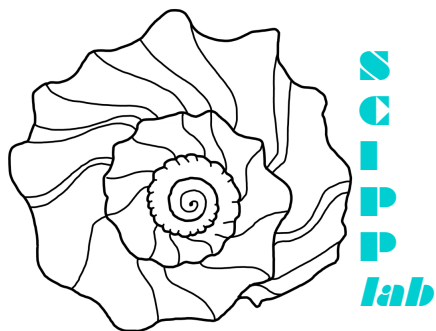




Estimating **PALEOSEASONALITY** *using Clumped Isotopes* *on Gastropods*



Sierra V. Petersen
University of Michigan



How can we use new techniques to improve paleoclimate reconstruction?

(PALEO) SEASONALITY

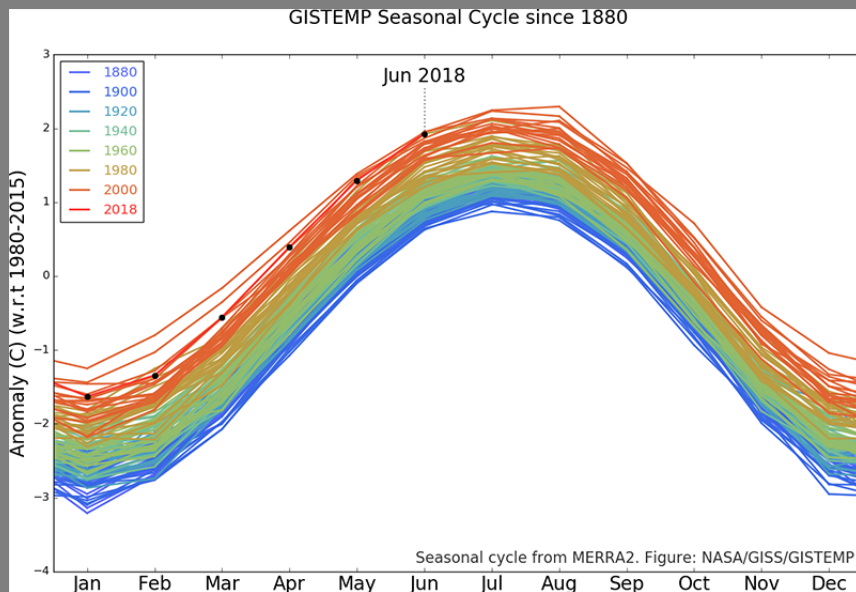
Changes in seasonality impact...

- Agricultural effects
- Ice sheet mass balance

More *felt* by average person than $+0.5^{\circ}\text{C}$ MAT

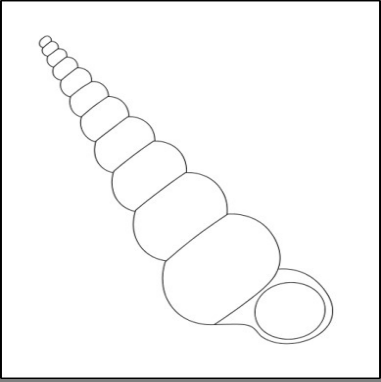


(PALEO) SEASONALITY

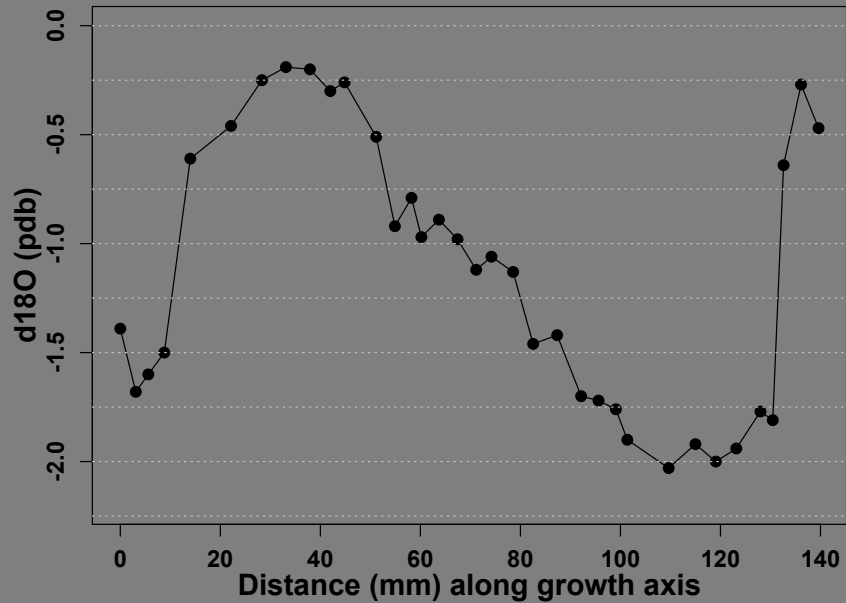
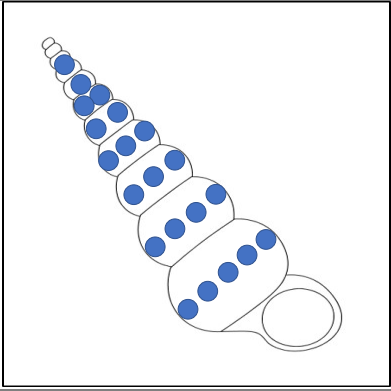


- Get it from models, but not from many proxies
- No idea whether models are accurately predicting seasonal cycle!

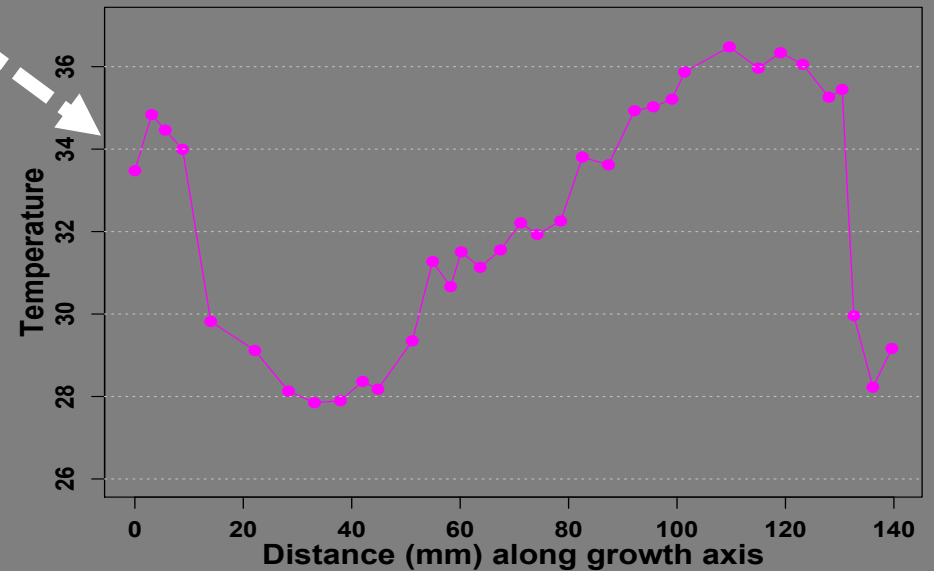
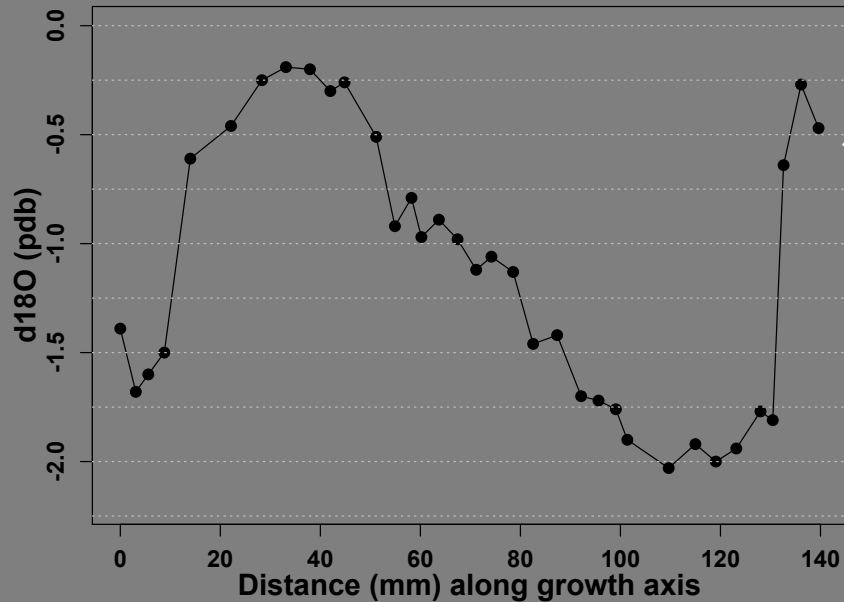
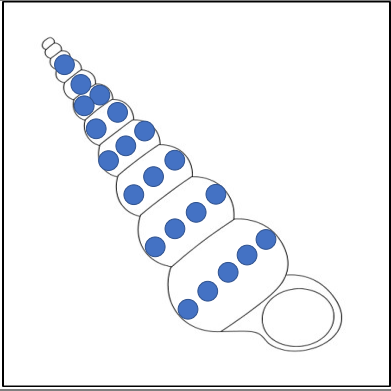
Isotopic SCLEROCHRONOLOGY



Isotopic SCLEROCHRONOLOGY



Isotopic SCLEROCHRONOLOGY

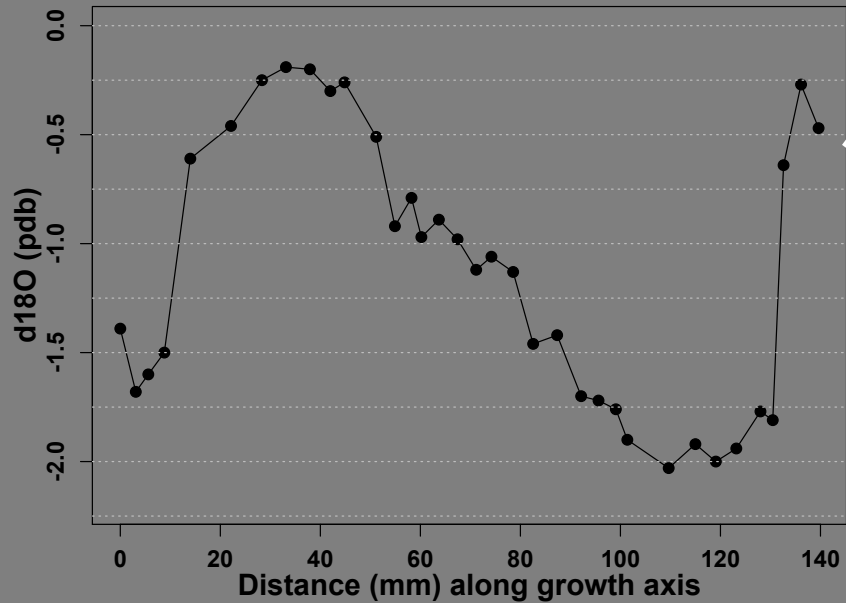
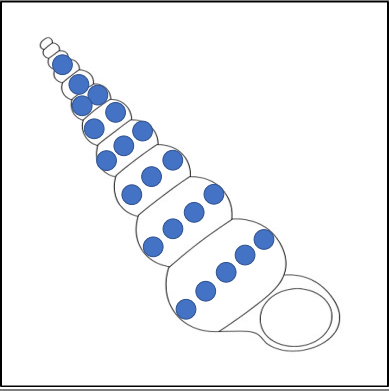


$$\text{Temp} = 21.8 - 4.69 * (\delta^{18}\text{O}_{\text{carb}} - \delta^{18}\text{O}_{\text{water}})$$

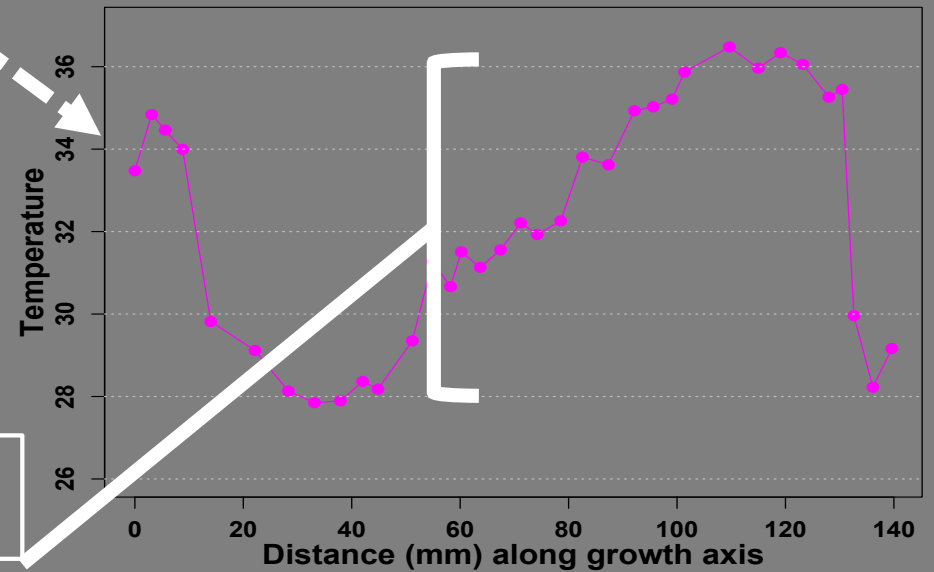
[Grossman & Ku, 1986]

(assumed = 1.1‰)

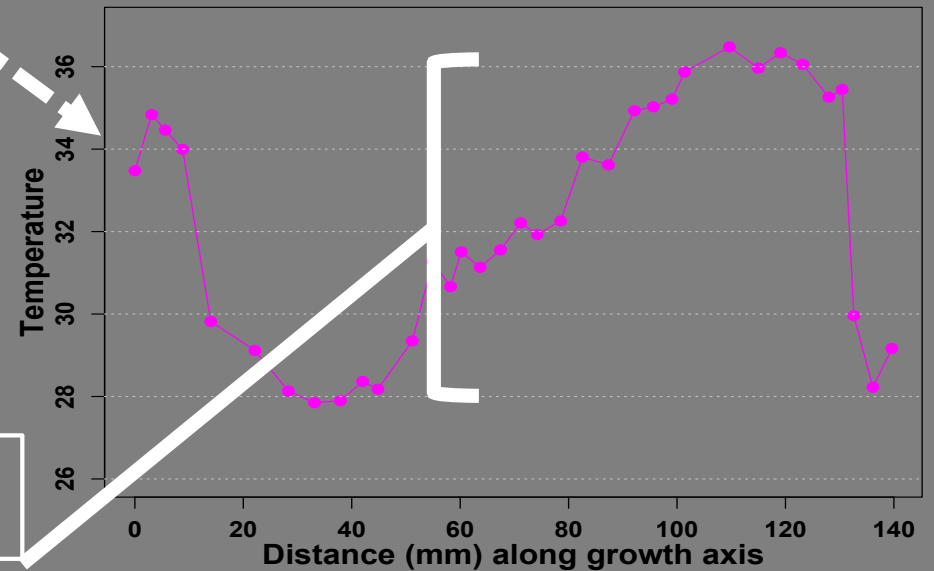
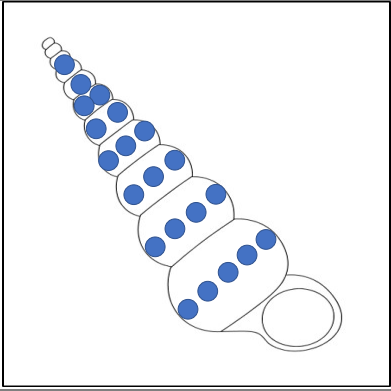
Isotopic SCLEROCHRONOLOGY



Max-Min Range = 8°



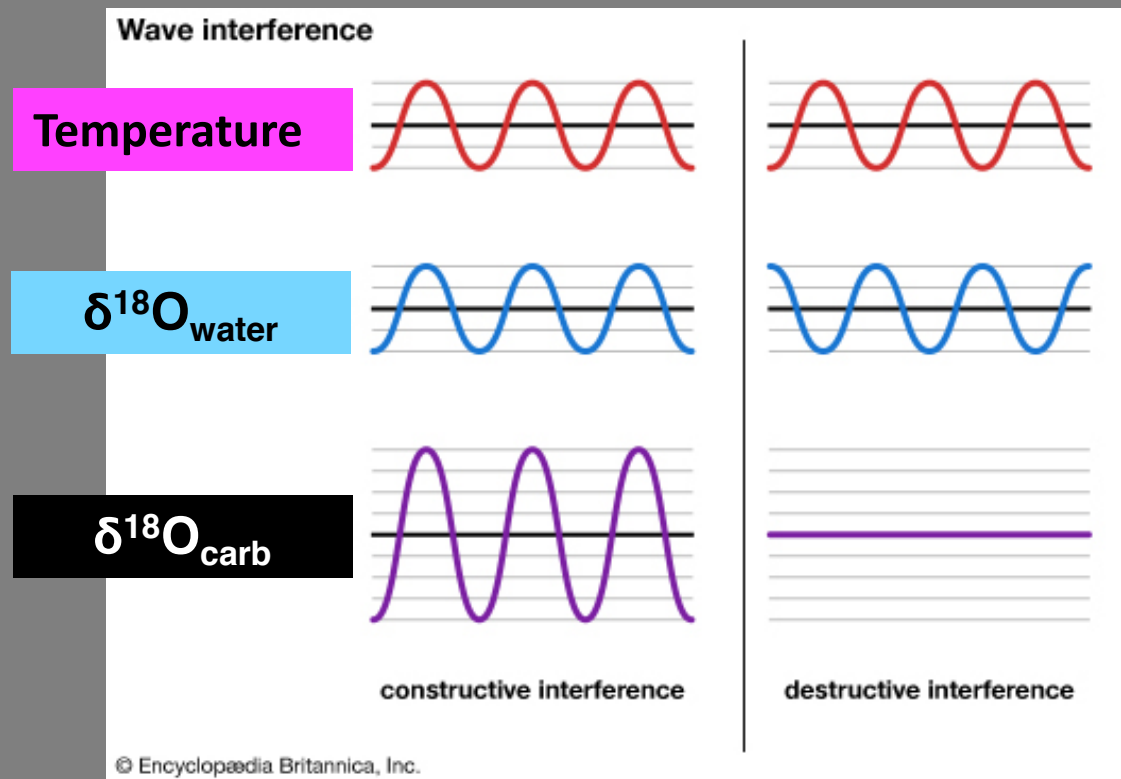
Isotopic SCLEROCHRONOLOGY



Max-Min Range = 8°

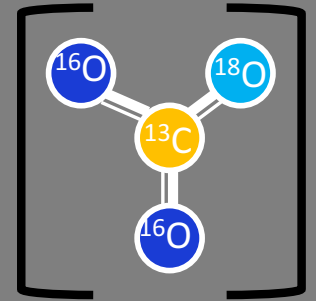
Actual < 2°

Changes in $\delta^{18}\text{O}_{\text{water}}$ can effect
inferred **Temperature** seasonality
in either a constructive or
destructive way



Clumped Isotopic SCLEROCHRONOLOGY

$$\Delta_{47} = f(\text{Temperature})$$



Clumped Isotopic SCLEROCHRONOLOGY

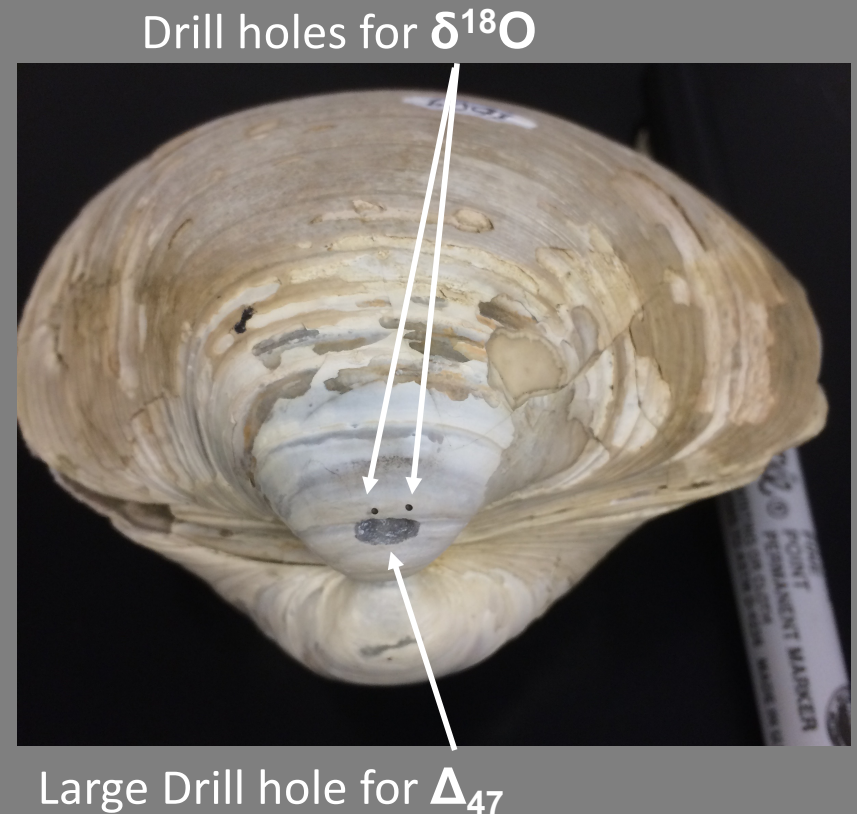
$$\Delta_{47} = f(\text{Temperature})$$

$$+ \text{Temp} = 21.8 - 4.69 * (\delta^{18}\text{O}_{\text{carb}} - \delta^{18}\text{O}_{\text{water}})$$

→ Can calculate **Temperature** AND $\delta^{18}\text{O}_{\text{water}}$
and determine whether each varies subannually

why hasn't this been done before?

- **Time Intensive**
 - 6 hours of machine time per data point
- **Requires large amounts of sample material**
 - 15-25mg per data point



Marine GASTROPODS

- Fast growing
- Easy to get enough material for SUBANNUAL clumped isotopes
- More Δ_{47} calibration work needed!



Indian Top
Shell
*Cittarium
pica*

Knobbed Whelk
Busycon carica



Atlantic Auger
Terebra dislocata



Florida Fighting
Conch
Strombus alatus

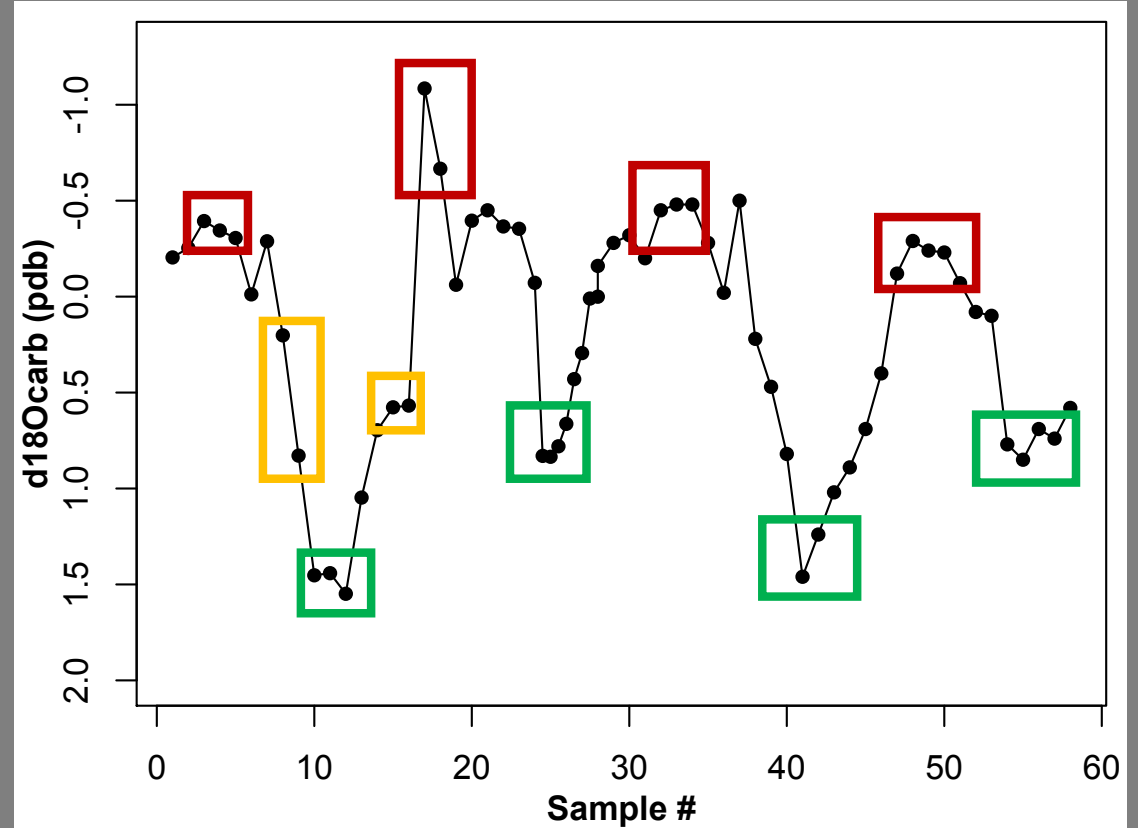


Lightning Whelk
Busycon contrarium

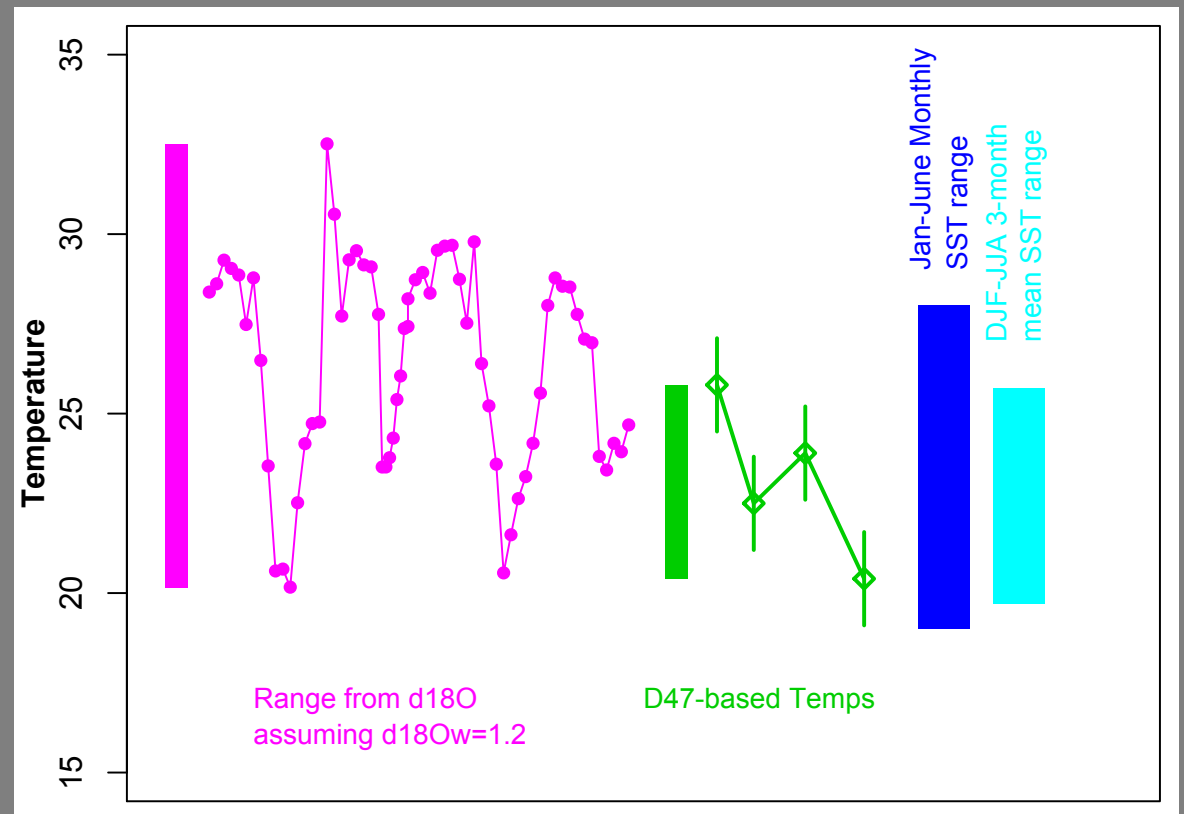


Turritella variegata

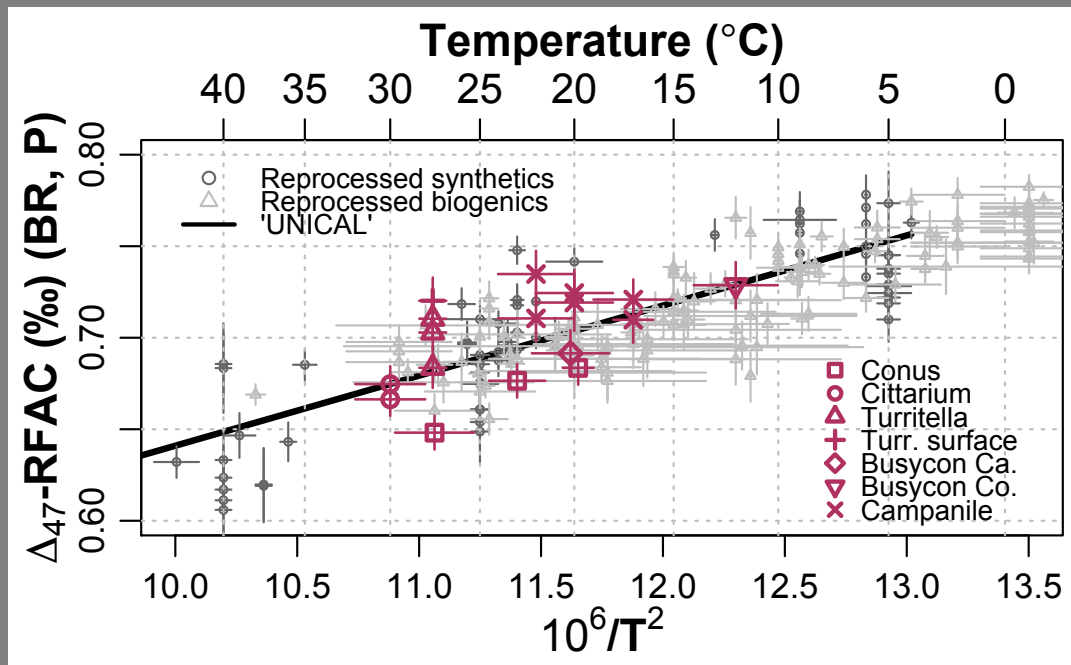
Example: Modern *C. pica*



Example: Modern *C. pica*

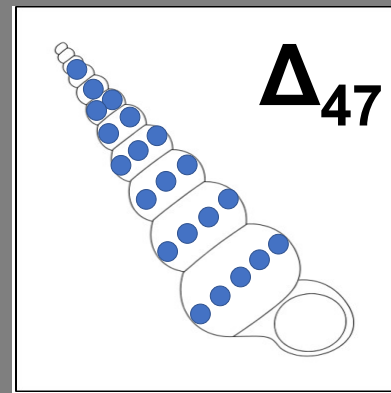
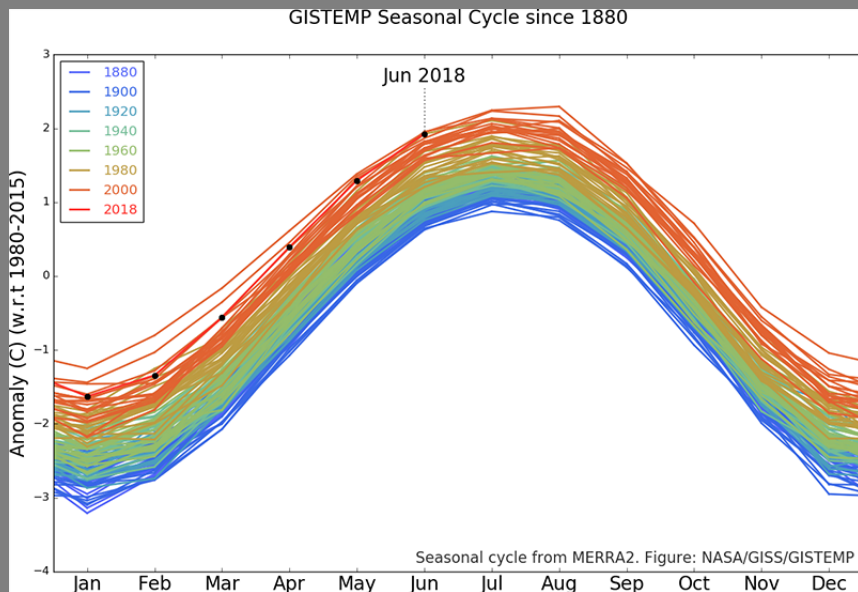


Δ_{47} CALIBRATION using modern gastropod species



- Nothing grossly out of equilibrium
- Certain species (*Turritella*, *Campanile*) biased too cold
- Whelks, Top Shell look good!

PALEOSEASONALITY via Clumped Isotopic Sclerochronology



- Better constrain past seasonality
- Validate models
- Learn something about hydrological cycle