

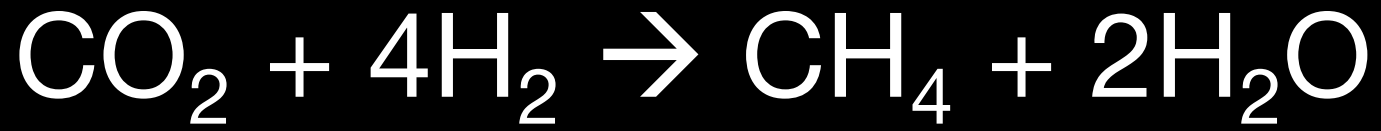
Distinguishing Biological vs. Geological Methane

Stephanie L. Olson

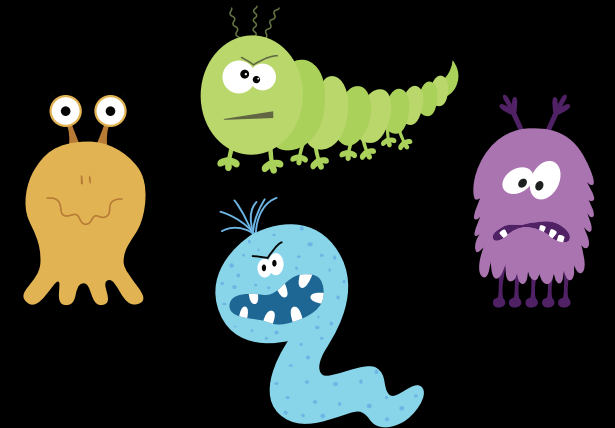


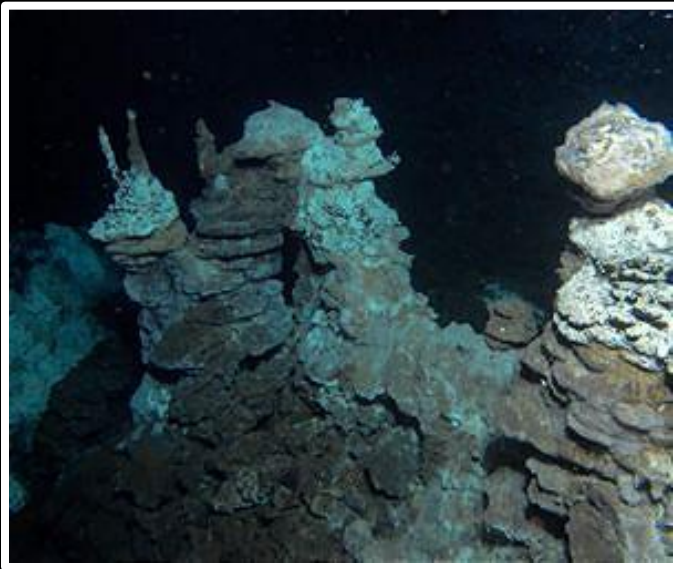
THE UNIVERSITY OF
CHICAGO

Common in the Universe!



Key ingredient for long-term habitability





Serpentinization



Volcanism

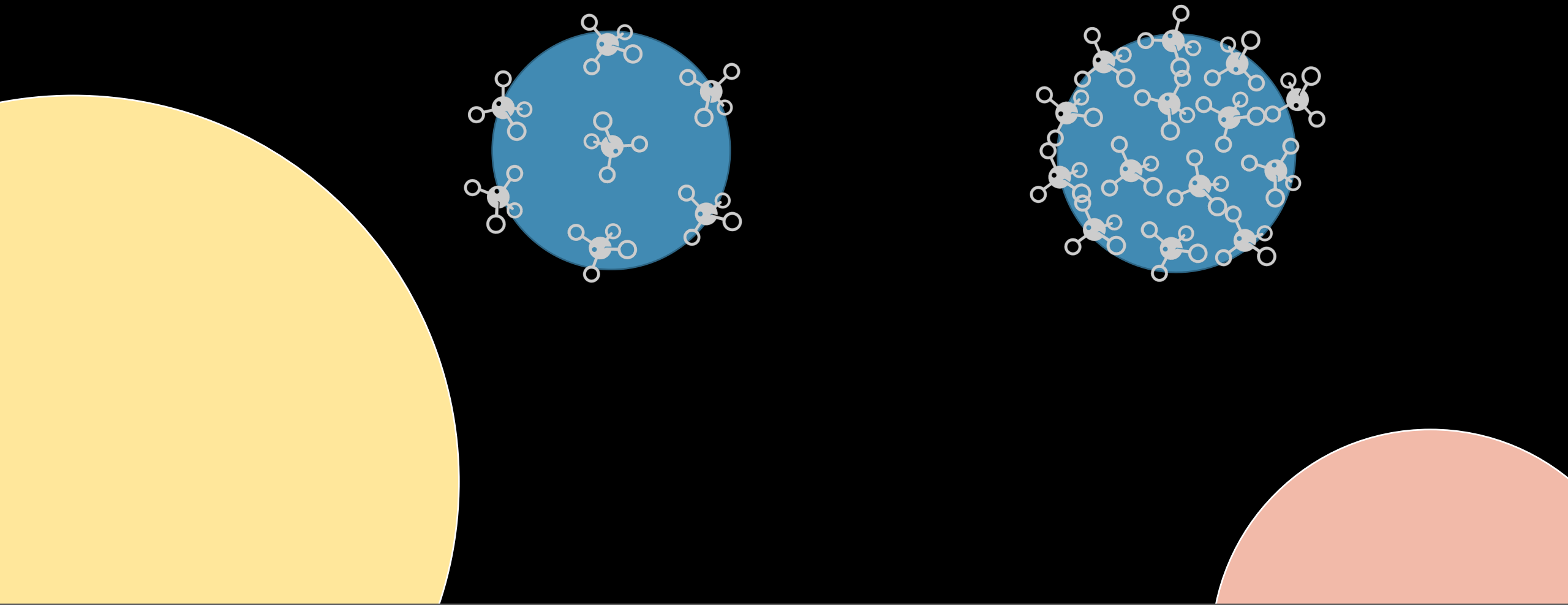


Clathrates



Impacts

False positives: abiotic signals that mimic life



Stellar spectrum matters!

Coping with ambiguities:

1. Look for odd couples (disequilibrium)



Coping with ambiguities:

2. Look for red flags (false positive indicators)



Betsy, 3

My milkshake brings all the boys to the yard



Doug, 4,219

Hot AF and lookin' for love on this big, flat Earth



Coping with ambiguities:

3. Take a raincheck (seasonality)

80 F



JUNE 23, 2018



JAN 30, 2019

-20 F

Coping with ambiguities:

3. Take a raincheck (seasonality)

A single observation



Many observations



Outline:

Josh Krissansen-Totton*



1. Disequilibrium

2. False positive indicators

3. Seasonality

*Save your hard questions for him

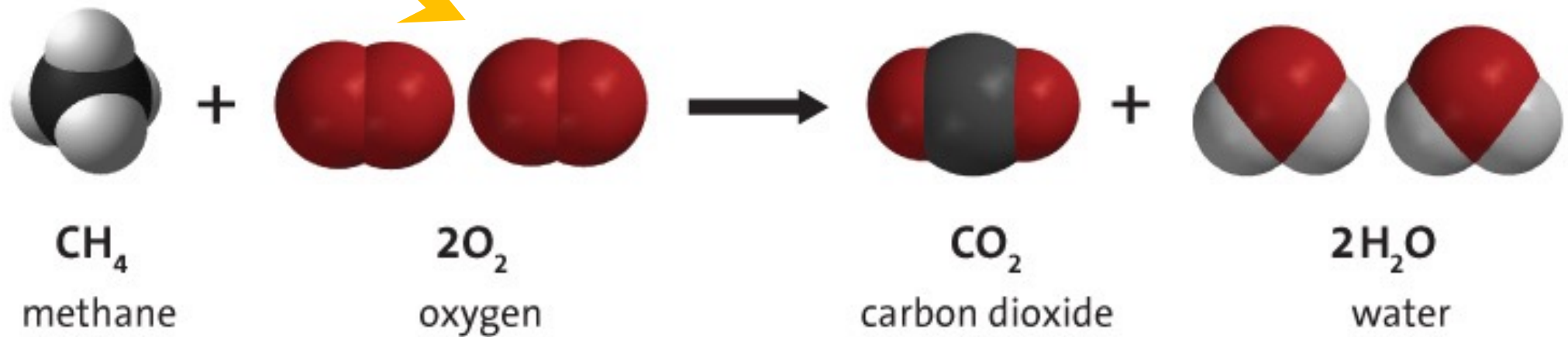


Disequilibrium

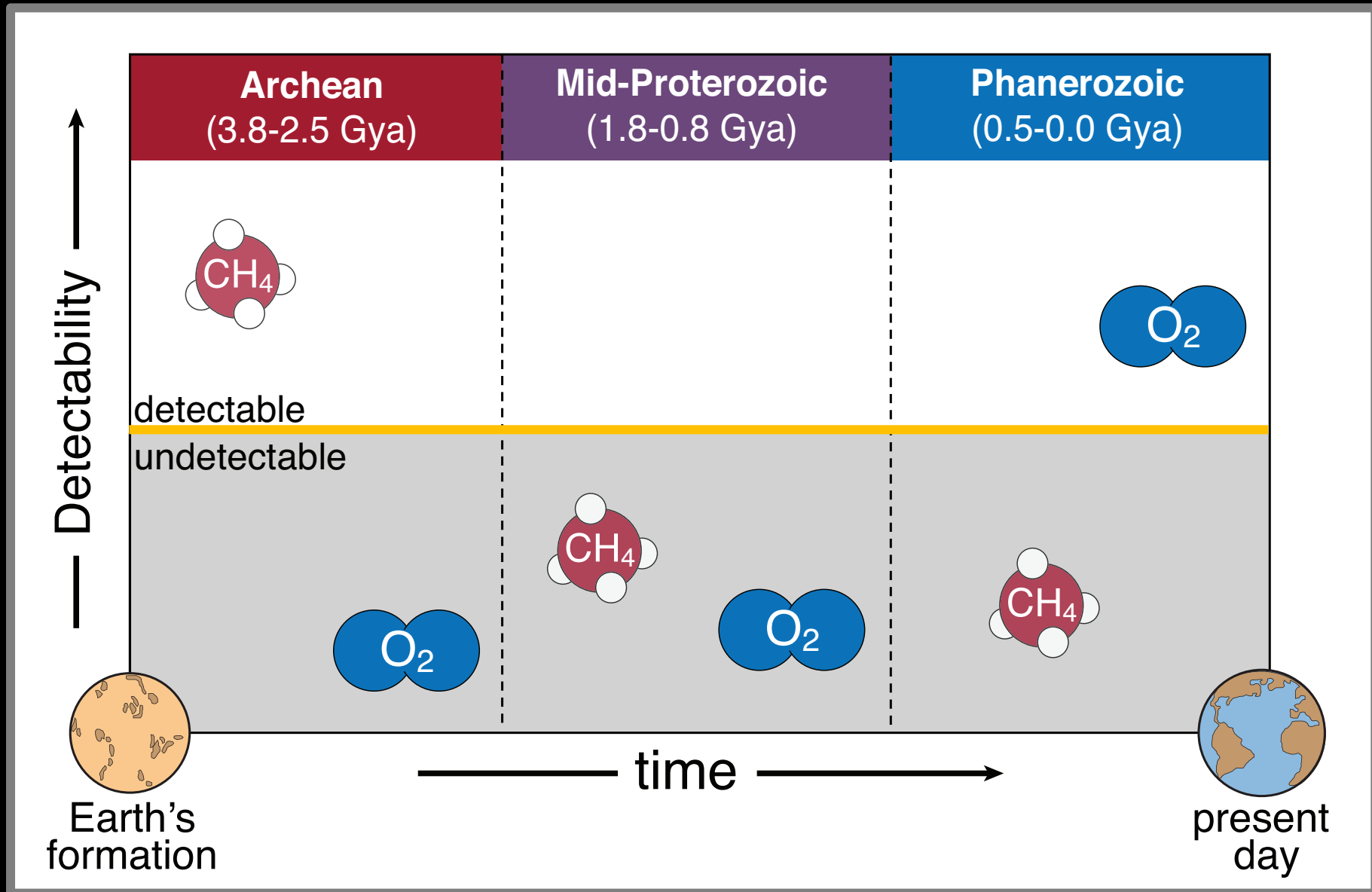
The co-existence of incompatible species

Methane and Oxygen co-exist on Earth thanks to large surface fluxes:

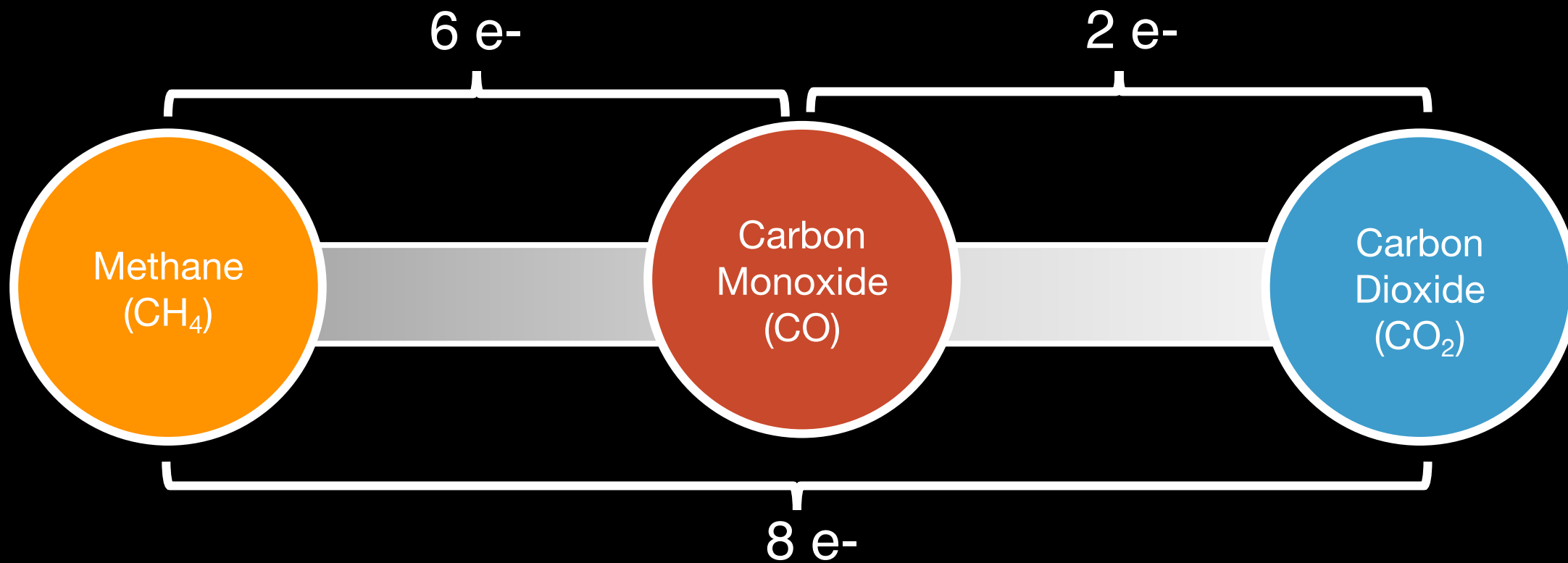
Oxygenic photosynthesis



Methanogenesis

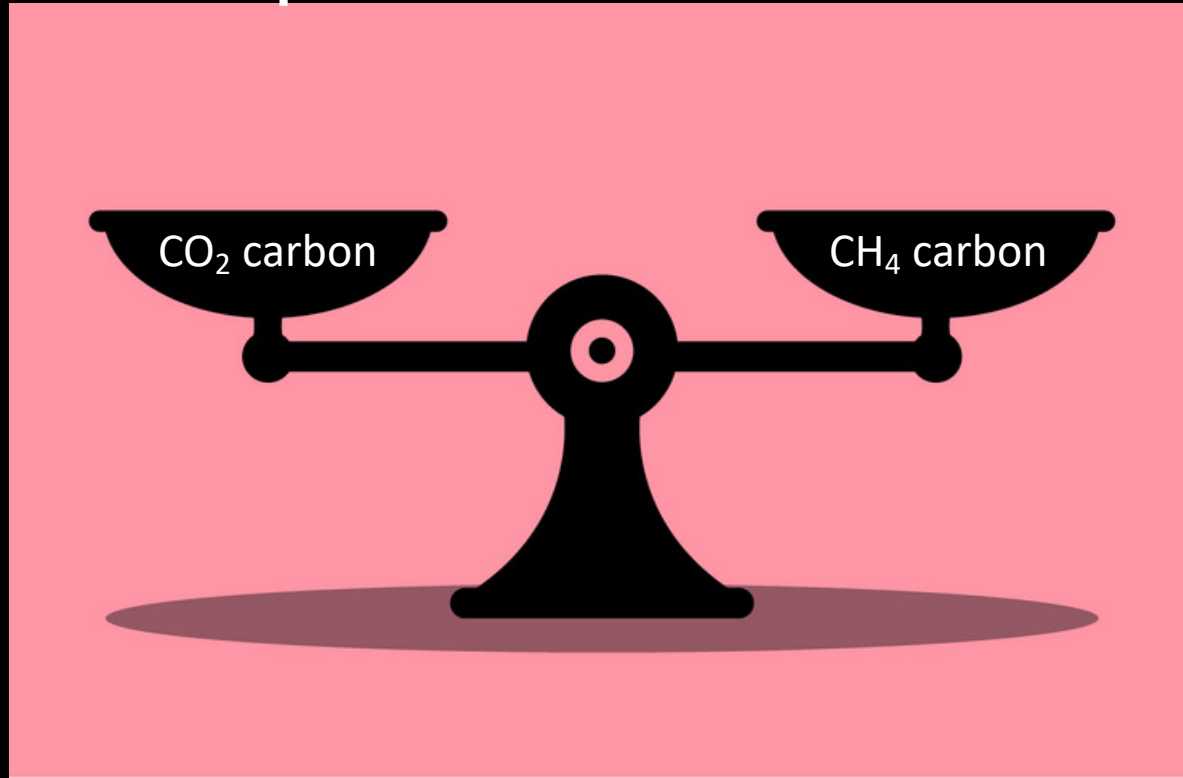


Reinhard et al., 2017, *Astrobiology*; Schwieterman et al., 2018, *Astrobiology*

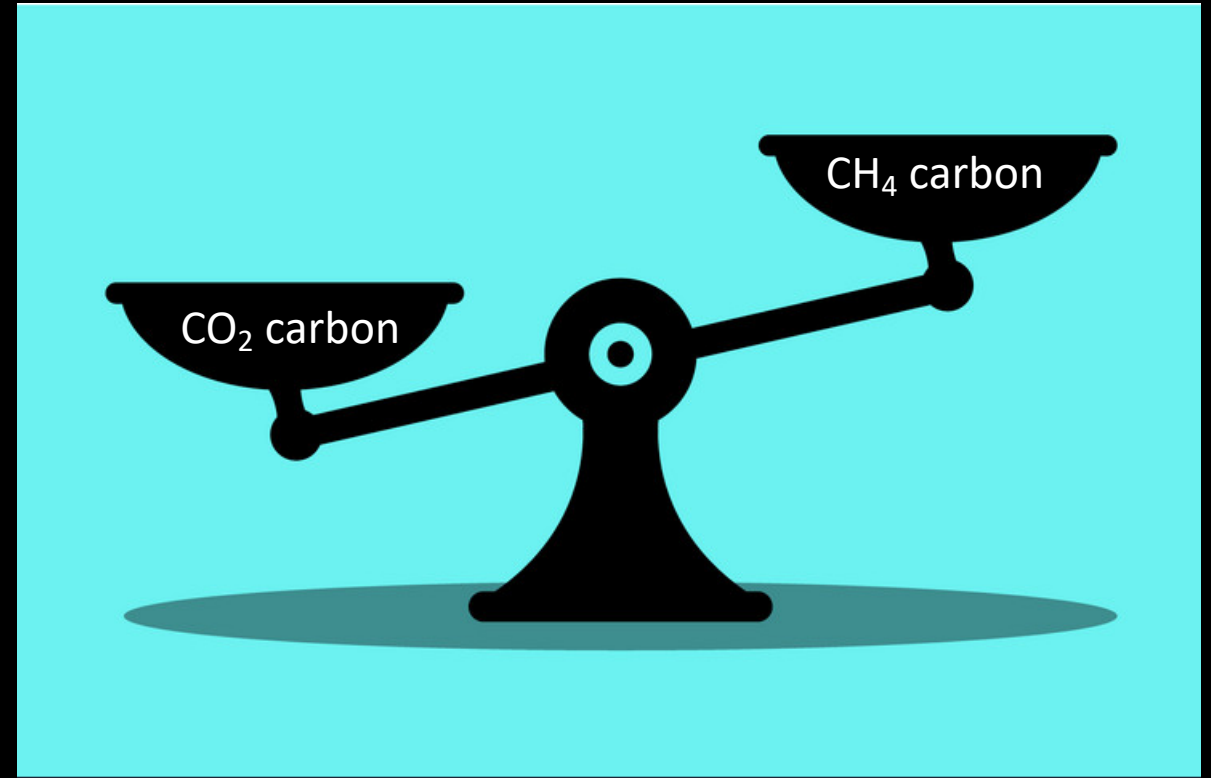


Isotope disequilibrium

False positive?



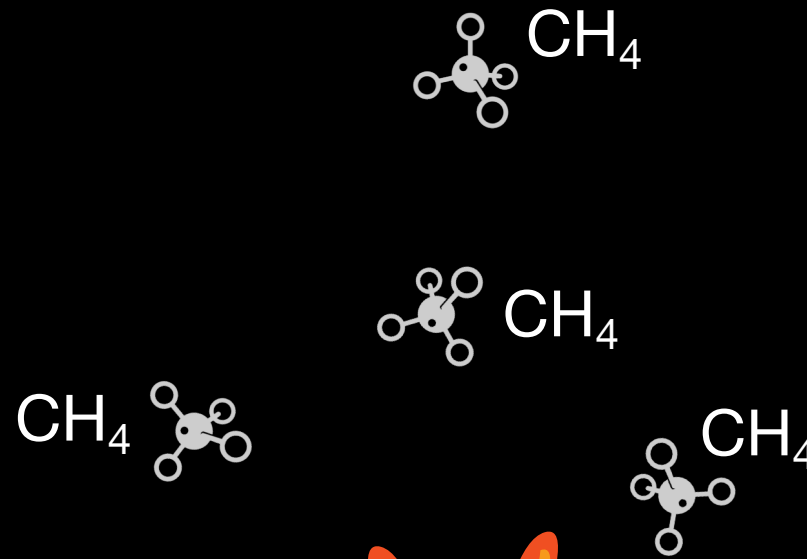
Life?





False positive indicators:

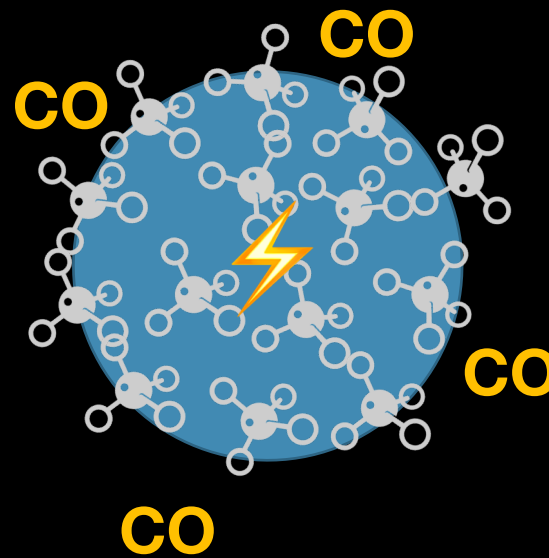
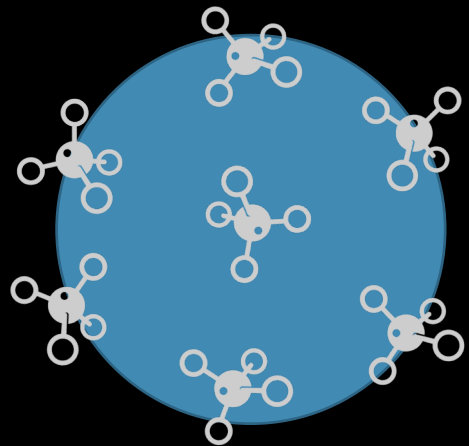




Geo methane (false positive)

≠

Sterile planet



Photochemical CO does NOT
inform surface CH₄ source

Stellar spectrum matters!

Other types of red flags:

Antibiosignatures: evidence for the absence of life on an apparently habitable planet—just as nuanced as biosignatures (no clear examples).

Classical* wisdom: CO is a tasty molecule; high levels are incompatible with life

Reality: Life on Earth makes more CO than it eats.

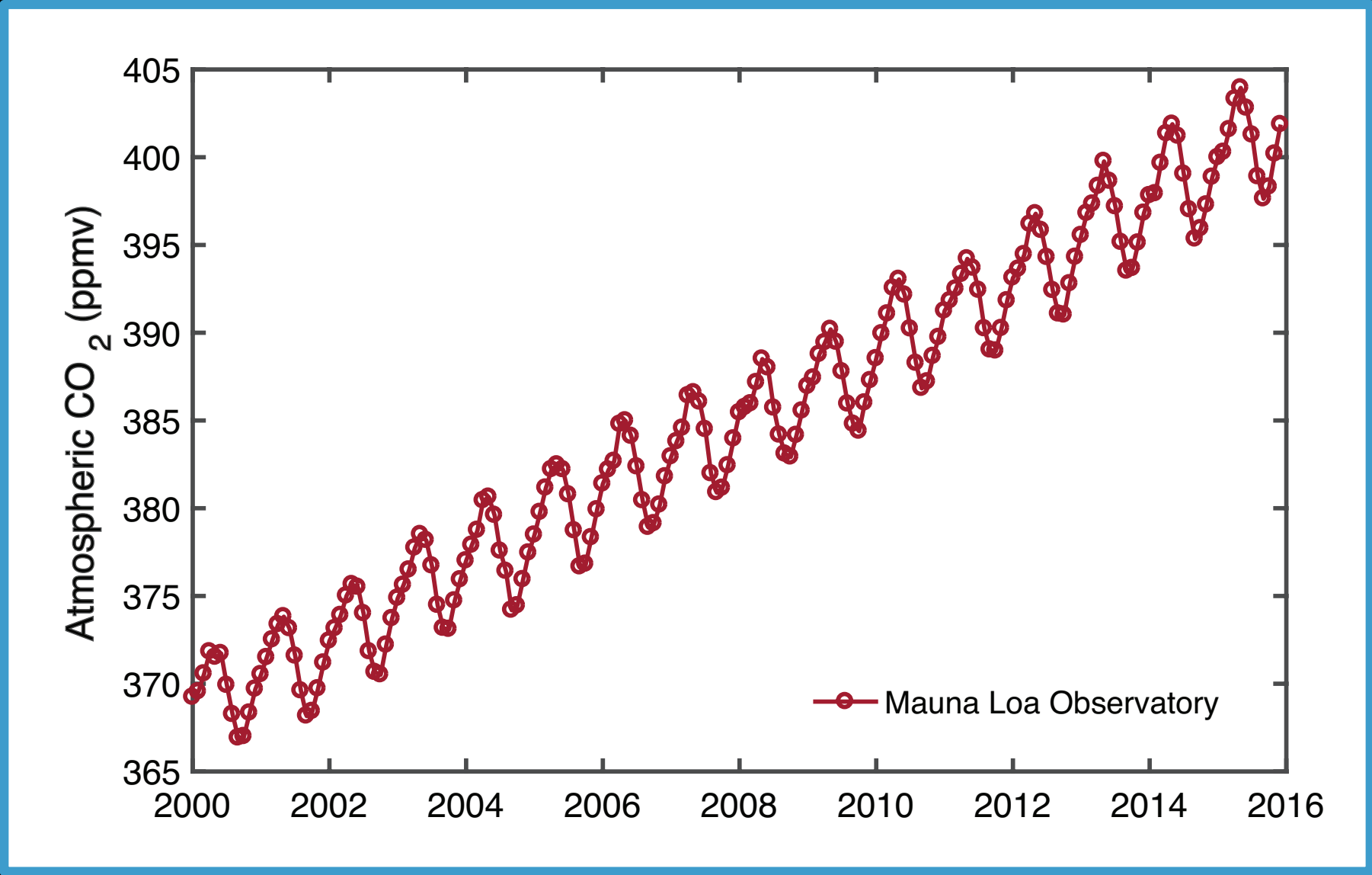
Other types of red flags:

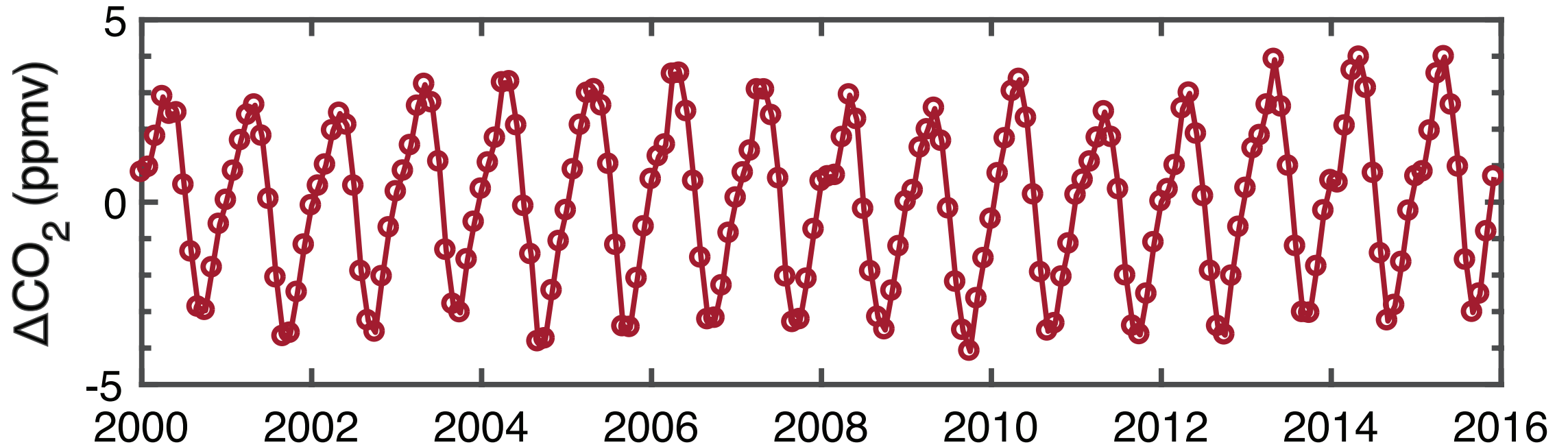
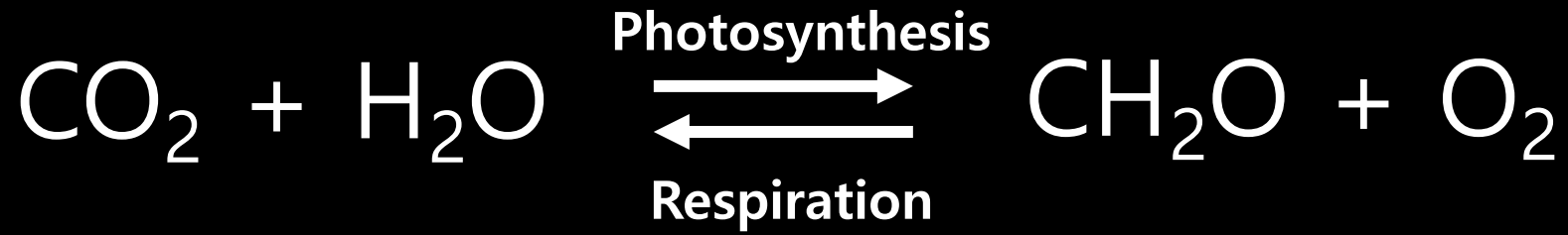
Antibiosignatures: evidence for the absence of life on an apparently habitable planet—just as nuanced as biosignatures (no clear examples).

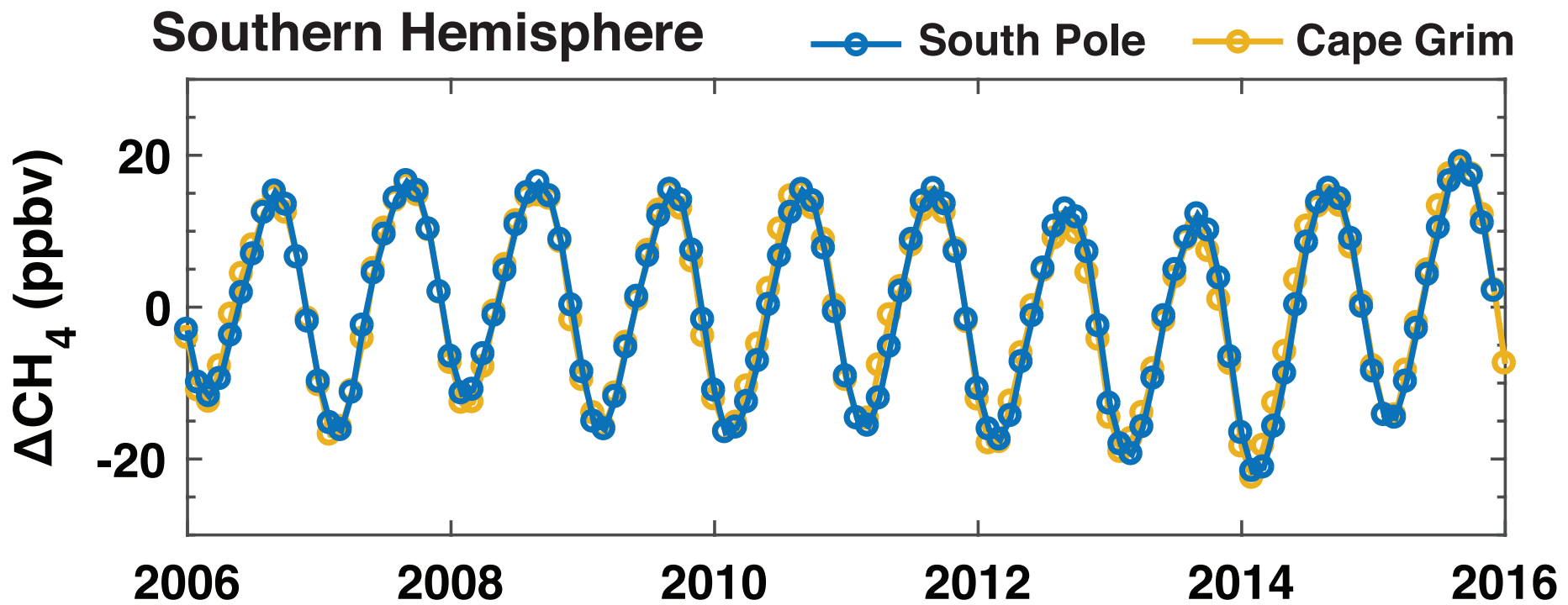
Habitability precluders: evidence that a planet isn't actually capable of supporting life as we know it (e.g., no water).

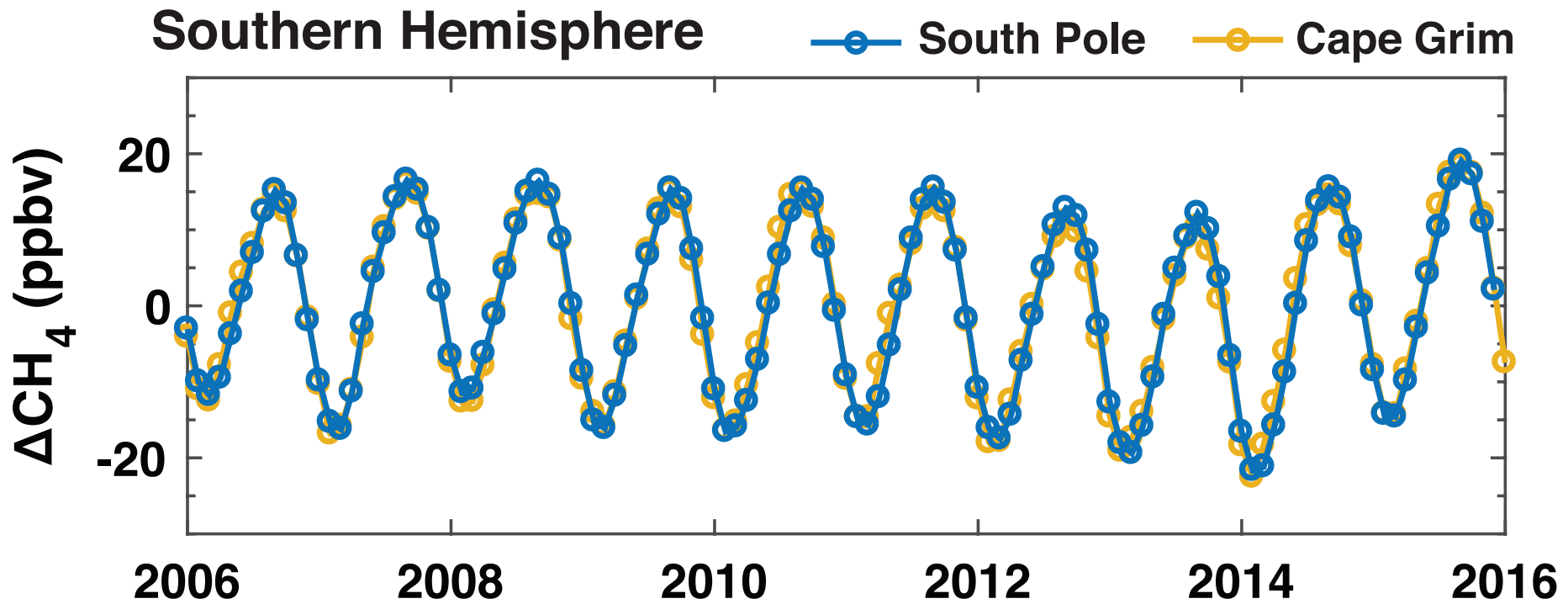
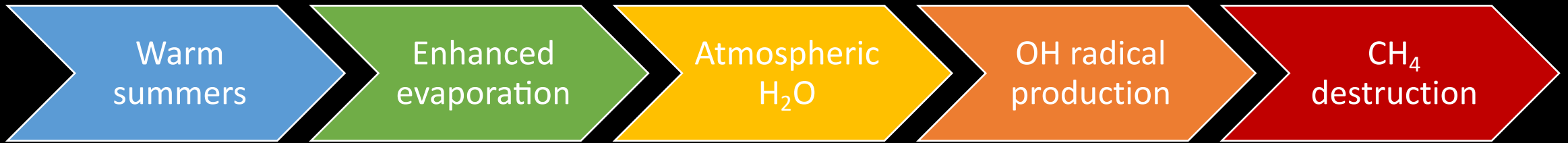


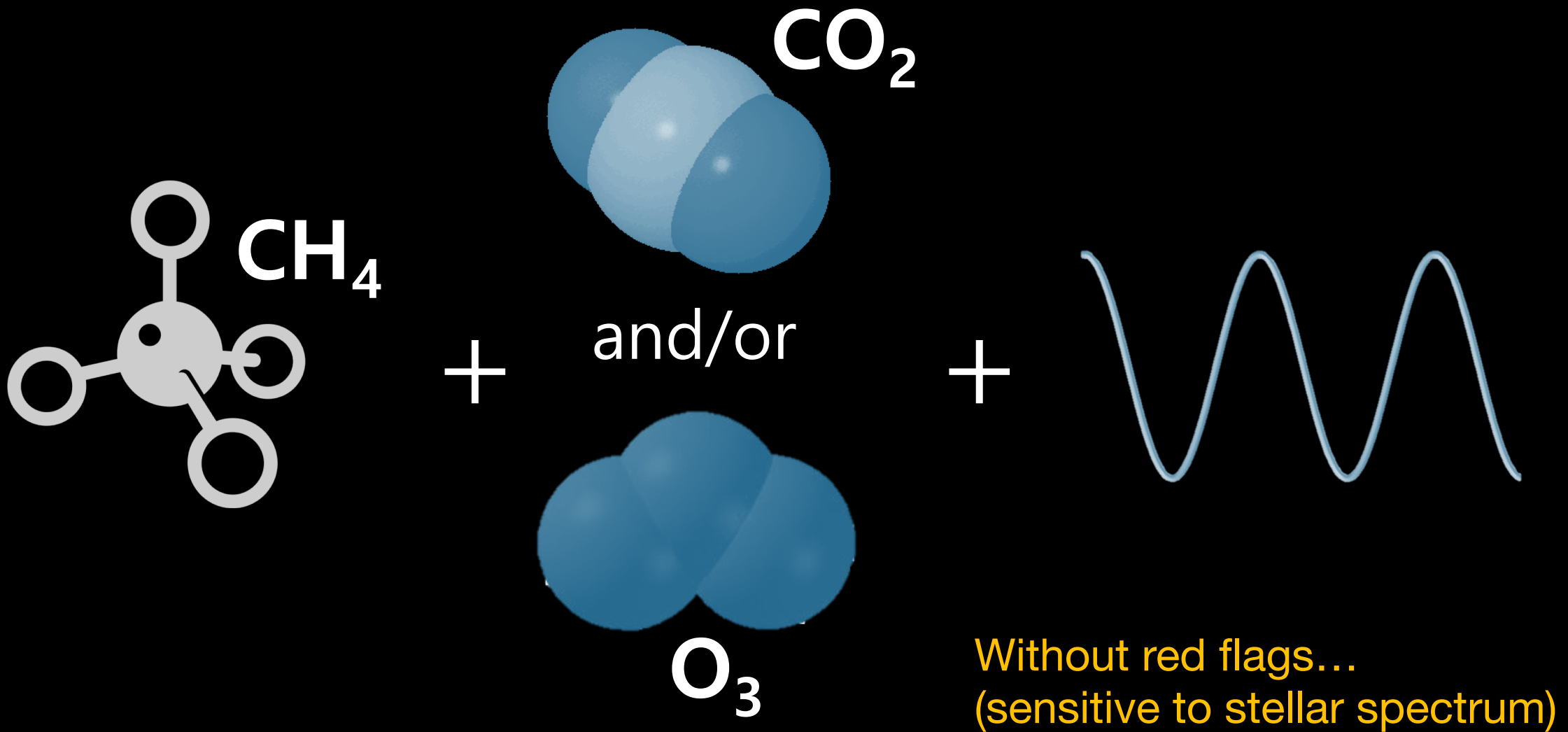
Seasonality: the pulse of a biosphere











Methane biosignatures: best case scenario

METHANE AS A BIOSIGNATURE

Need:

Stellar context

Want:

Disequilibrium

Absence of red flags

Wish list:

Seasonality

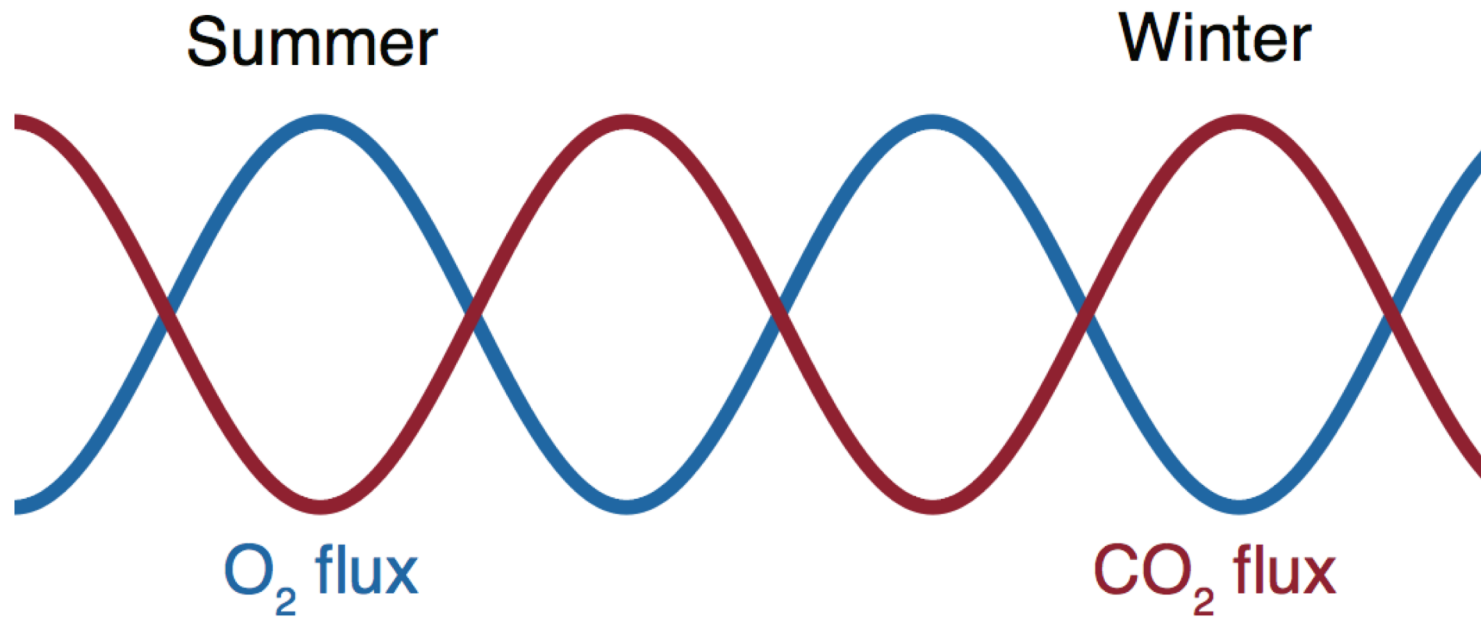
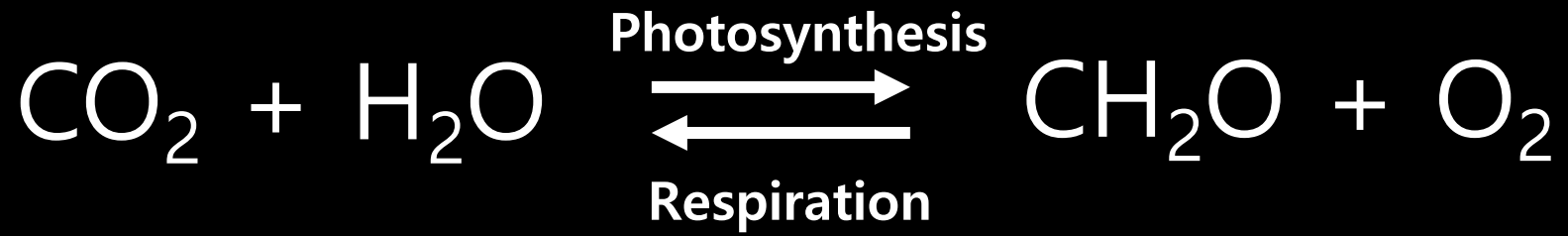
Isotopes



stephanieolson@uchicago.edu



Ask me about student and postdoc opportunities at Purdue for Fall 2020!



Winter O₂ minimum

Annual average

Summer O₂ maximum

