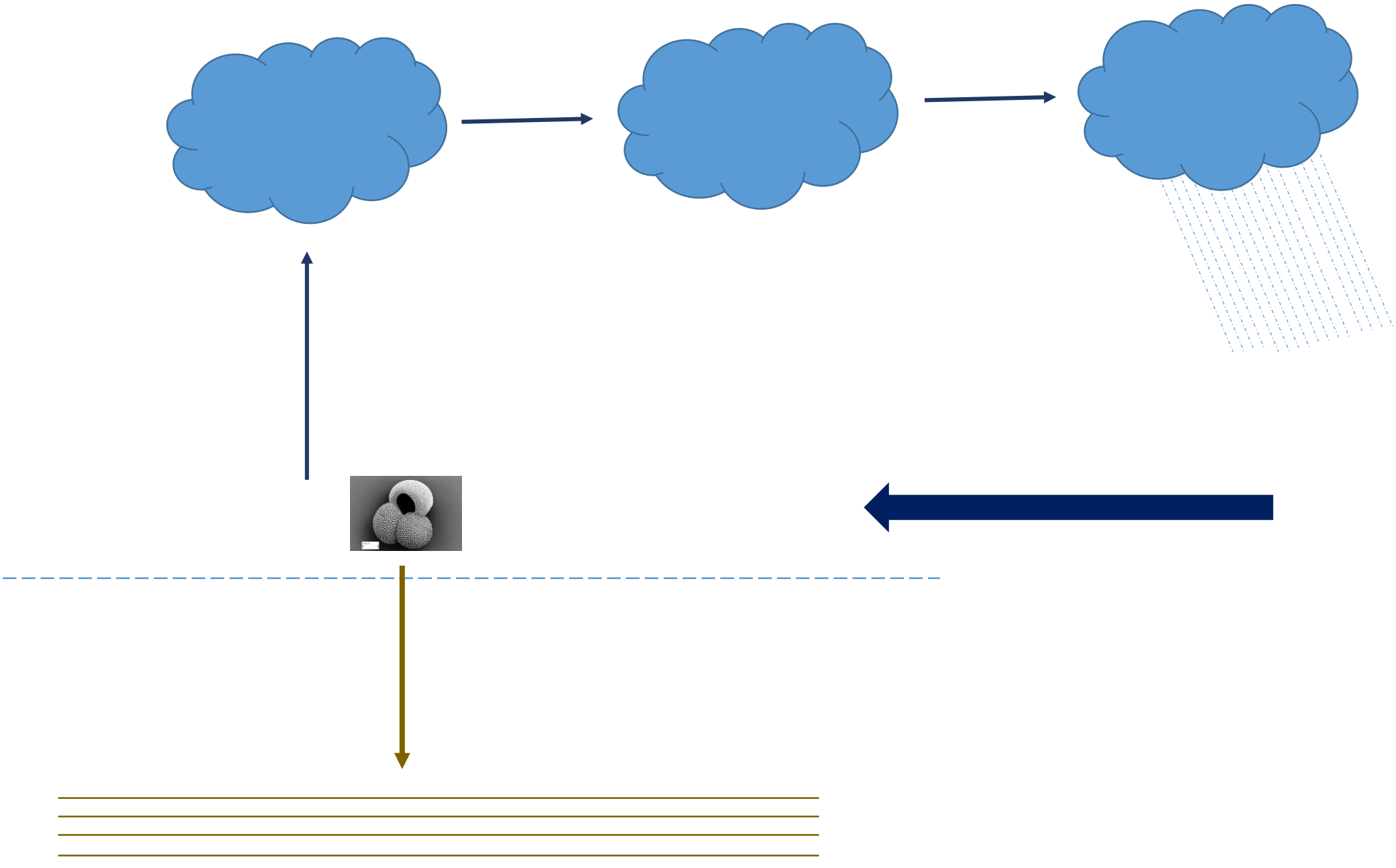
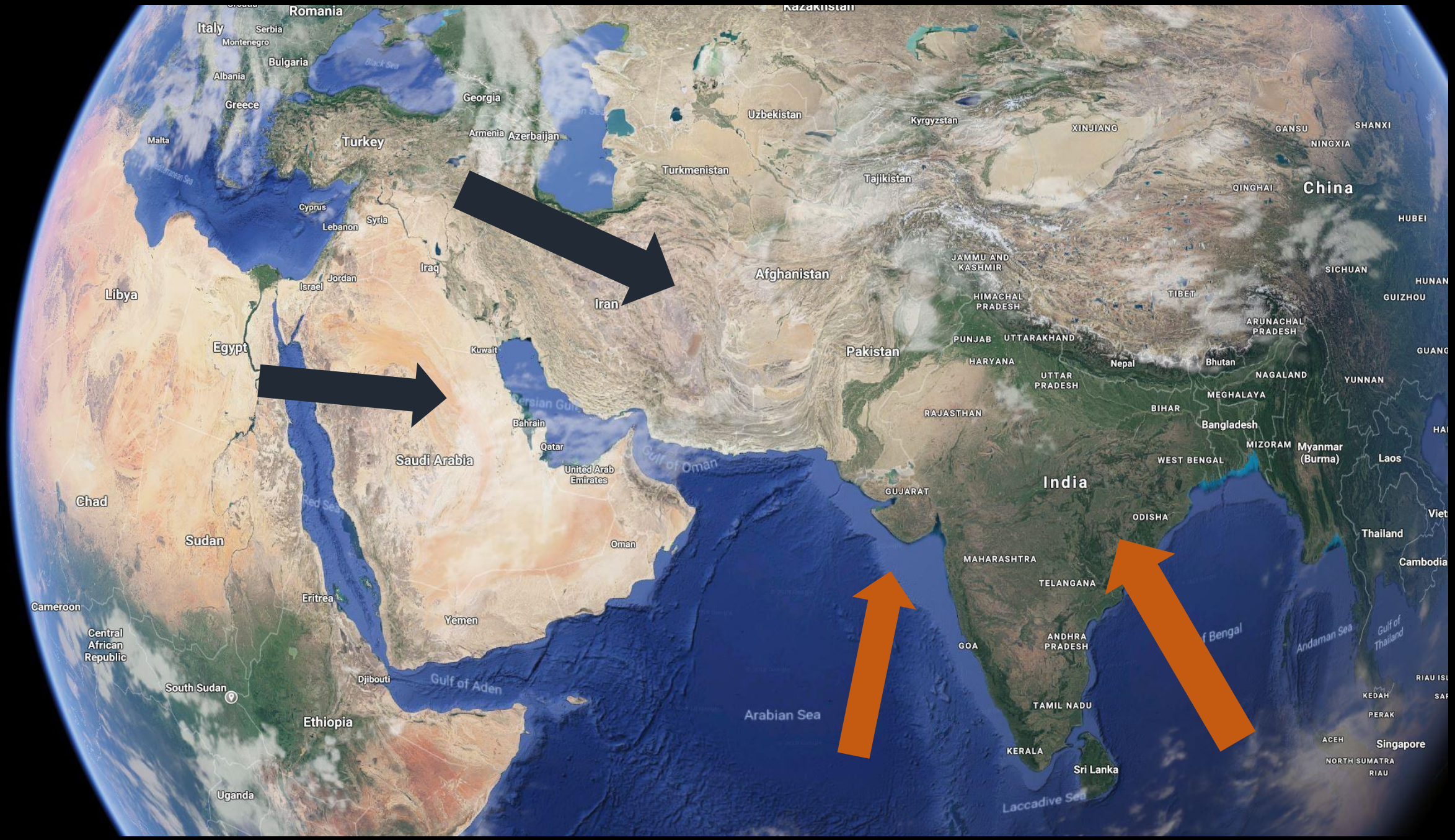
A lot of things combined, but mainly sea surface temperatures and salinity.

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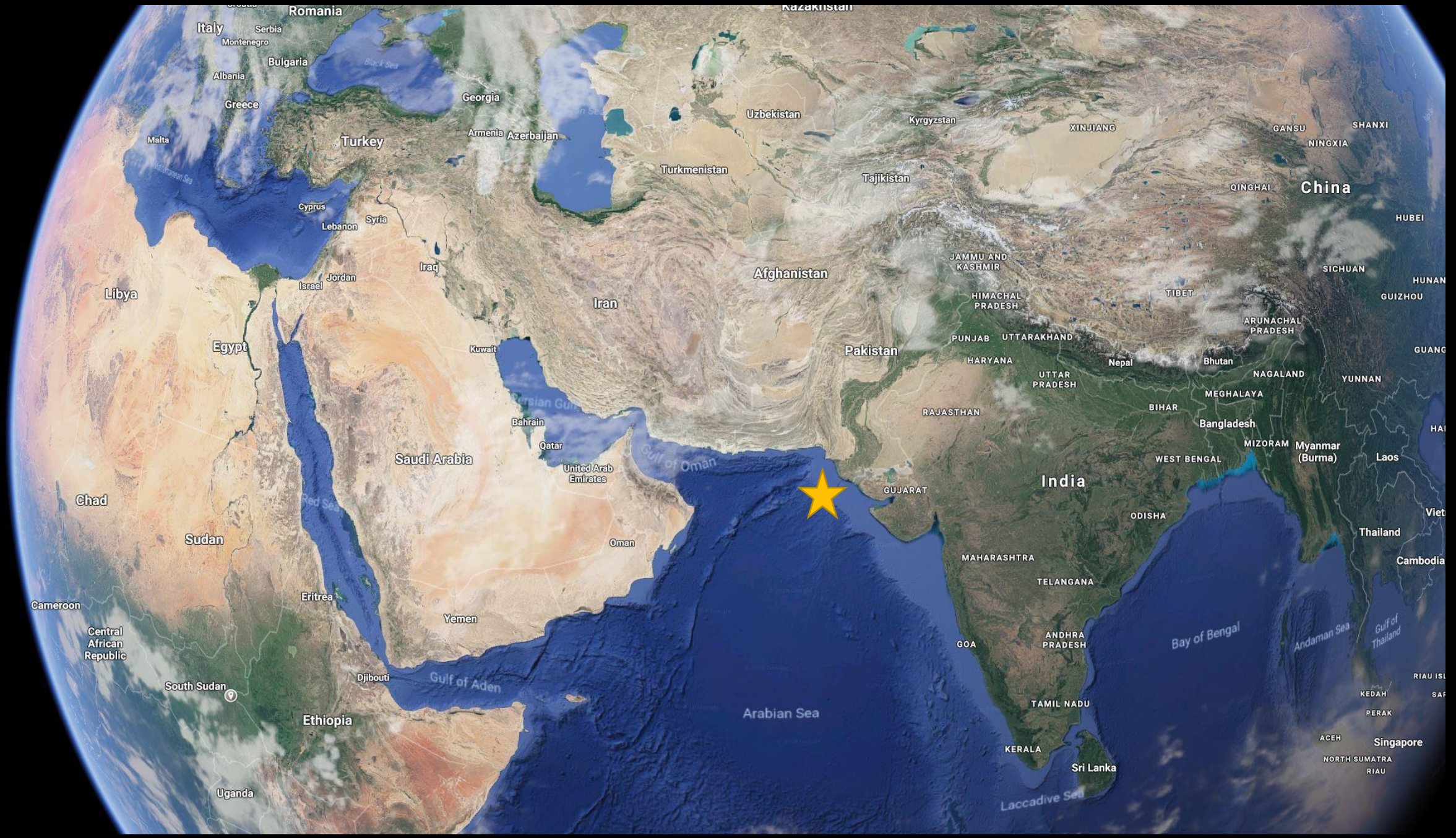
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How is the 4.2 Ka drought expressed in the 63 Ka sediment core?

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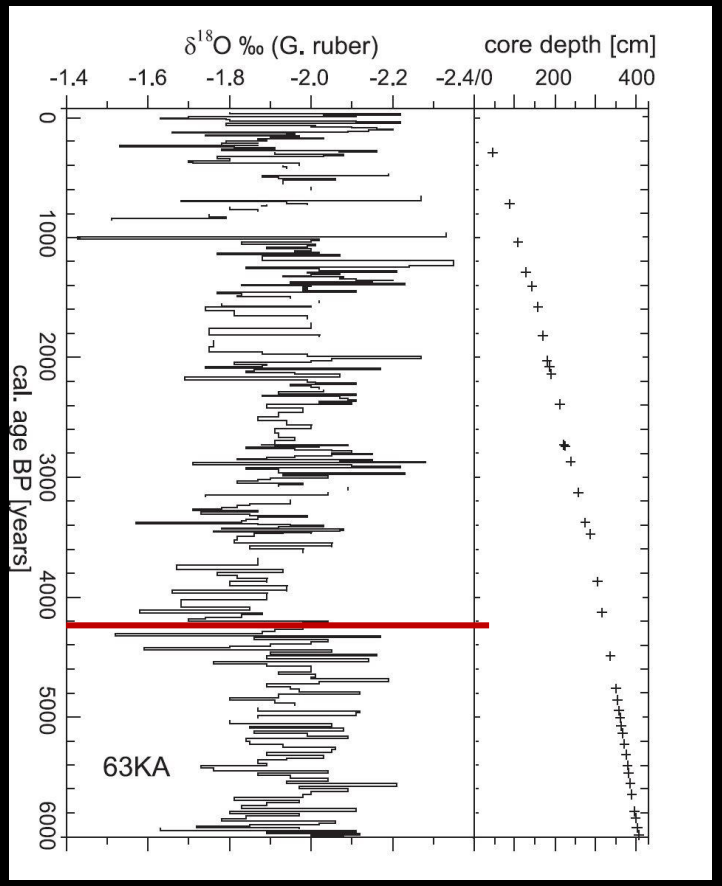
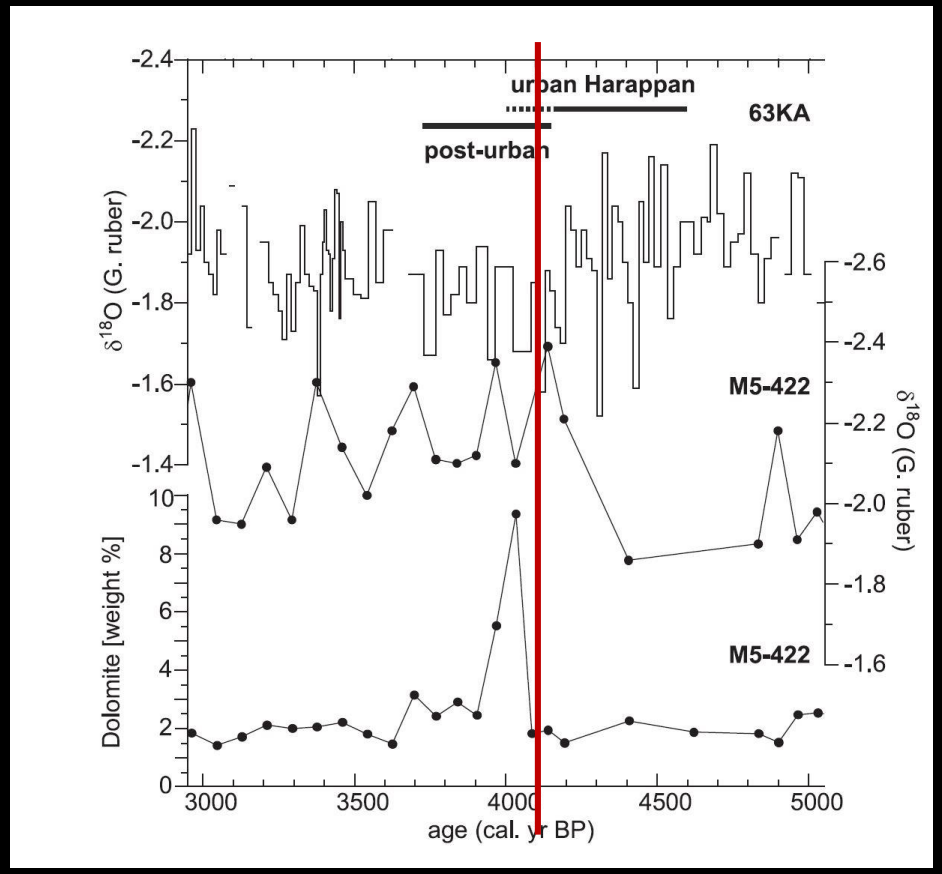
A: *Heavier* del18O values, which could mean cooler SSTs or higher salinity. There is also a spike in dust content.





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Could this affect a record of drought/monsoon? If so, how?

A: Yes! It would dampen the signal, as the monsoon is characterized by more depleted del18O of precipitation.

Do you see a connection between insolation and del18O?