

MODEL OF DUAL ISOTOPES OF PEDOGENIC CARBONATES



GEOLOGY & GEOPHYSICS

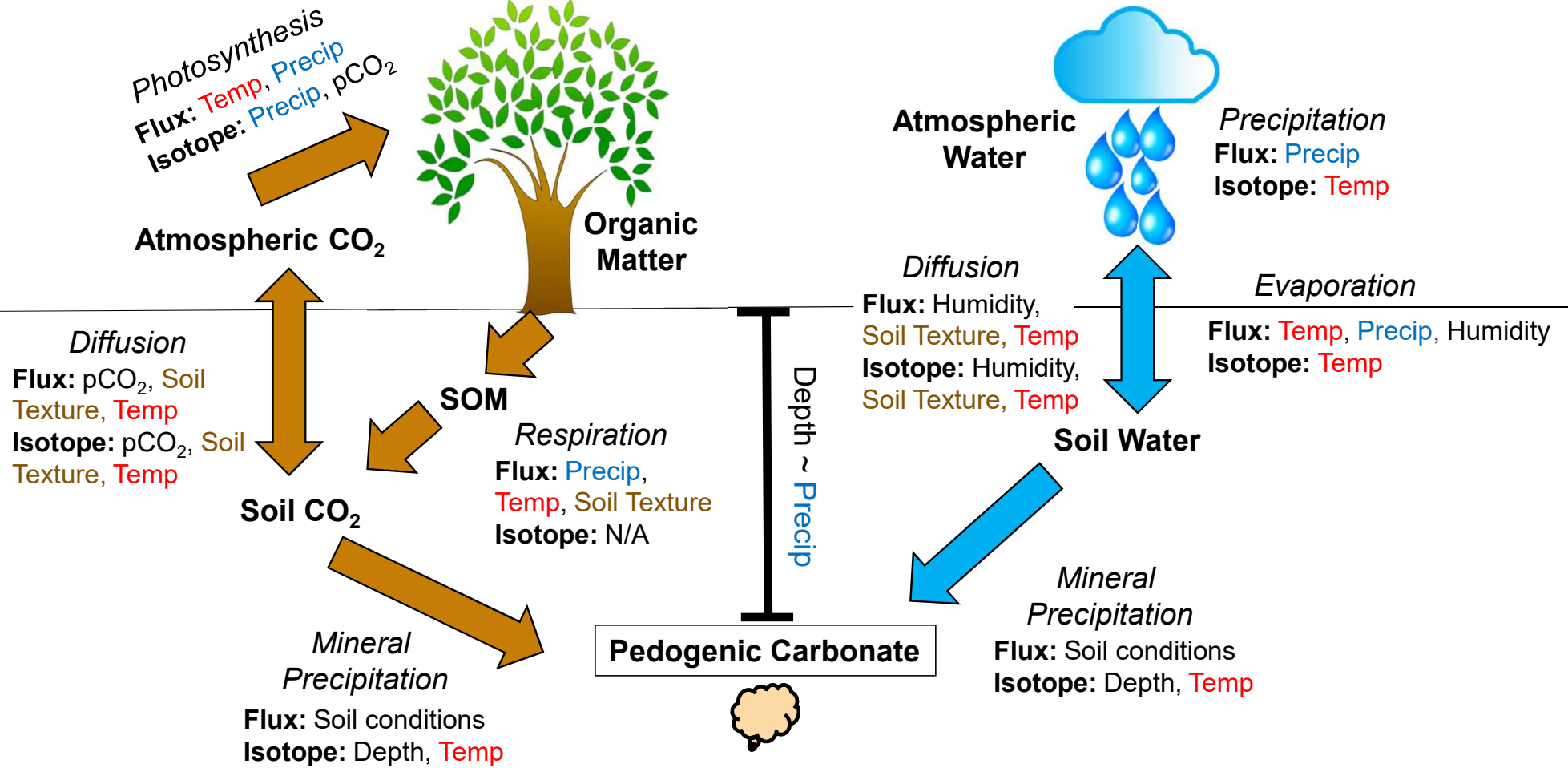
MINES AND EARTH SCIENCES | THE UNIVERSITY OF UTAH

PEDOGENIC CARBONATES AS PALEOCLIMATE PROXIES

- Robust recorder of carbon cycle perturbations
 - Not susceptible to diagenesis under most burial conditions
 - Found in many fluvial sequences with paleosols
 - Carbon isotope values are complex to interpret - many controls
- Timing and season of carbonate formation still relatively unknown
 - Pedogenic carbonate mineral precipitation conditions favor the warm and dry season (Quade et. al. 2013, Breker et. al. 2009)
 - BUT sometimes the dry season isn't the warm season
 - Clumped isotope measurements have issues with calibration curves, but most indicate at or above MAT conditions of formation (Quade. et. al. 2013)

Carbon

Oxygen

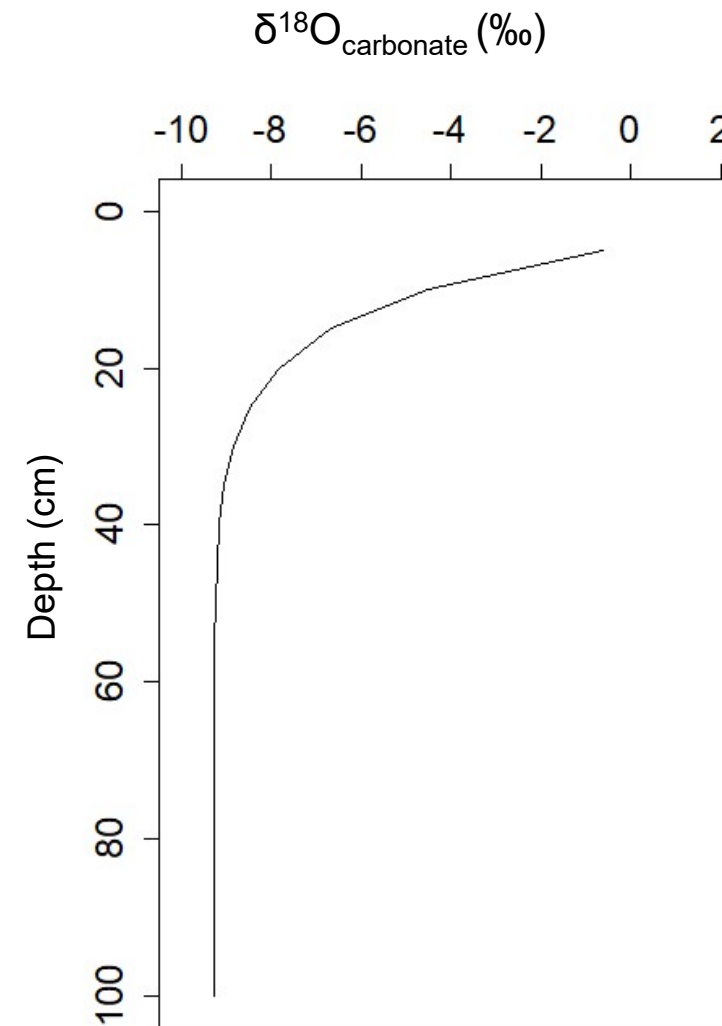
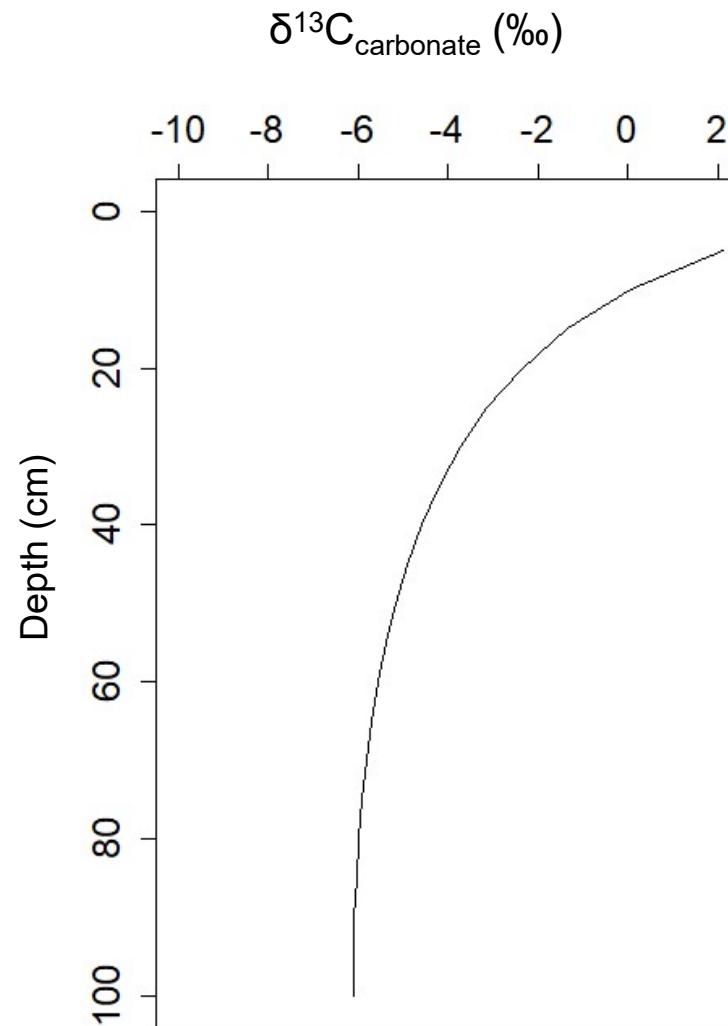


MODEL ISOTOPE VALUES OF PEDOGENIC CARBONATES

Create two depth
curves with governing
equations based on
climate and modern
correlations to
processes

$\delta^{18}\text{O}_{\text{soil water}}$ by Barnes
and Allison (1993)

$\delta^{13}\text{C}_{\text{soil CO}_2}$ by Cerling
(1984)

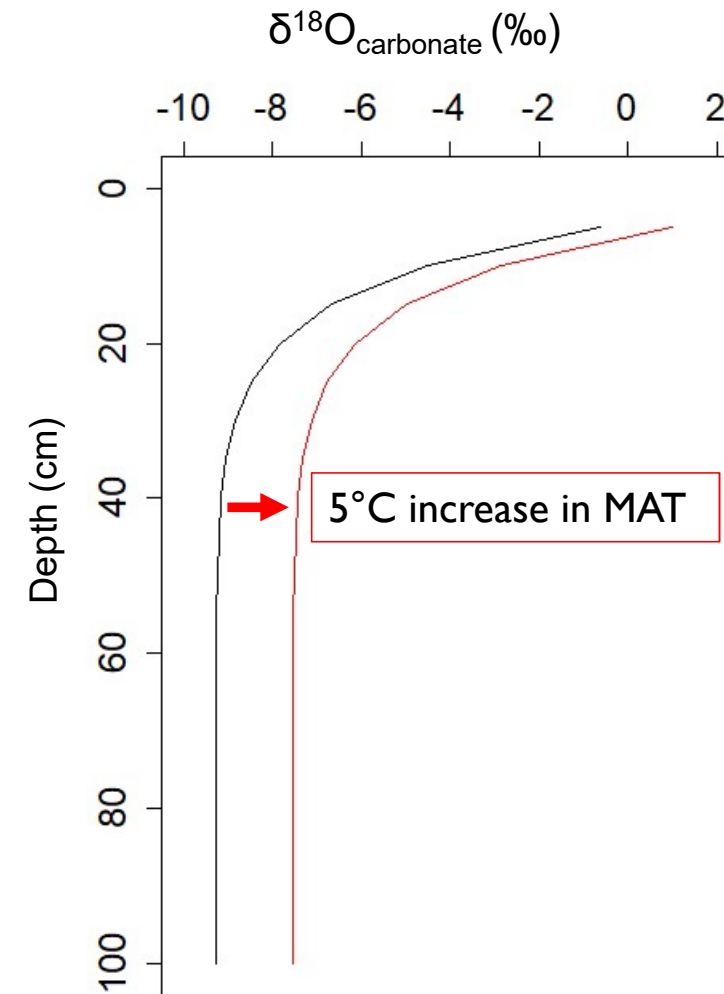
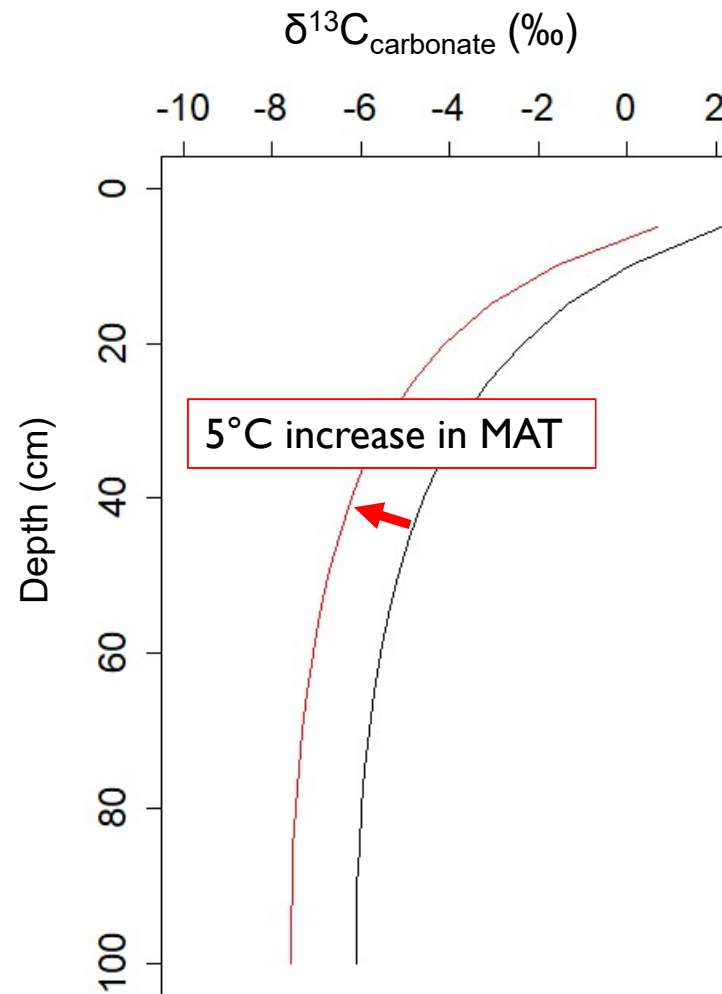


MODEL ISOTOPE VALUES OF PEDOGENIC CARBONATES

Create two depth
curves with governing
equations based on
climate and modern
correlations to
processes

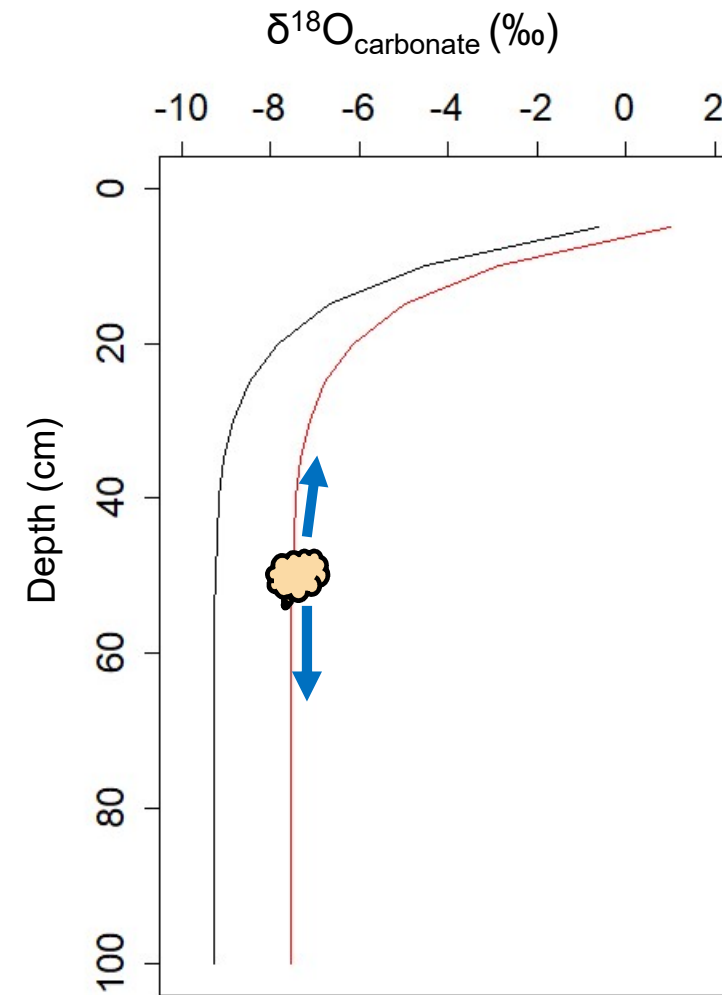
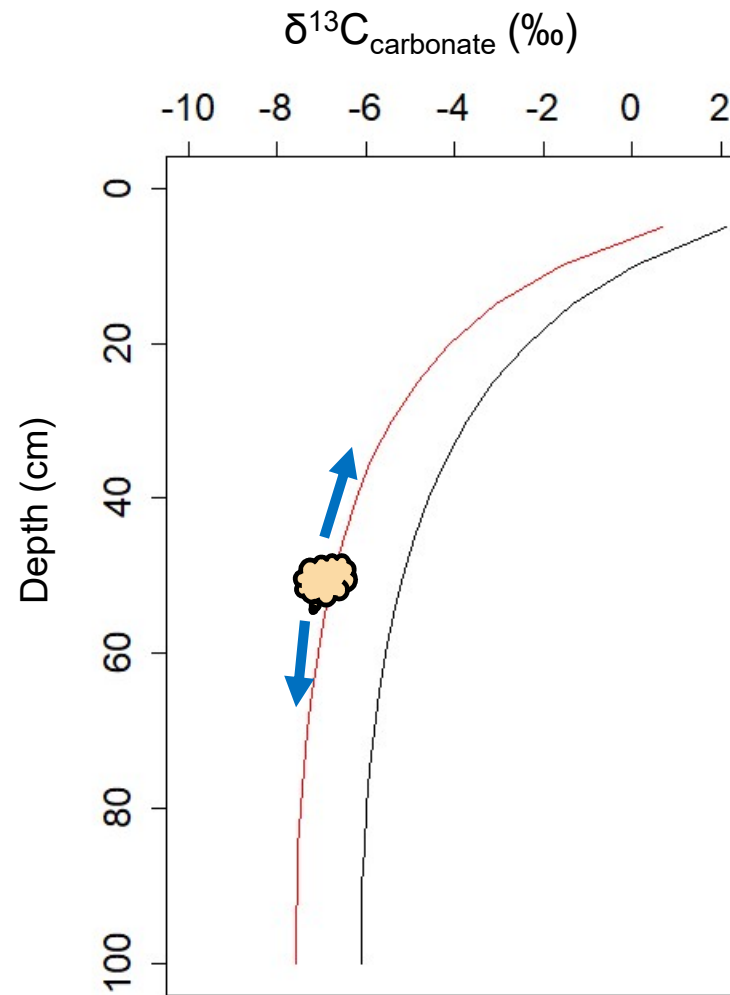
$\delta^{18}\text{O}_{\text{soil water}}$ by Barnes
and Allison (1993)

$\delta^{13}\text{C}_{\text{soil CO}_2}$ by Cerling
(1984)



MODEL ISOTOPE VALUES OF PEDOGENIC CARBONATES

Place carbonate
formation on these
curves based on MAP



COMPILATION OF MODERN DATA

Both carbon and oxygen isotope values from the same pedogenic carbonates

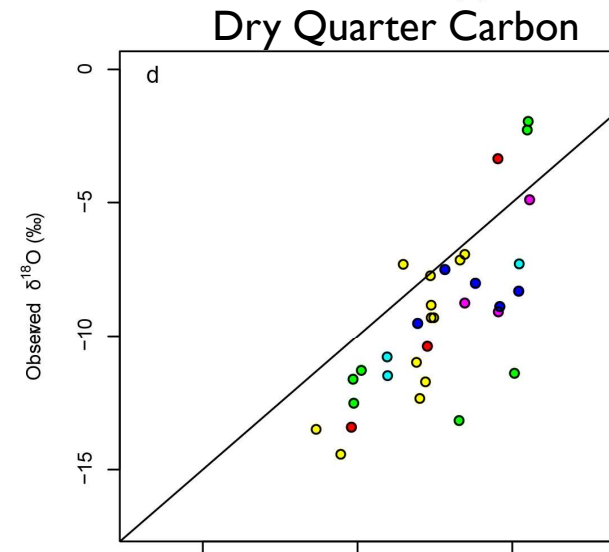
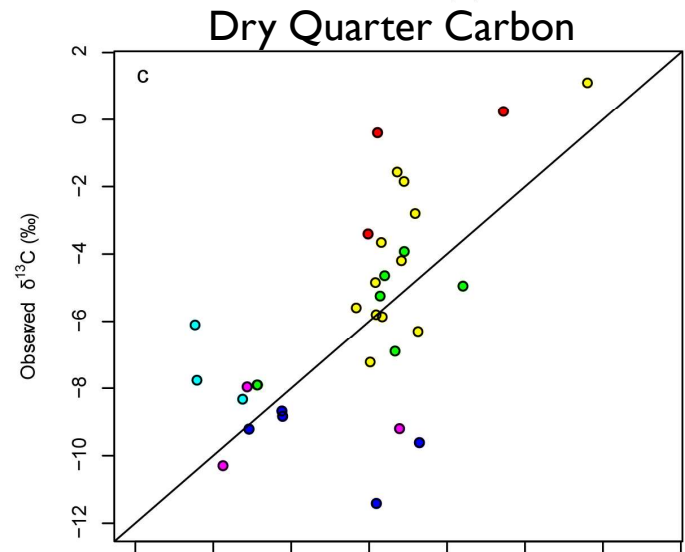
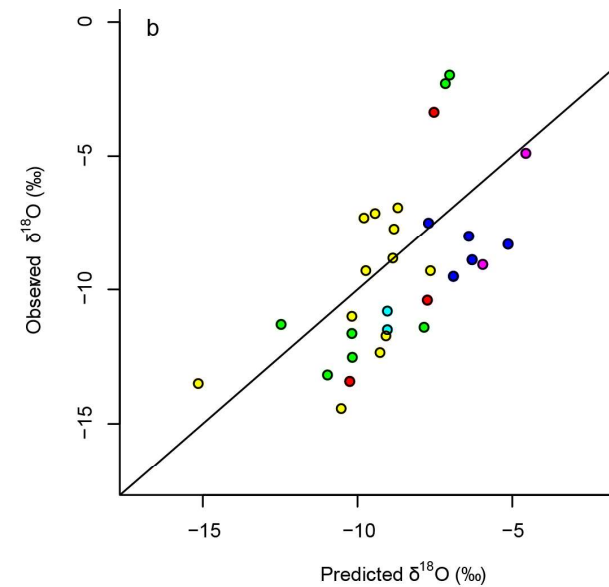
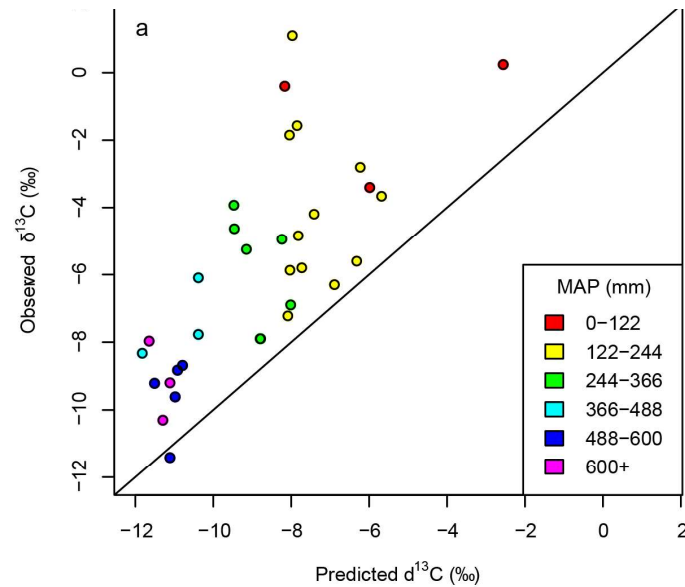
Only C₃ vegetation

‘Modern’ – within last 10ka – pedogenic carbonates

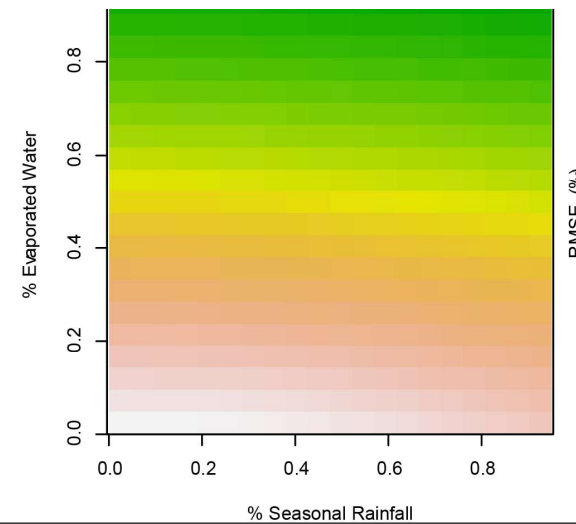
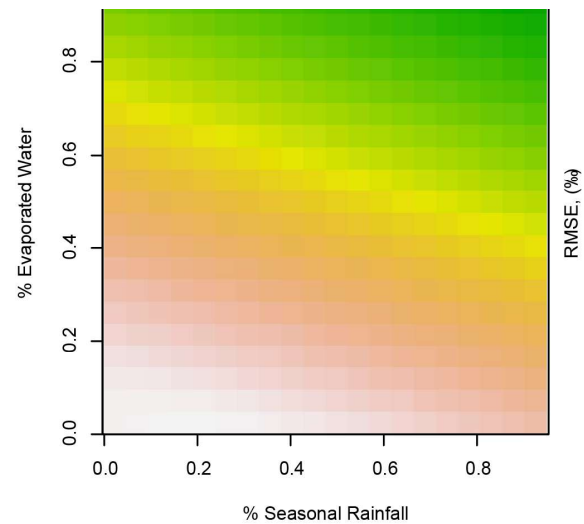
No super weird sites – super-arid or rapid degassing

33 sites, worldwide (North America, South America, Europe)

COMPARE MODEL PREDICTIONS (VIA GCM) TO THE COMPILATION OF MODERN DATA

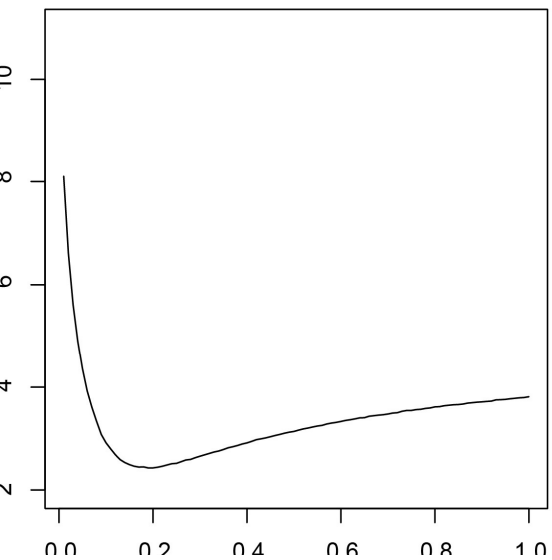


OPTIMIZATION

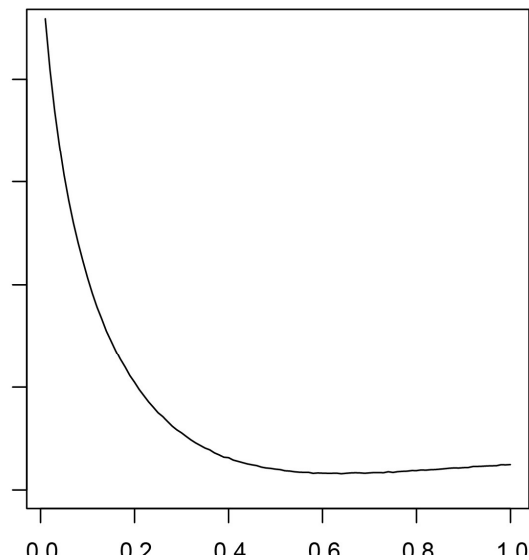


RESPIRATION RATE

Hot Quarter

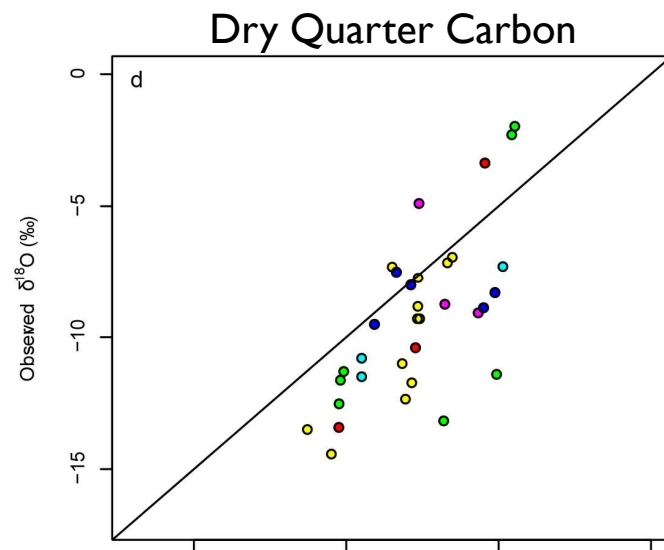
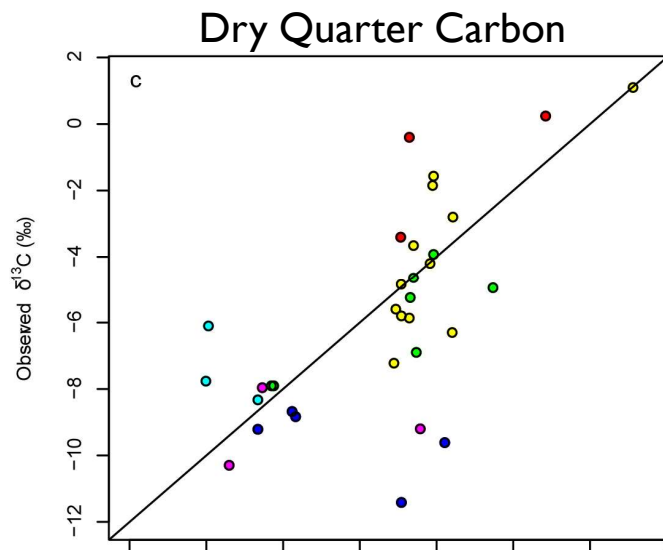
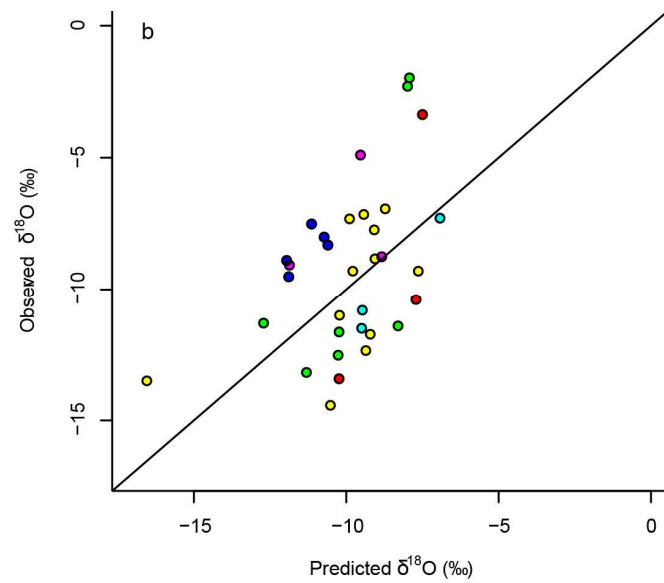
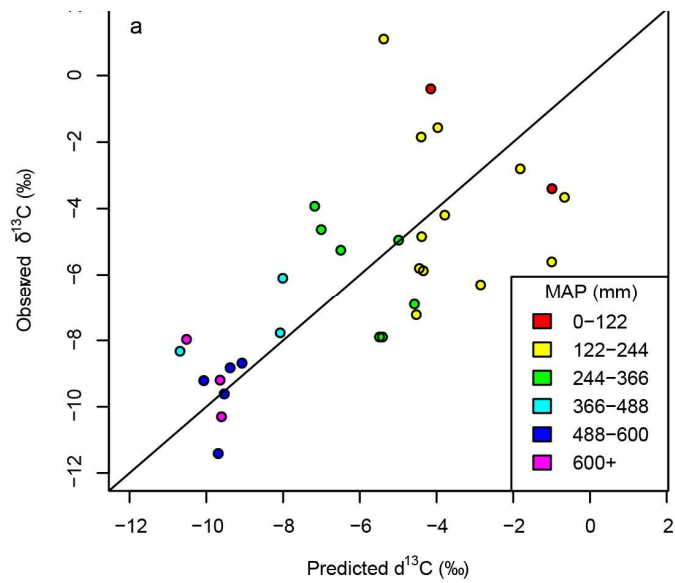


Dry Quarter



SEASONAL AND EVAPORATE WATER

OPTIMIZED COMPARISON



CONCLUSIONS - PRELIMINARY

Evaporation not a major driver of change in oxygen isotopes of pedogenic carbonate

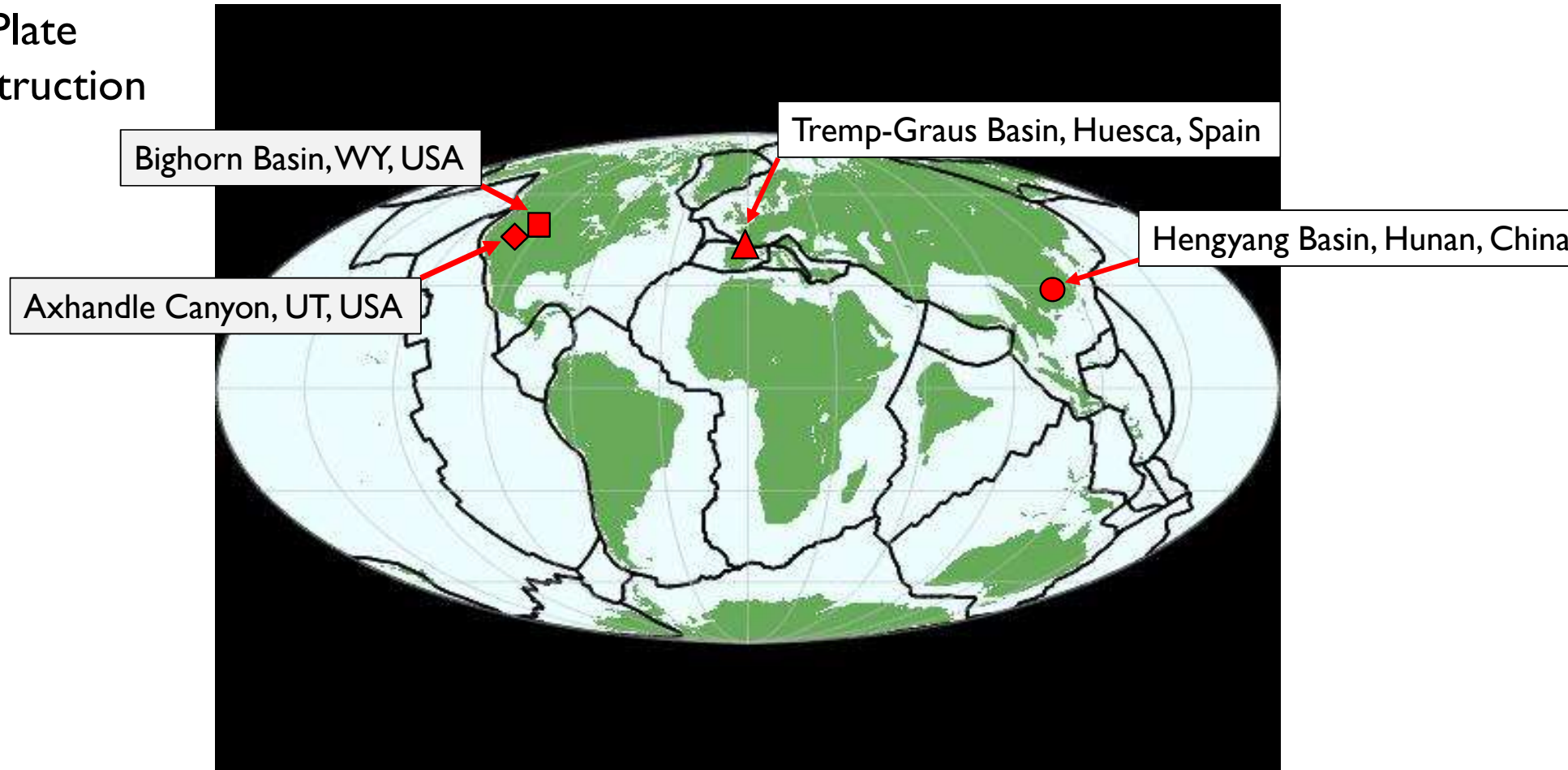
Respiration rates are significantly lower during periods of pedogenic carbonate formation (especially in dry quarter), which makes some sense because low δCO_2 is favorable for carbonate precipitation.

Dry vs. hot quarter not conclusive, but likely depends on climate / seasonal rainfall patterns

QUESTIONS?

NORTHERN MID-LATITUDE PETM SECTIONS THAT CONTAIN PEDOGENIC CARBONATES

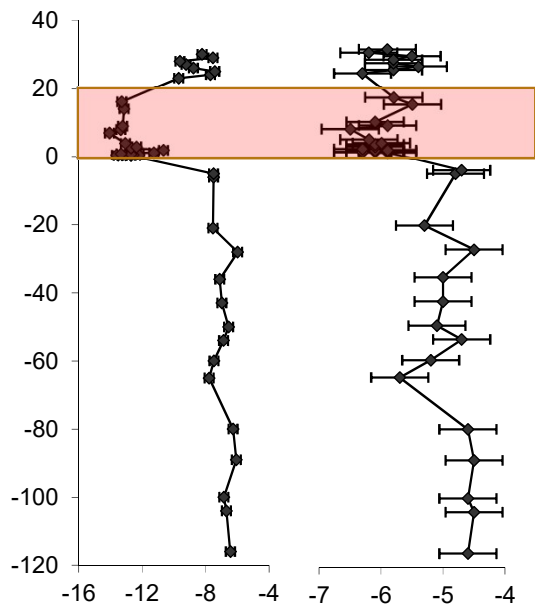
56 Ma Plate
Reconstruction



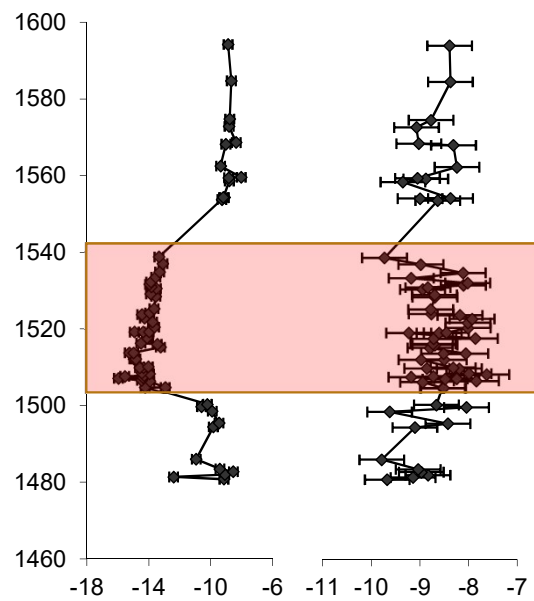
ISOTOPE STRATIGRAPHY

➤ Red shaded area is the PETM

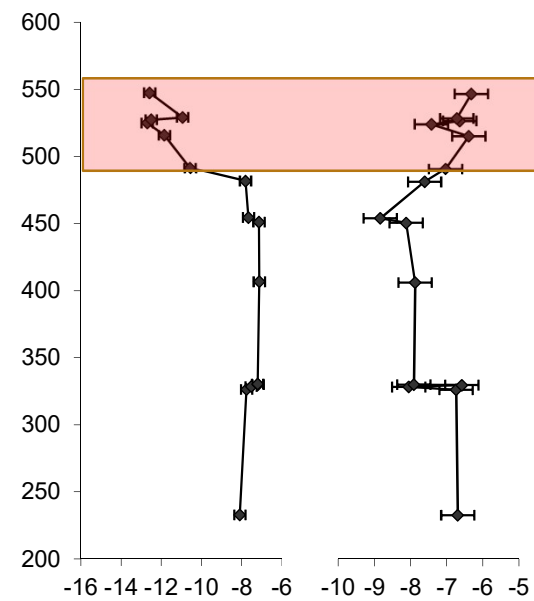
Tremp-Graus Basin, Huesca, Spain



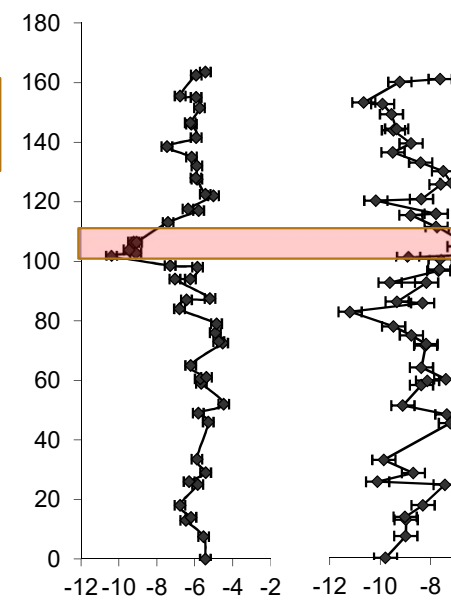
Bighorn Basin, Wyoming, USA



Hengyang Basin, Hunan, China



Axhandle Canyon, Utah, USA



PEDOGENIC CARBONATE CIE-OIE CORRELATION

- Spatially heterogeneous climate change **driving** the correlation of magnitudes of isotope excursions?
- If so, which climate parameter(s) is/are the most likely culprit(s)?

