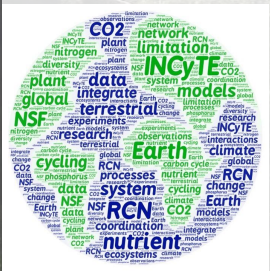


Flexible foliar stoichiometry reduces the magnitude of the land C sink

Emma Hauser¹, Will Wieder², Gordon Bonan², Sam Levis², Cory Cleveland¹

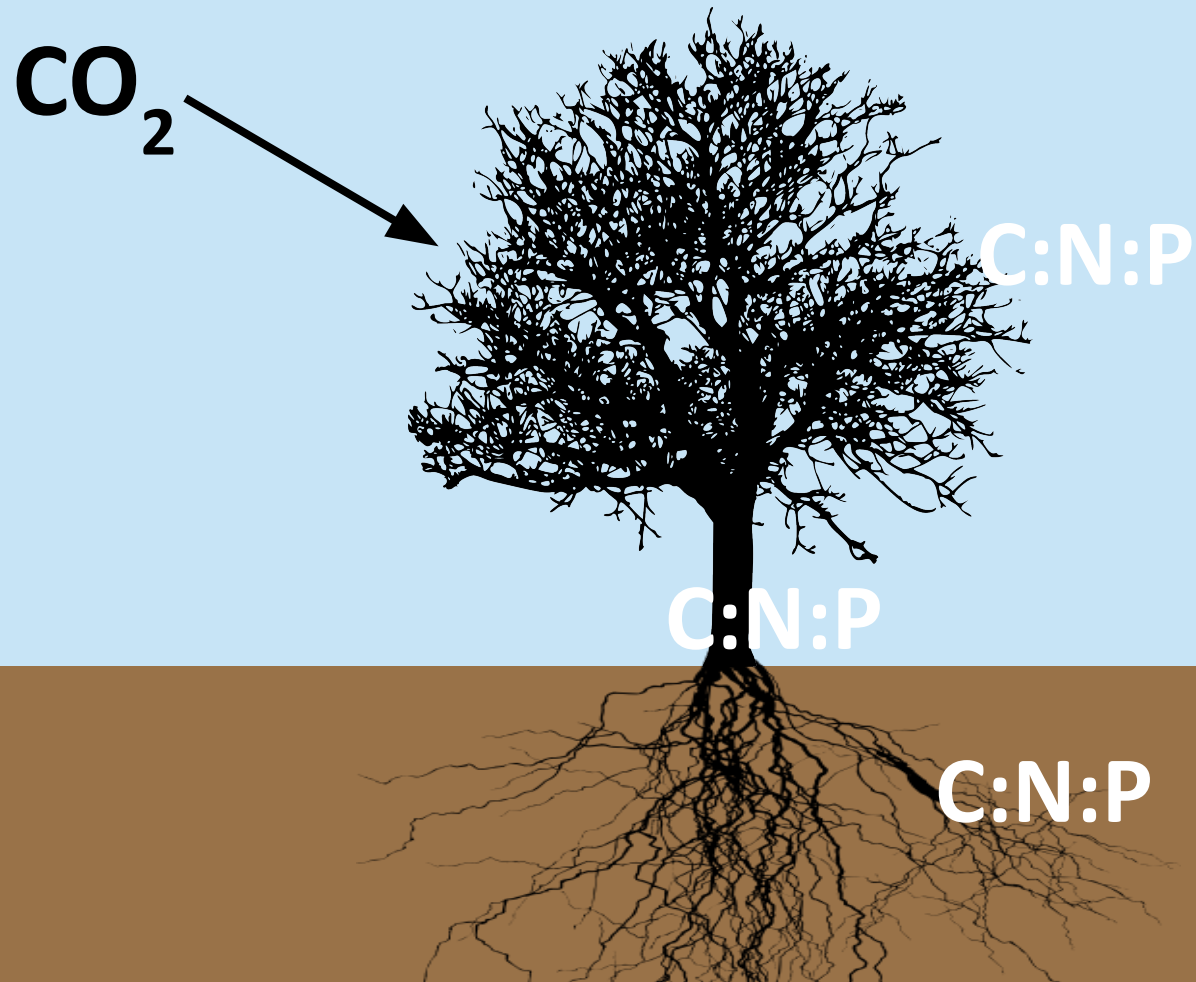
¹The University of Montana, ²National Center for Atmospheric Research

Wednesday, February 8, 2023

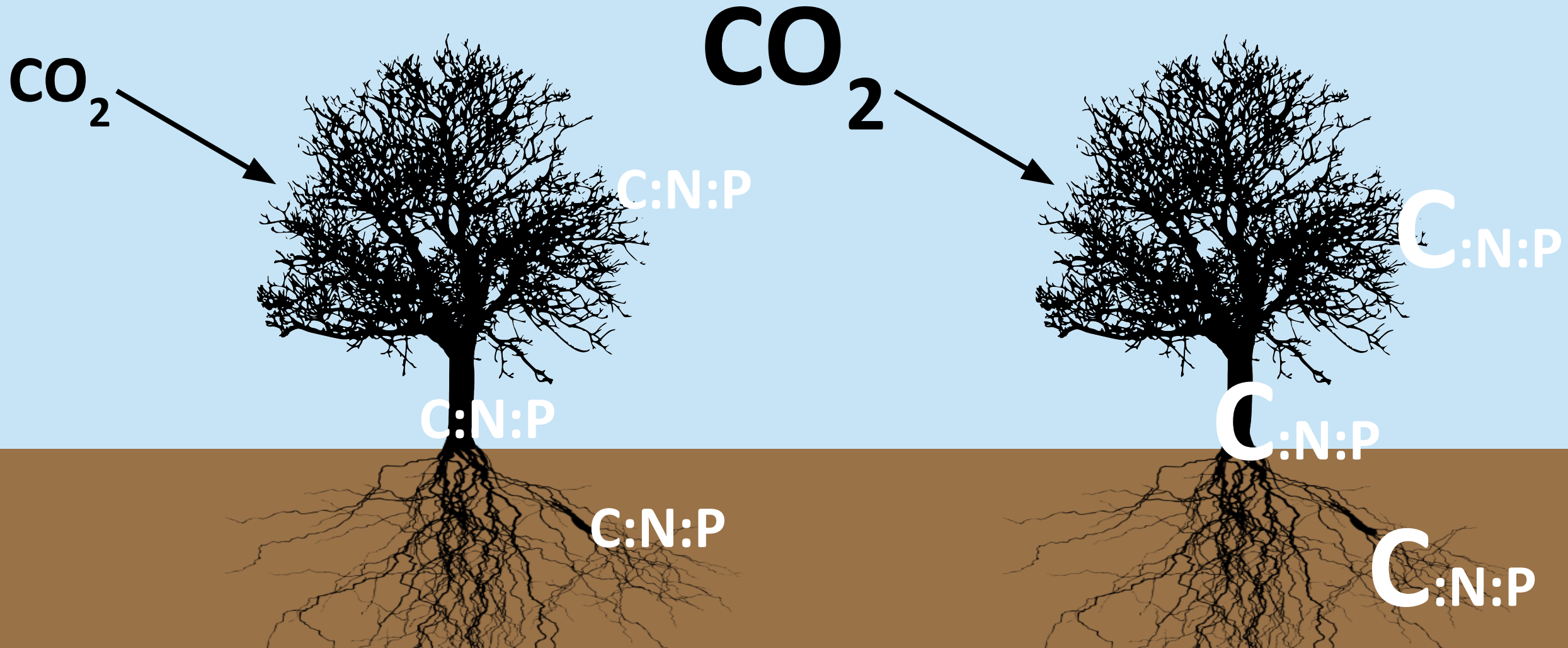


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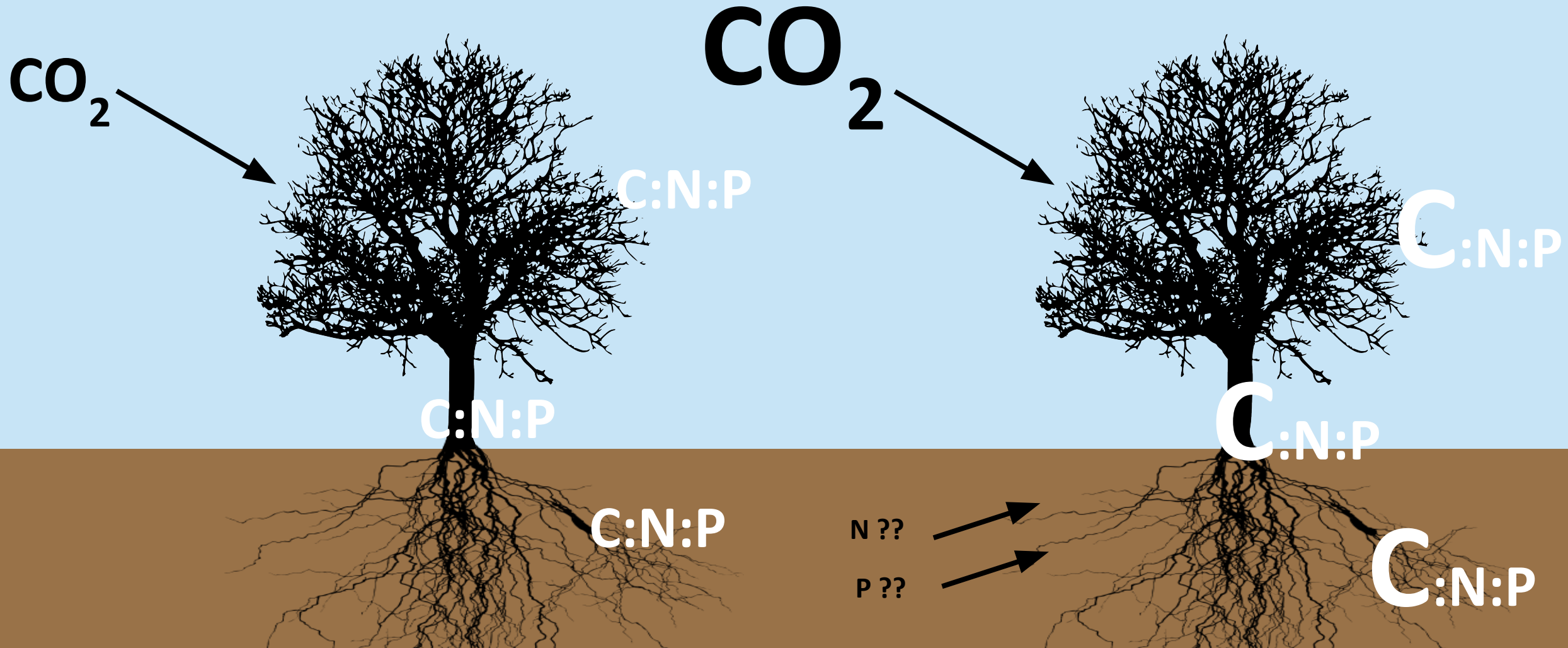
Uncertainty in the land C sink is partly due to uncertainty in vegetation response to rising CO₂.



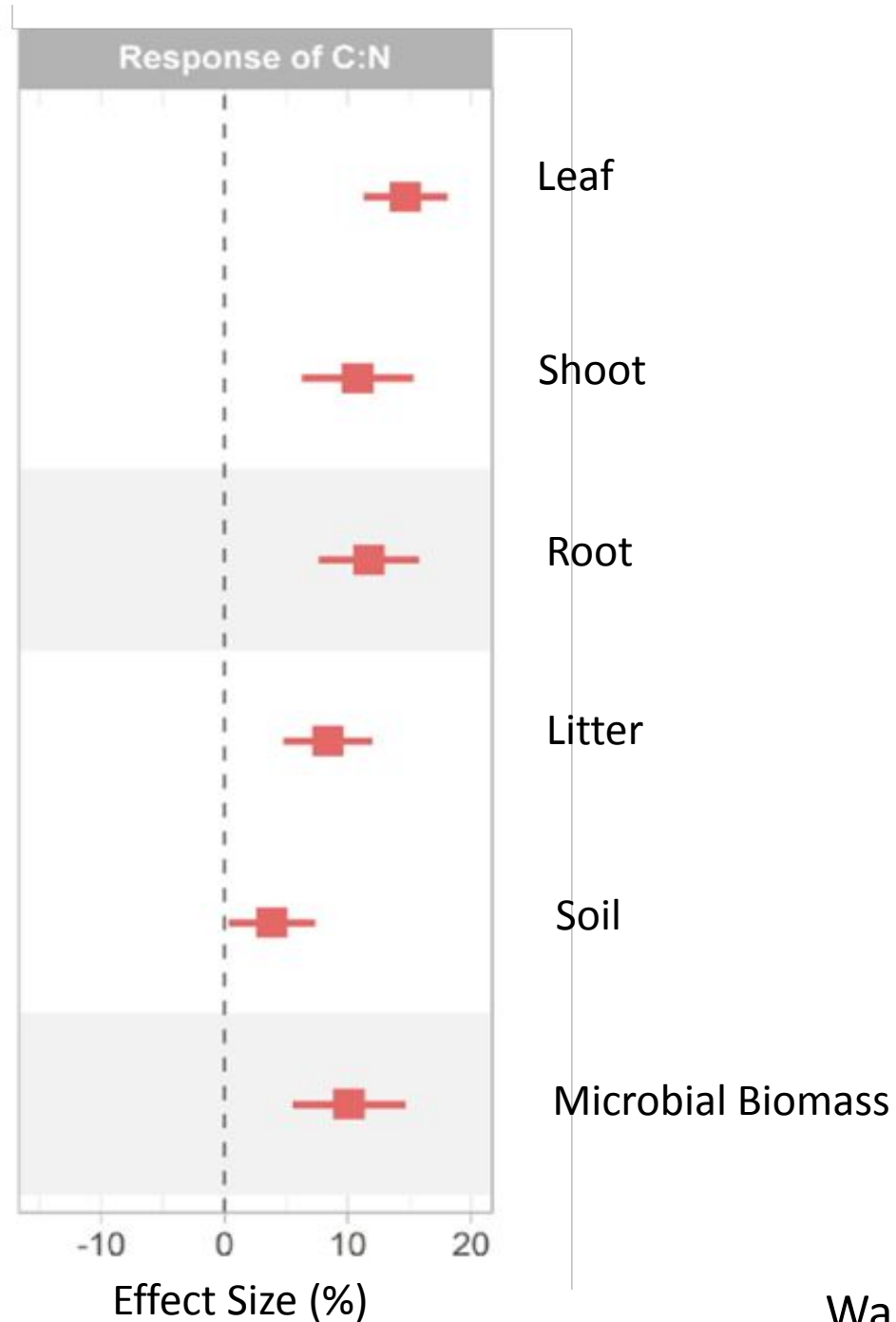
Foliar stoichiometry may regulate the strength of the CO₂ fertilization effect.



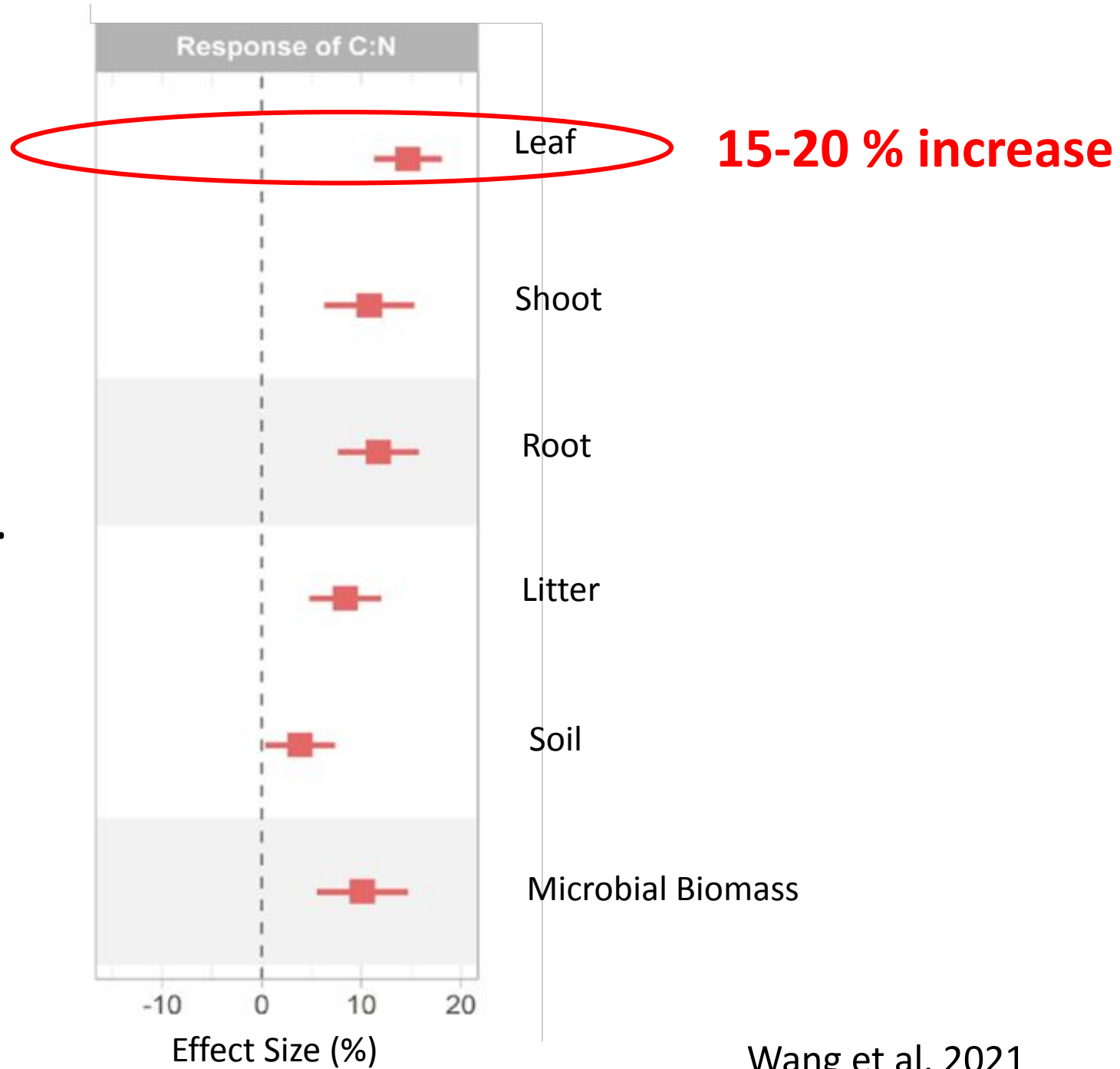
Foliar stoichiometry may regulate the strength of the CO₂ fertilization effect.

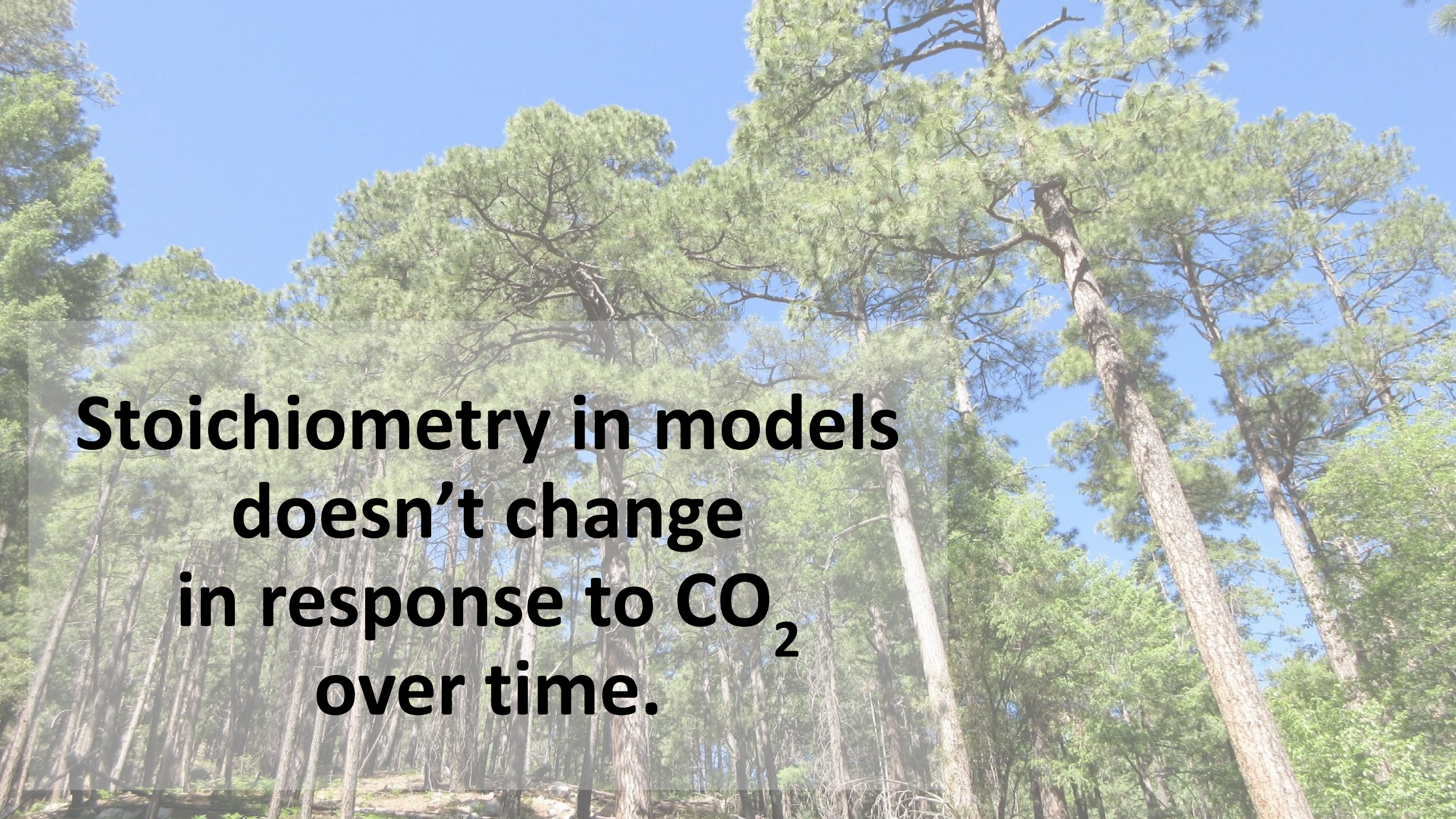


Foliar C:N increases under elevated CO₂.

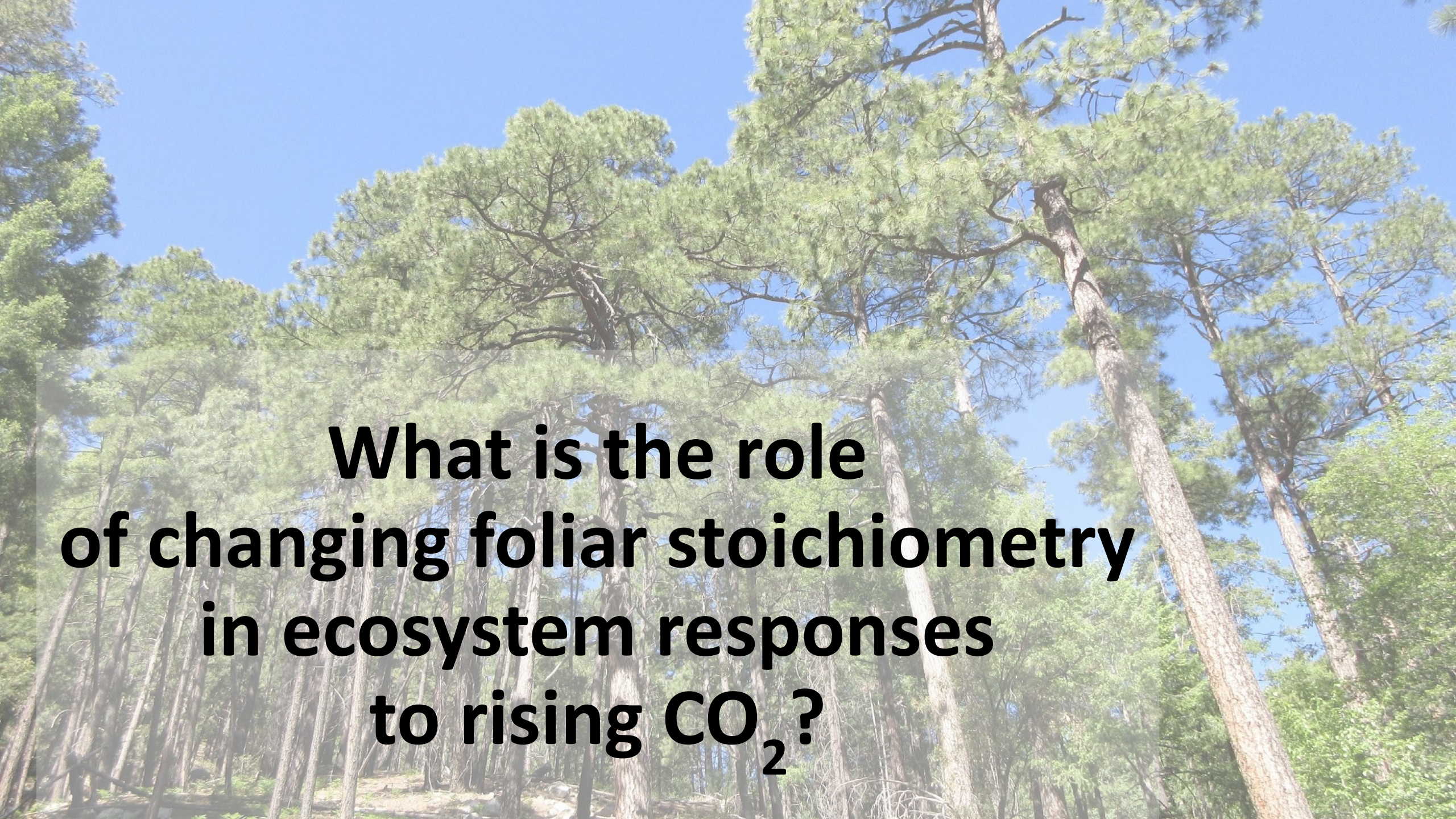


Foliar C:N increases under elevated CO₂.

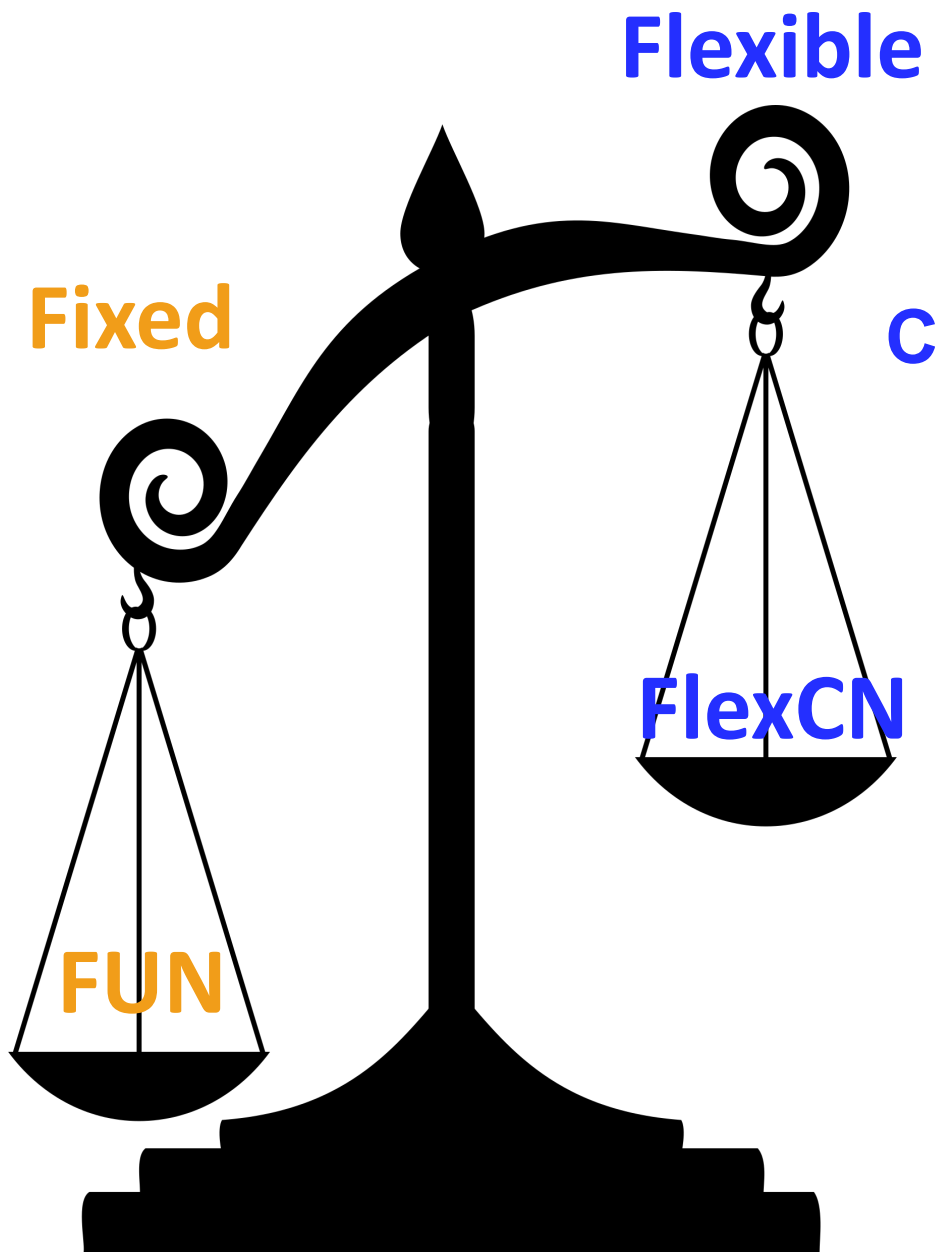




**Stoichiometry in models
doesn't change
in response to CO₂
over time.**



**What is the role
of changing foliar stoichiometry
in ecosystem responses
to rising CO₂?**



Fixed

Flexible

$$CN_{PFT} + \max(0, CN_{slope} * \log(CO2_{now} / CO2_{base}))$$

LeafCN =

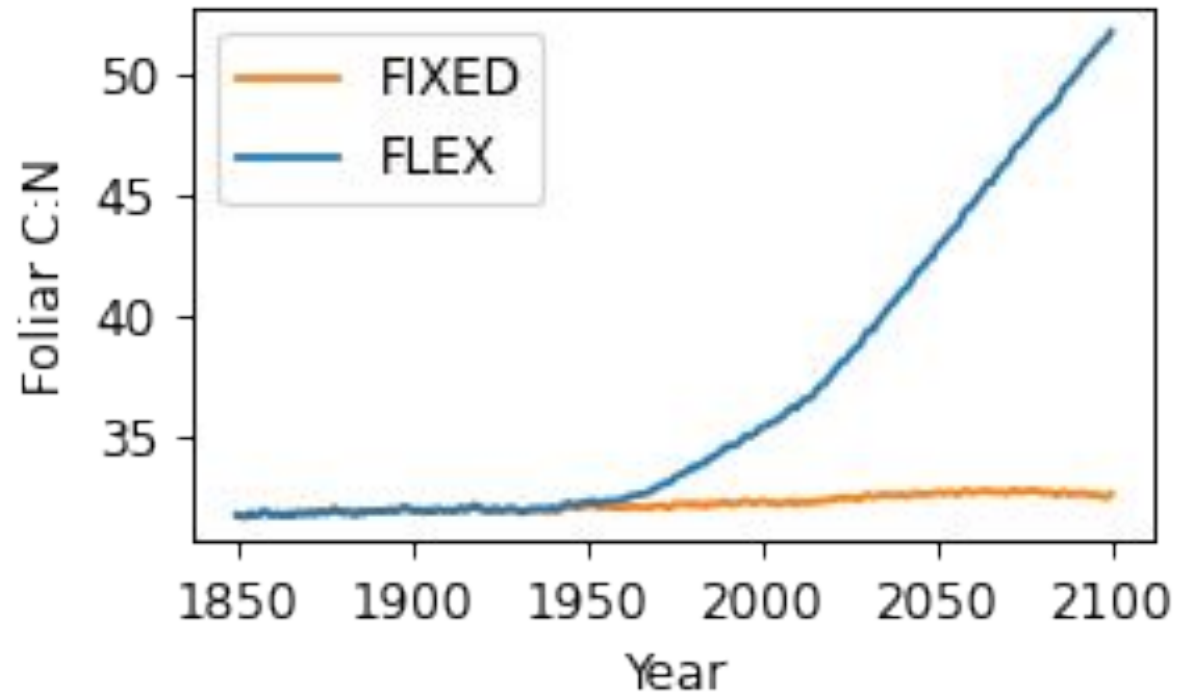
co2_base = 310 ppm

cn_slope = 20 or 0

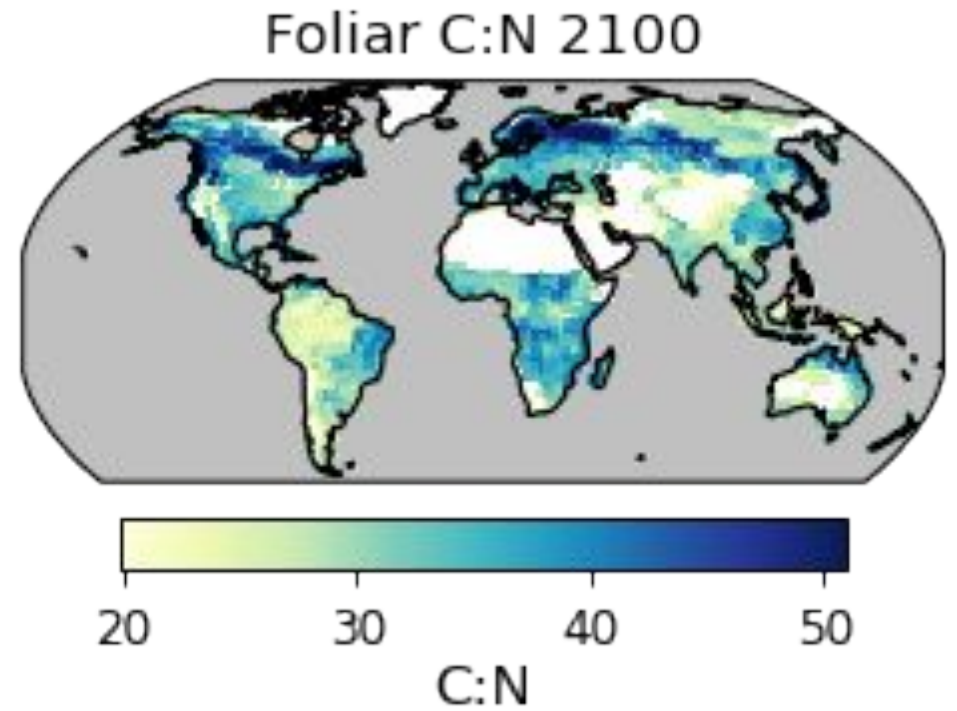
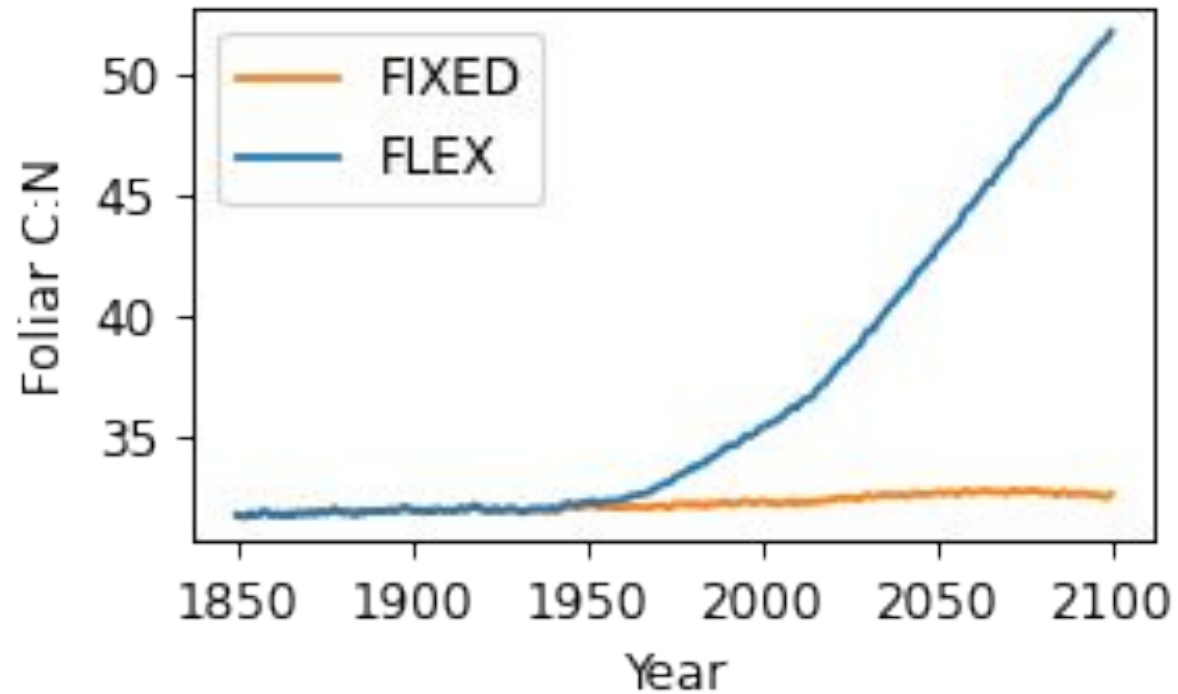
FlexCN

FUN

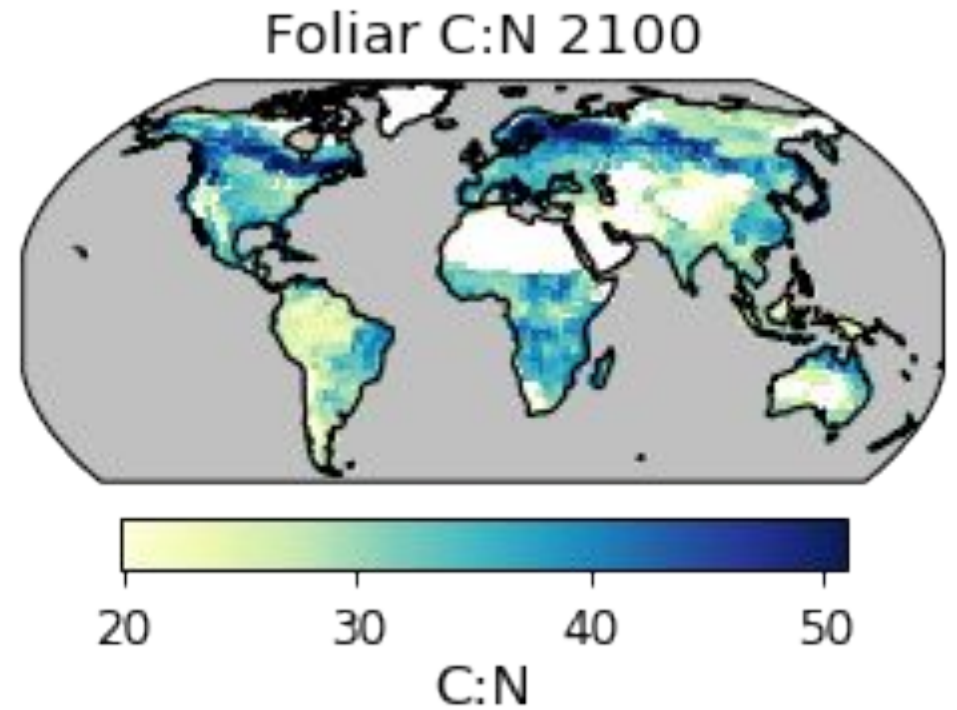
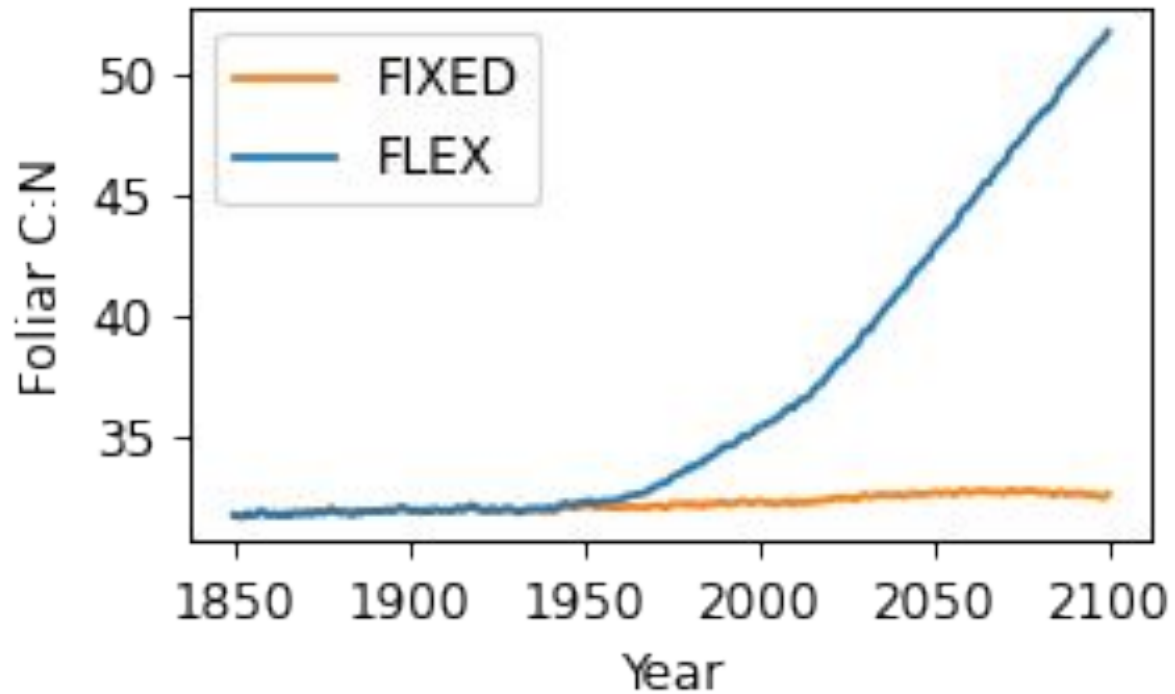
CO₂ based foliar C:N parameterization in the Community Land Model



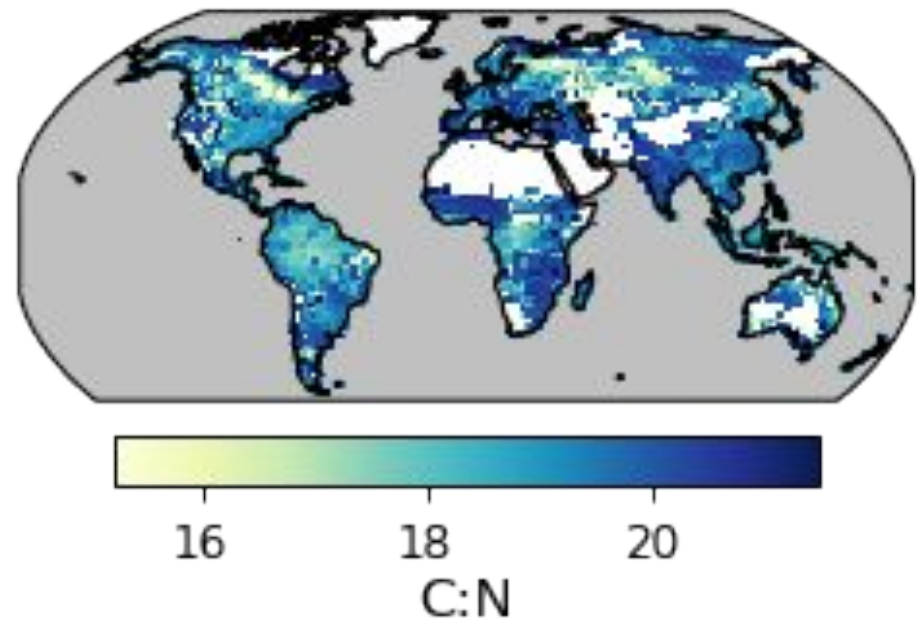
CO₂ based foliar C:N parameterization in the Community Land Model

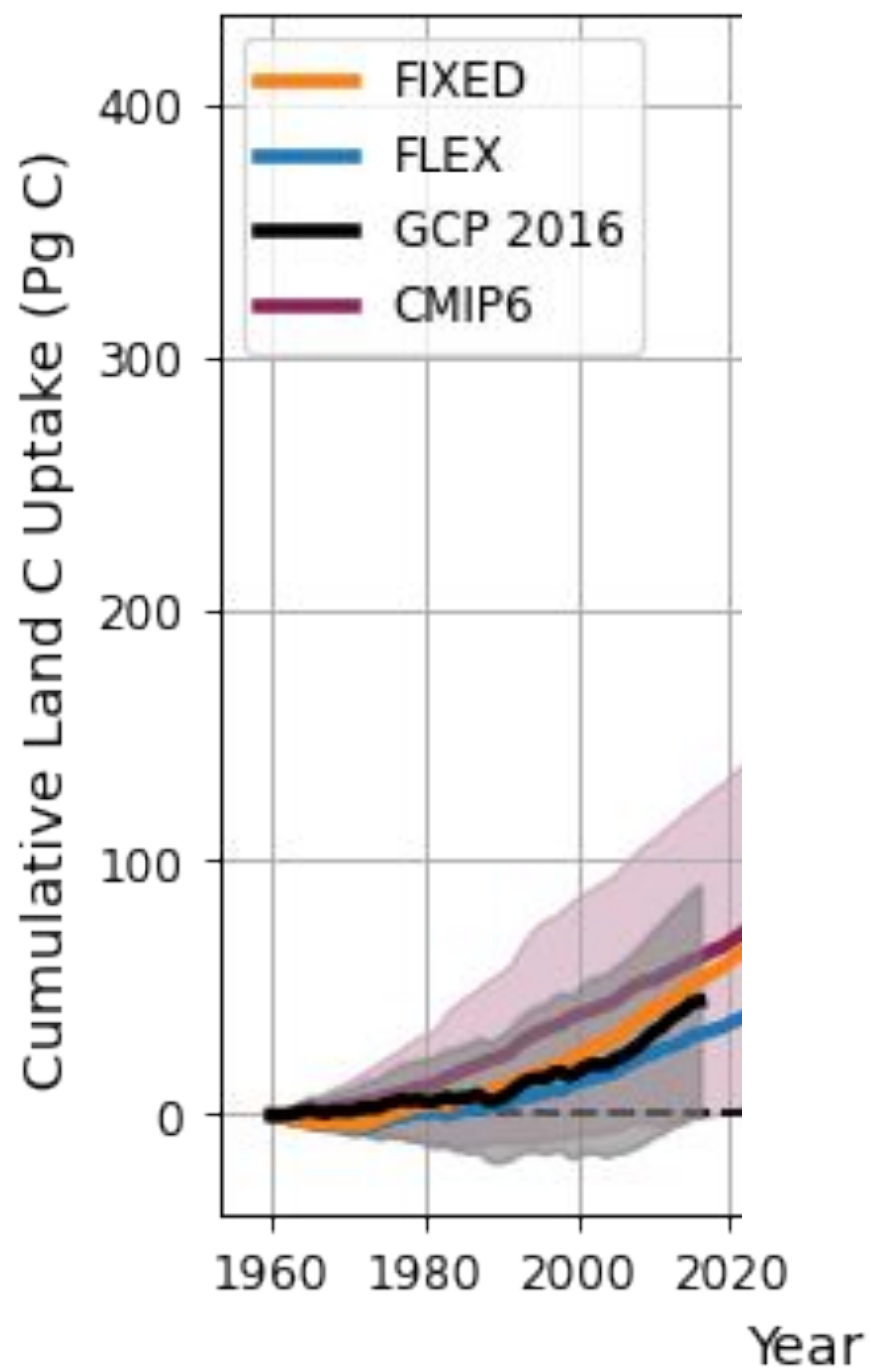


CO₂ based foliar C:N parameterization in the Community Land Model

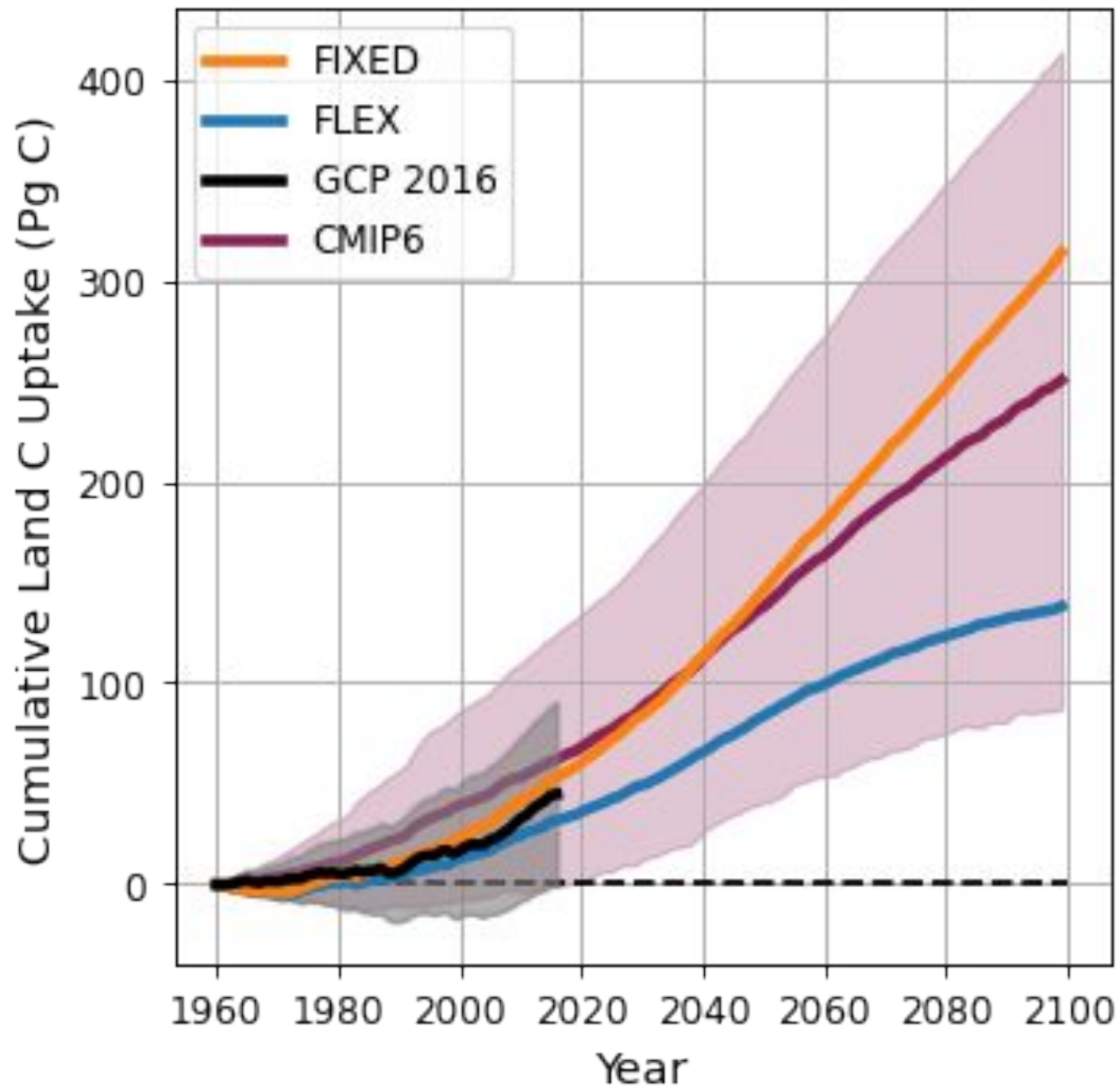


Difference between Fixed and Flex in 2100



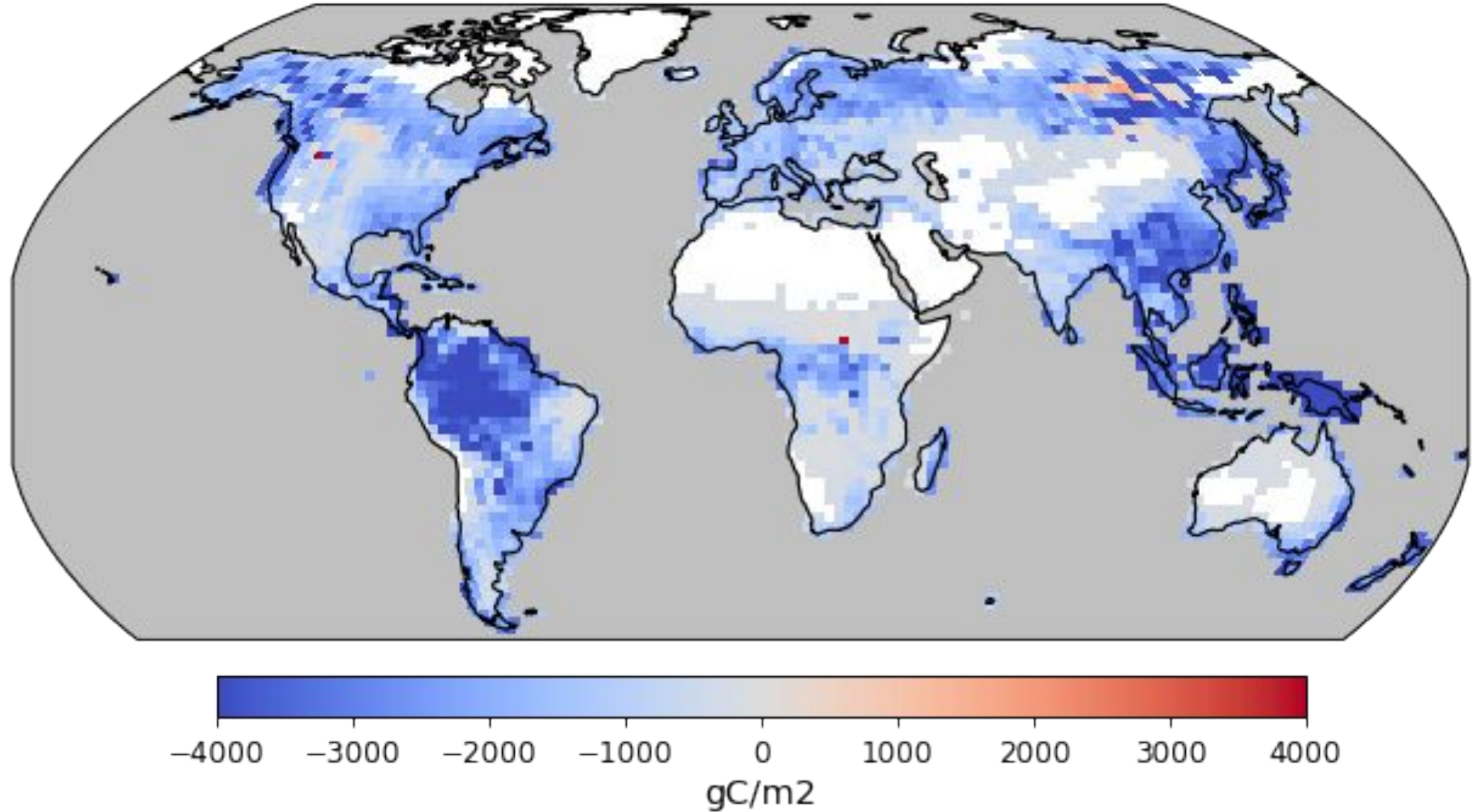


**Flexible C:N reduces
land C sink
by ~200 Pg C**

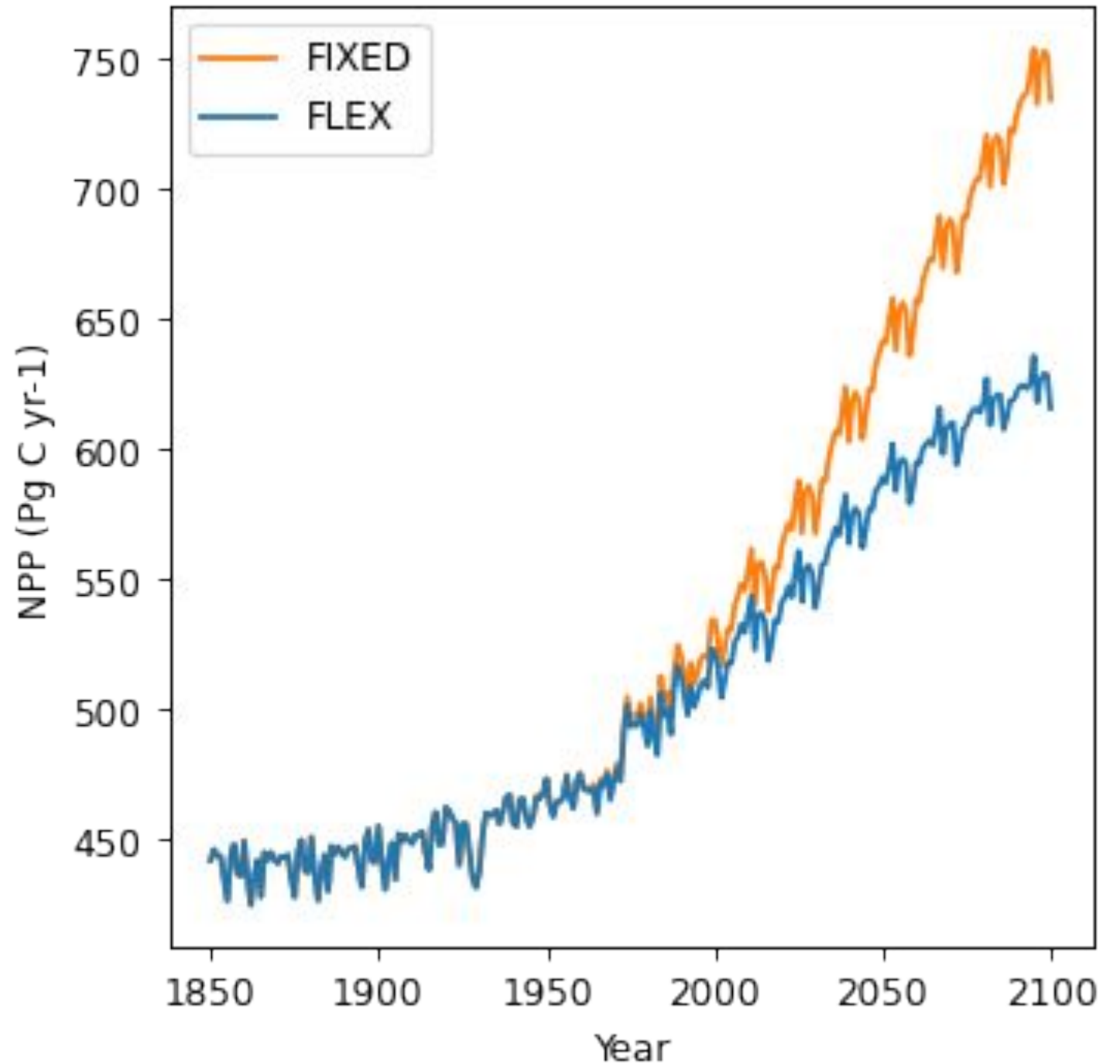


Flexible C:N reduces land C sink by ~ 200 Pg C

Difference between FIXED and FLEX in 2100

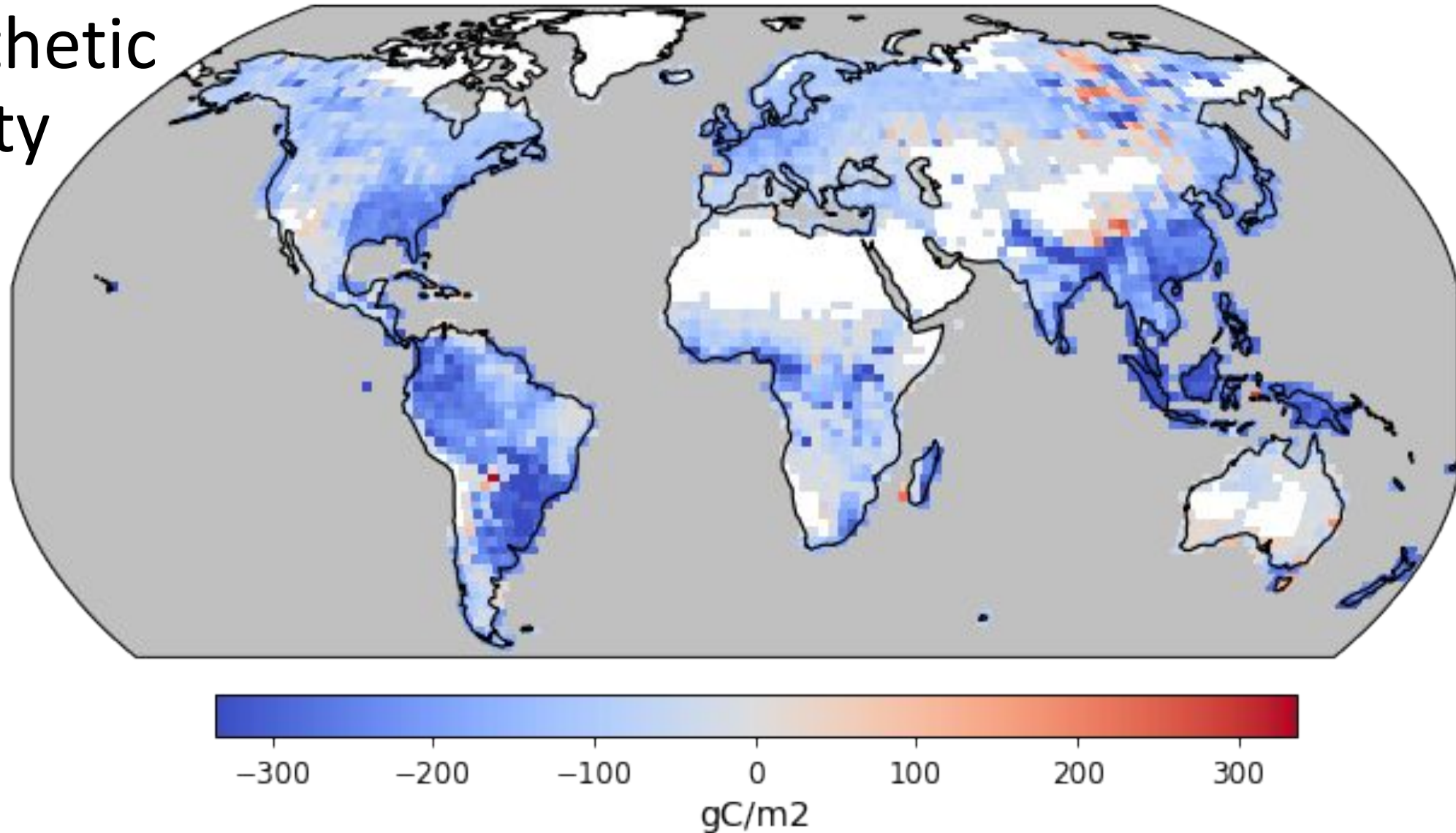


**C sink reduction
is due to
reduced
photosynthetic
capacity**



C sink reduction is
due to reduced
photosynthetic
capacity

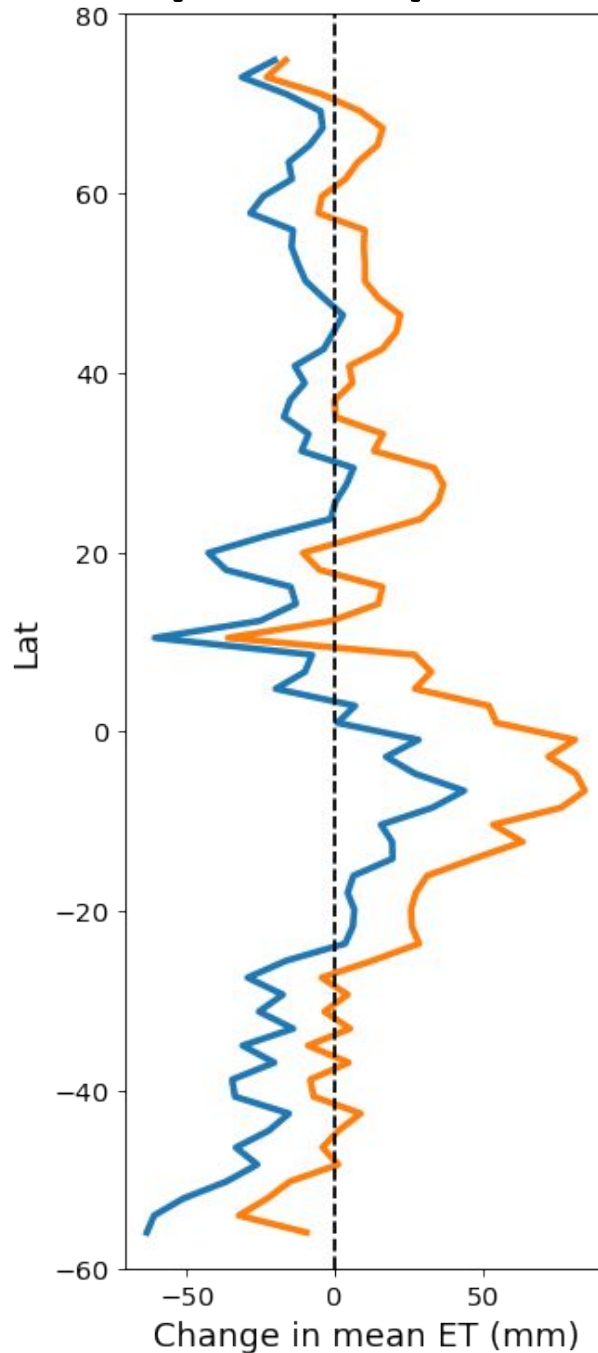
Difference between FIXED and FLEX in 2100



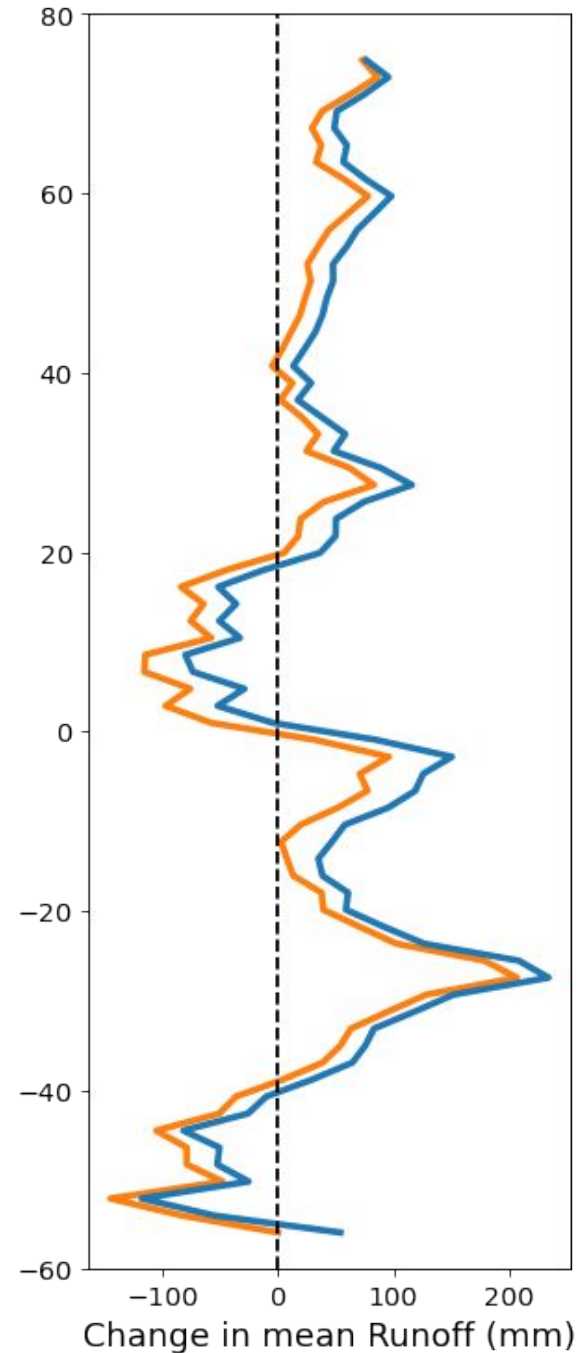
Foliar C:N changes
also affect
hydrologic processes

FLEX
FIXED

Evapotranspiration



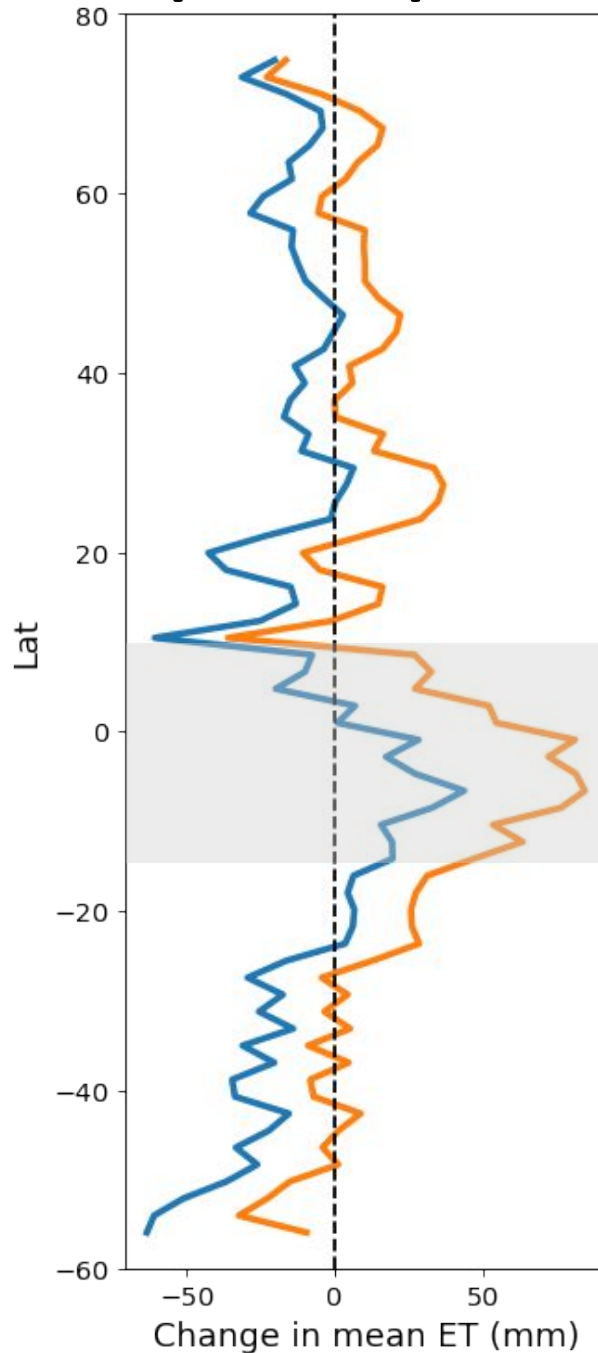
Runoff



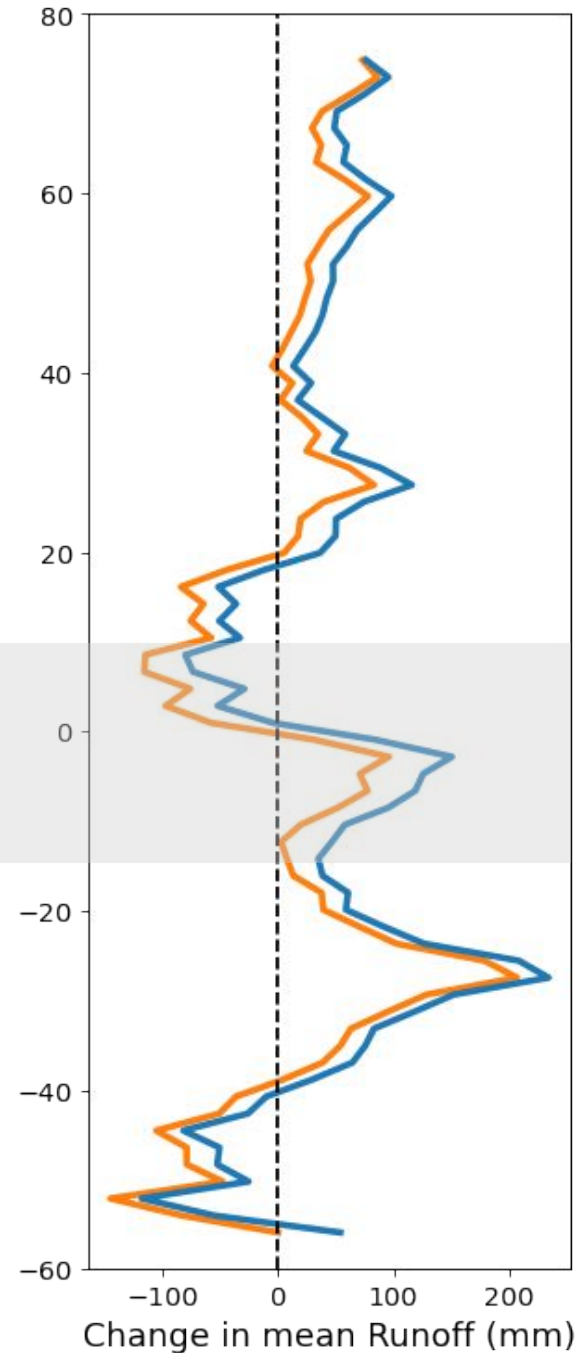
Foliar C:N changes
also affect
hydrologic processes

FLEX
FIXED

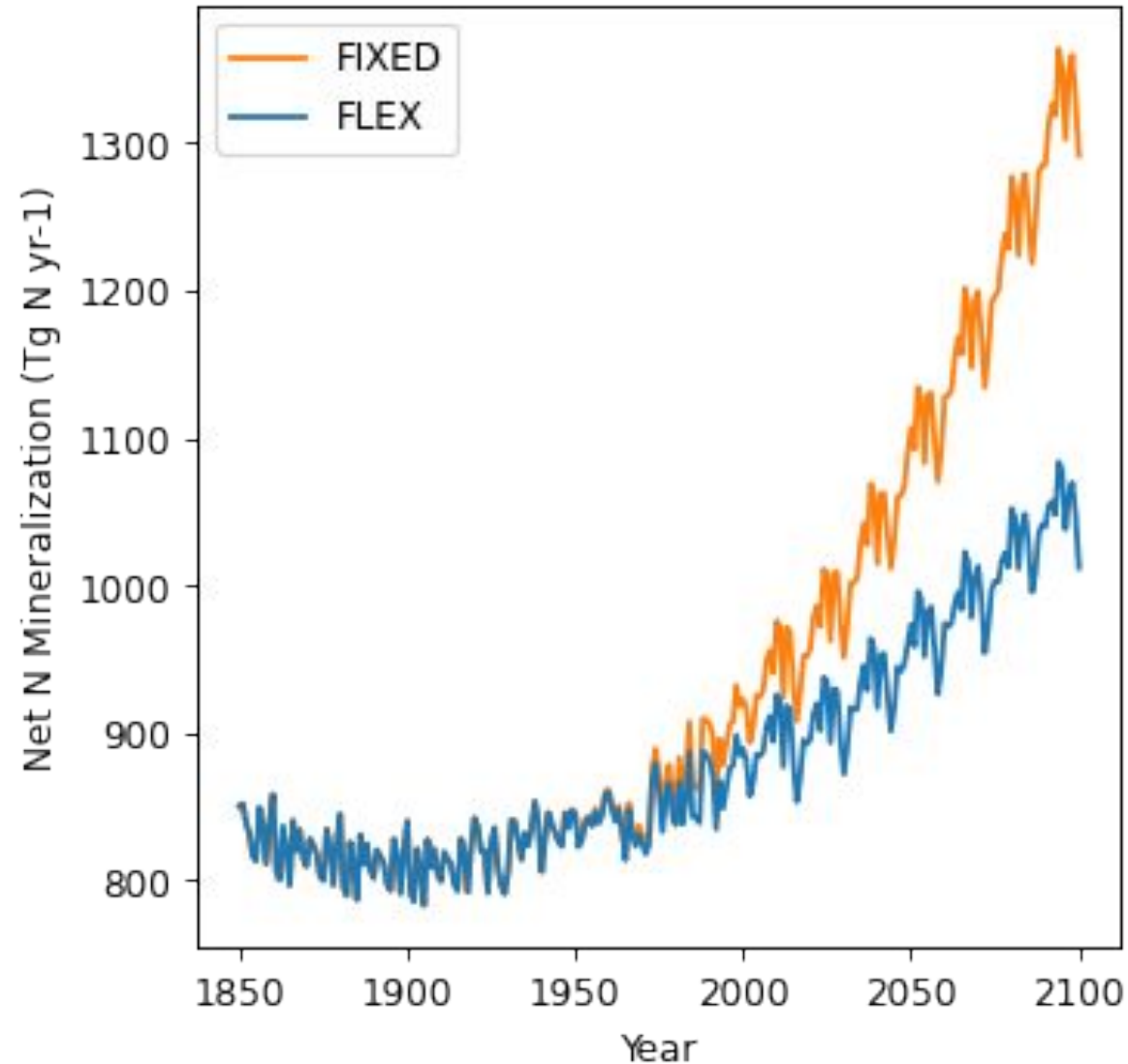
Evapotranspiration



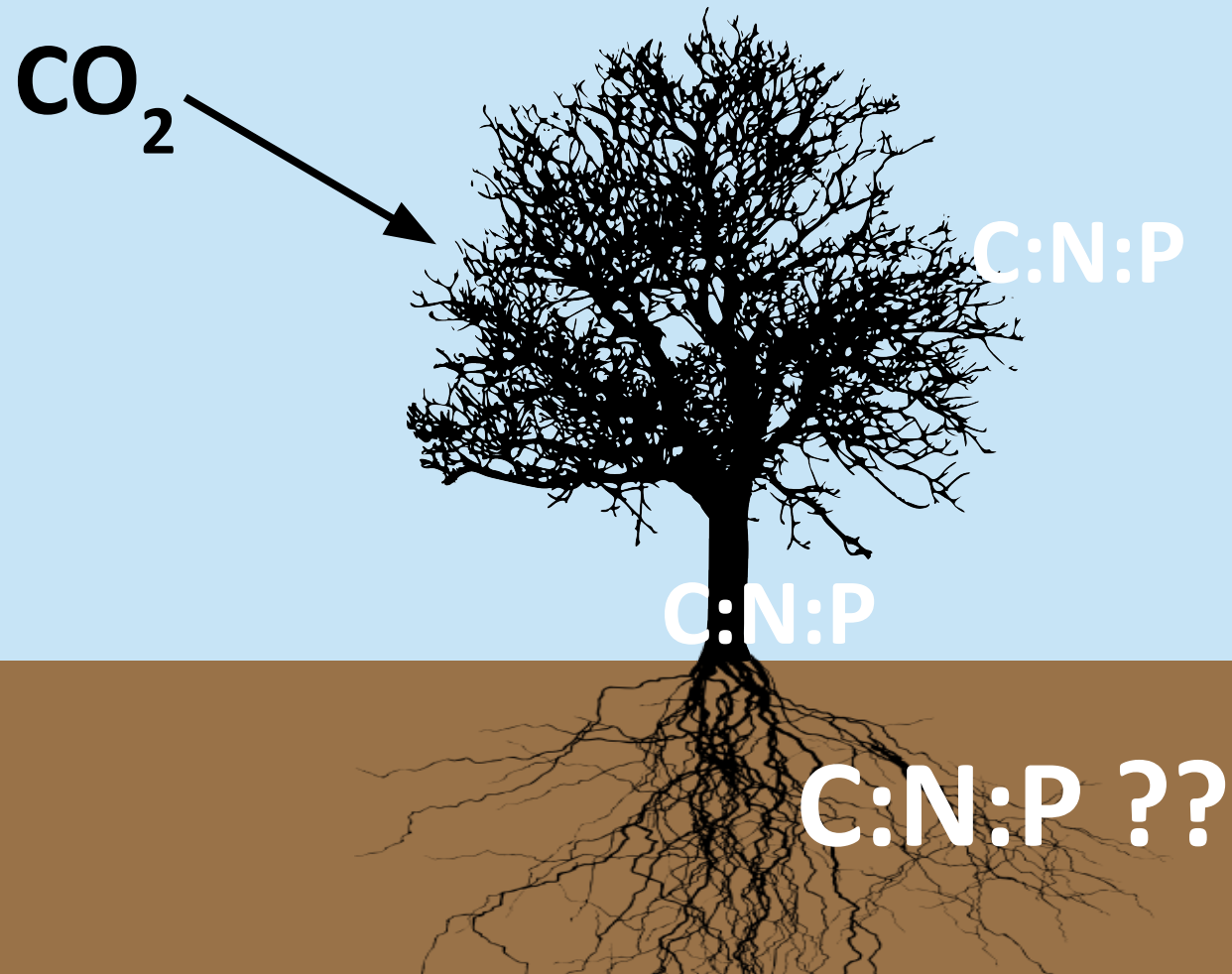
Runoff



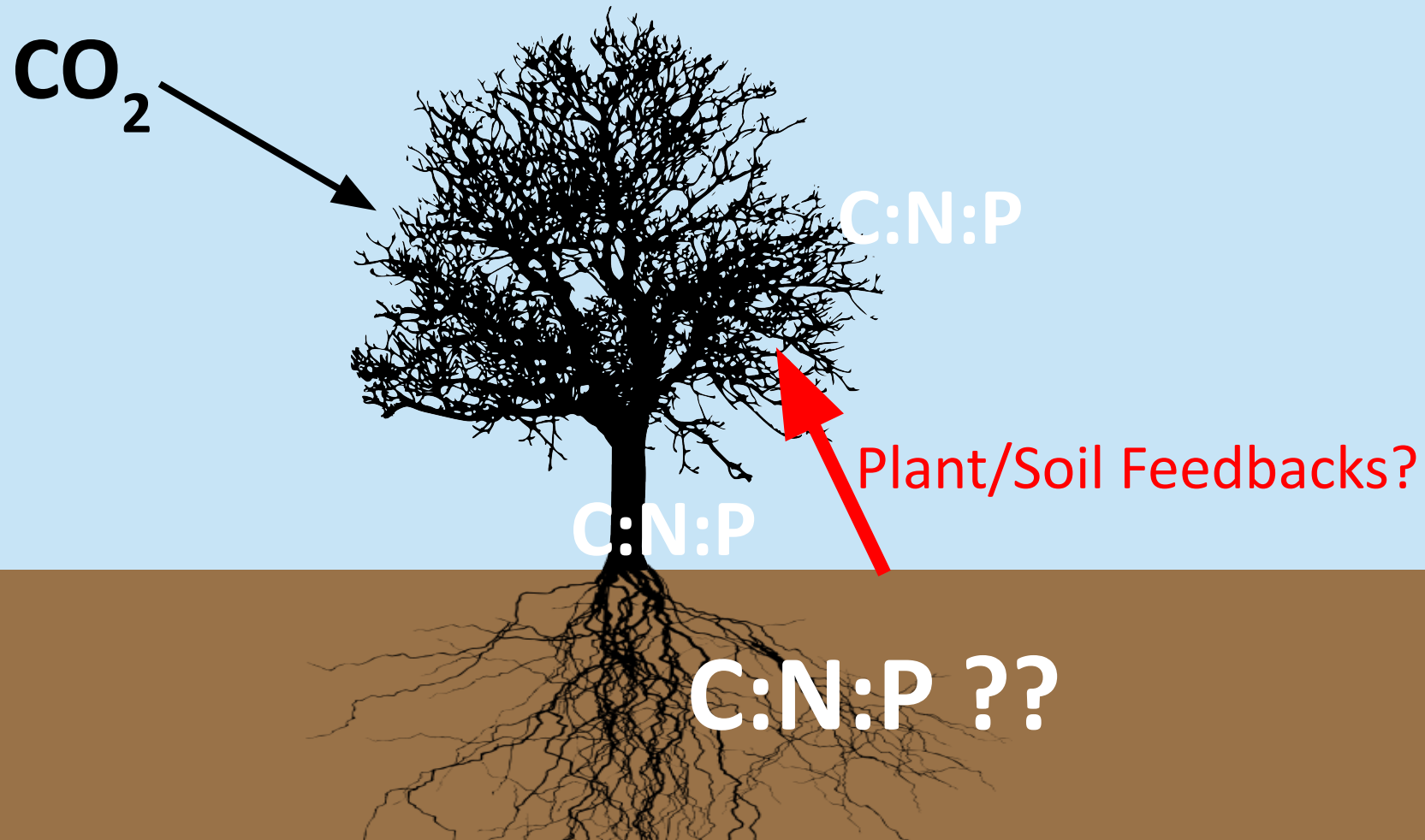
Flexible foliar C:N produces effects on N cycling
(reflecting changes in productivity).

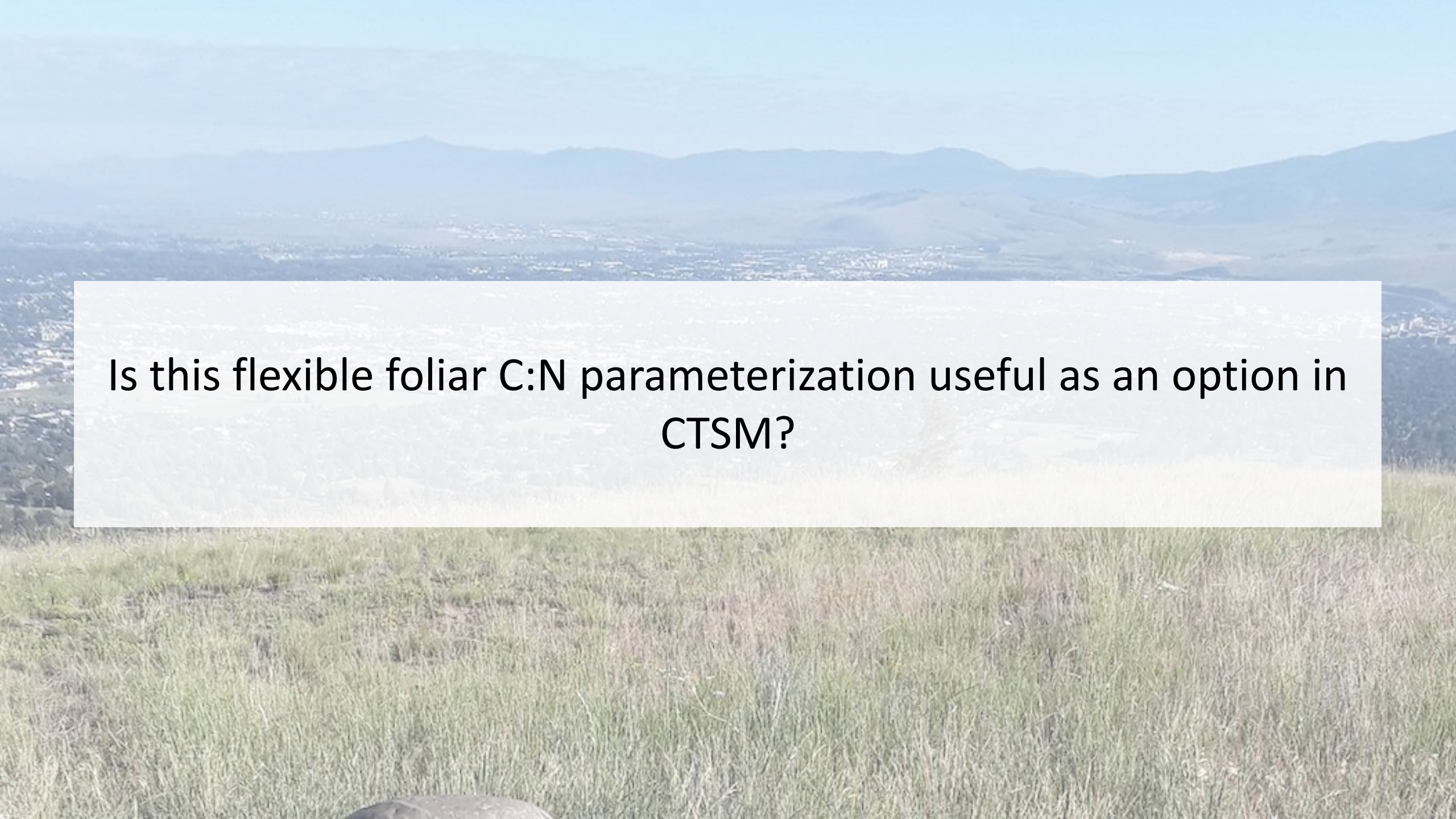


Need for integrated analysis of indirect effects.



Need for integrated analysis of indirect effects.



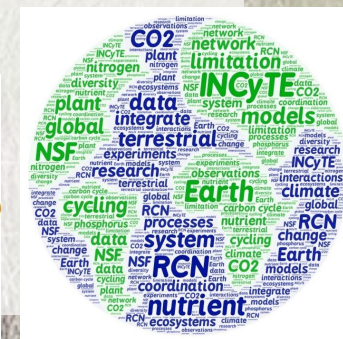
A landscape view from a grassy hilltop looking over a valley with a city and mountains in the distance. The foreground is filled with tall, dry grass. In the middle ground, a city is visible in a valley. The background consists of a range of blue mountains under a clear sky.

Is this flexible foliar C:N parameterization useful as an option in
CTSM?

Acknowledgements

Many thanks to the people who have supported and provided feedback on this research including:

- Members of the Cleveland Lab
- Wieder lab group members including Katya Jay and Else Schlerman
- Sam Levis
- The INCyTE Network
- Funding provided by the National Science Foundation





Questions?

Key Points

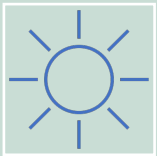


Degree of flexibility of foliar C:N has major implications for future terrestrial C uptake.

Key Points



Degree of flexibility of foliar C:N has major implications for future terrestrial C uptake.

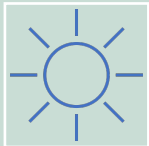


Changes to leaf chemistry also have biophysical feedbacks that demonstrate complex links between hydrologic and C cycles.

Key Points



Degree of flexibility of foliar C:N has major implications for future terrestrial C uptake.

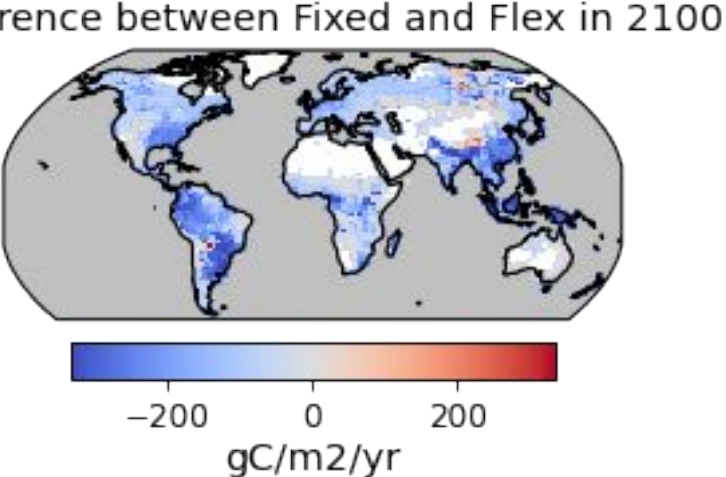
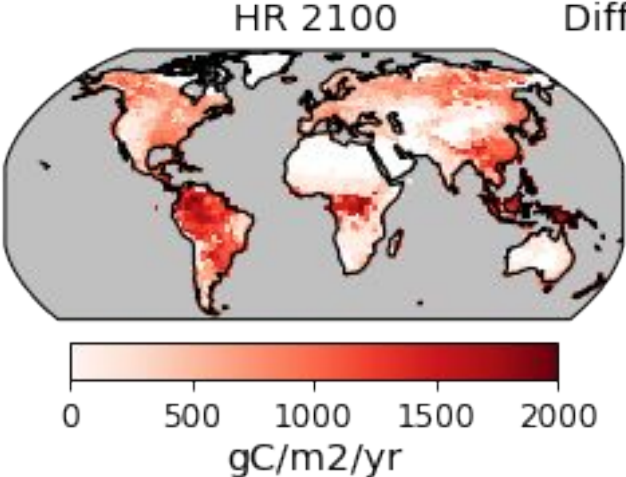
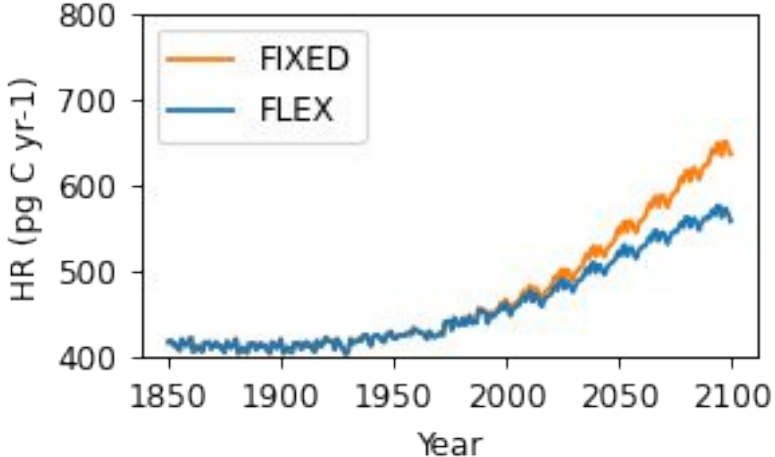
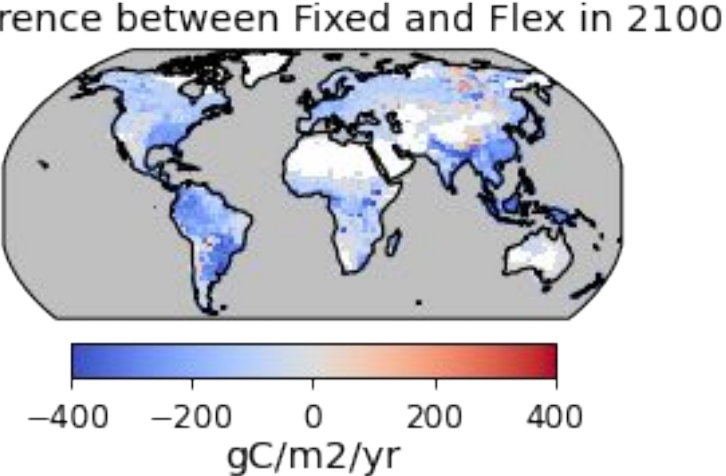
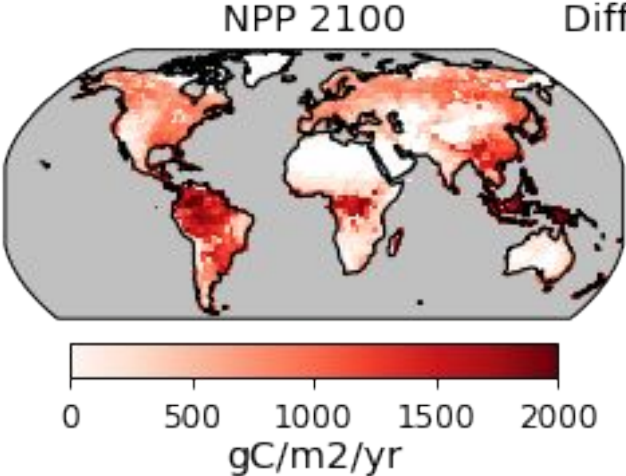
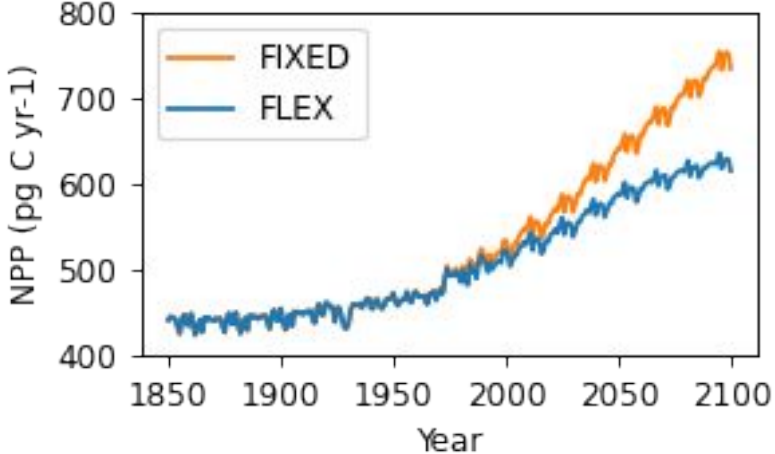


Changes to leaf chemistry also have biophysical feedbacks that demonstrate complex links between hydrologic and C cycles.



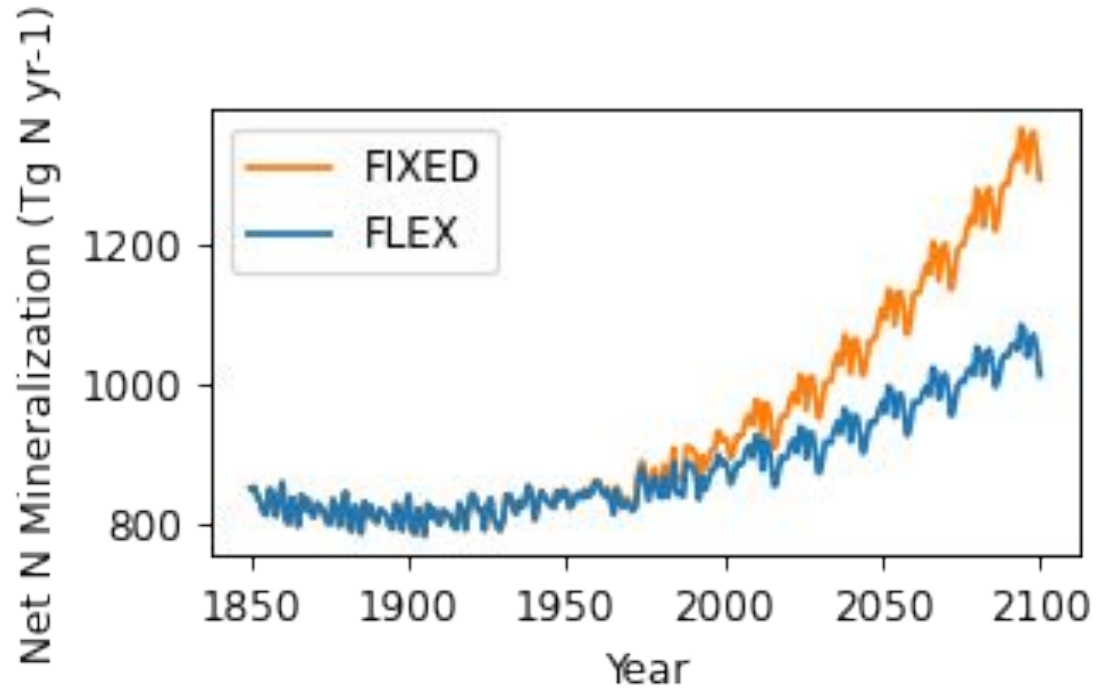
Future interdisciplinary work can improve mathematical representation of relationship between foliar C:N and CO_2 and improve ecological process representation in models.

C sink reduction due to reduced photosynthetic capacity, indirect response to reduced heterotrophic respiration



Reductions in N cycling rates

N Mineralization



N Fixation

