# Representation of Plant Roots in Terrestrial Biosphere Models

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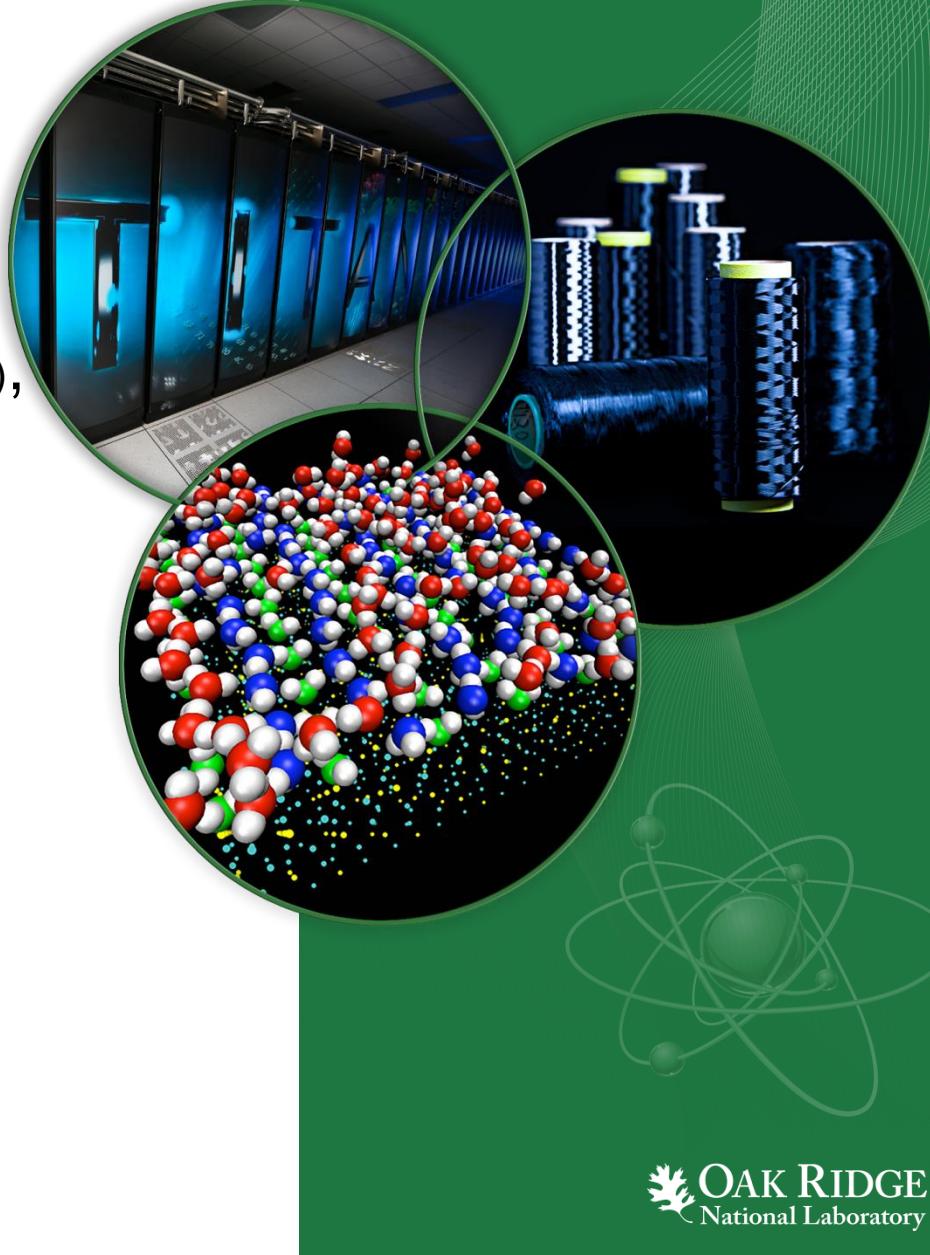
Describe current root representation in TBMs

Give examples of how roots influence model behaviour

The future of roots in TBMs

'Tree Roots', Vincent van Gogh, 1890

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# Why do Terrestrial Biosphere Models (TBMs) need roots?

What role do roots play in the ecosystem functions (at the appropriate spatial & temporal scales) that TBMs aim to model?

- Carbon flow (C is stored in & lost from roots)
  - Nutrient uptake

- Hydrology & water relations (source of soil water for transpiration & plant water limitation)

- Methane transport (from soil through aerenchyma to atmosphere)

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How are roots currently represented?

- C store (dynamic), growth (allocation), turnover
- Depth distribution (static)
- These are not linked

Oleson *et al.* (2013)
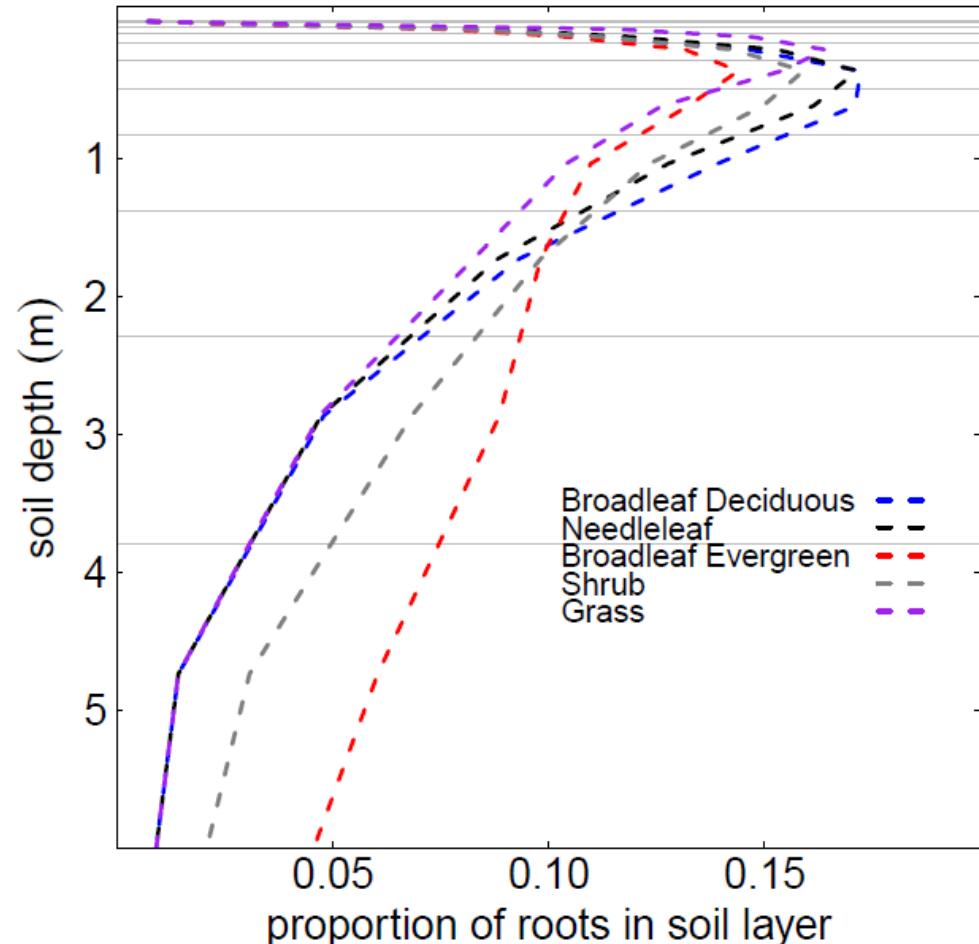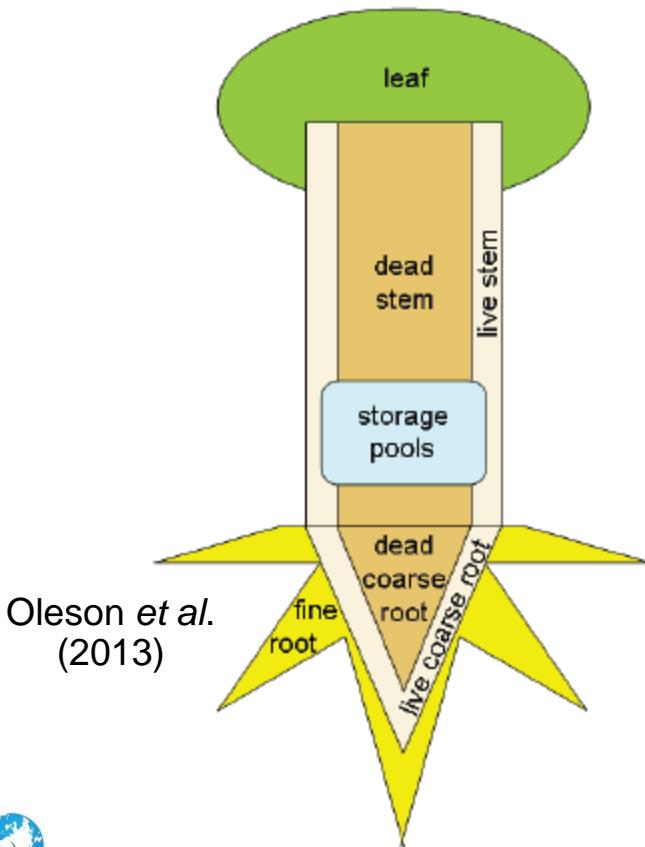
Alternative representations of depth distribution
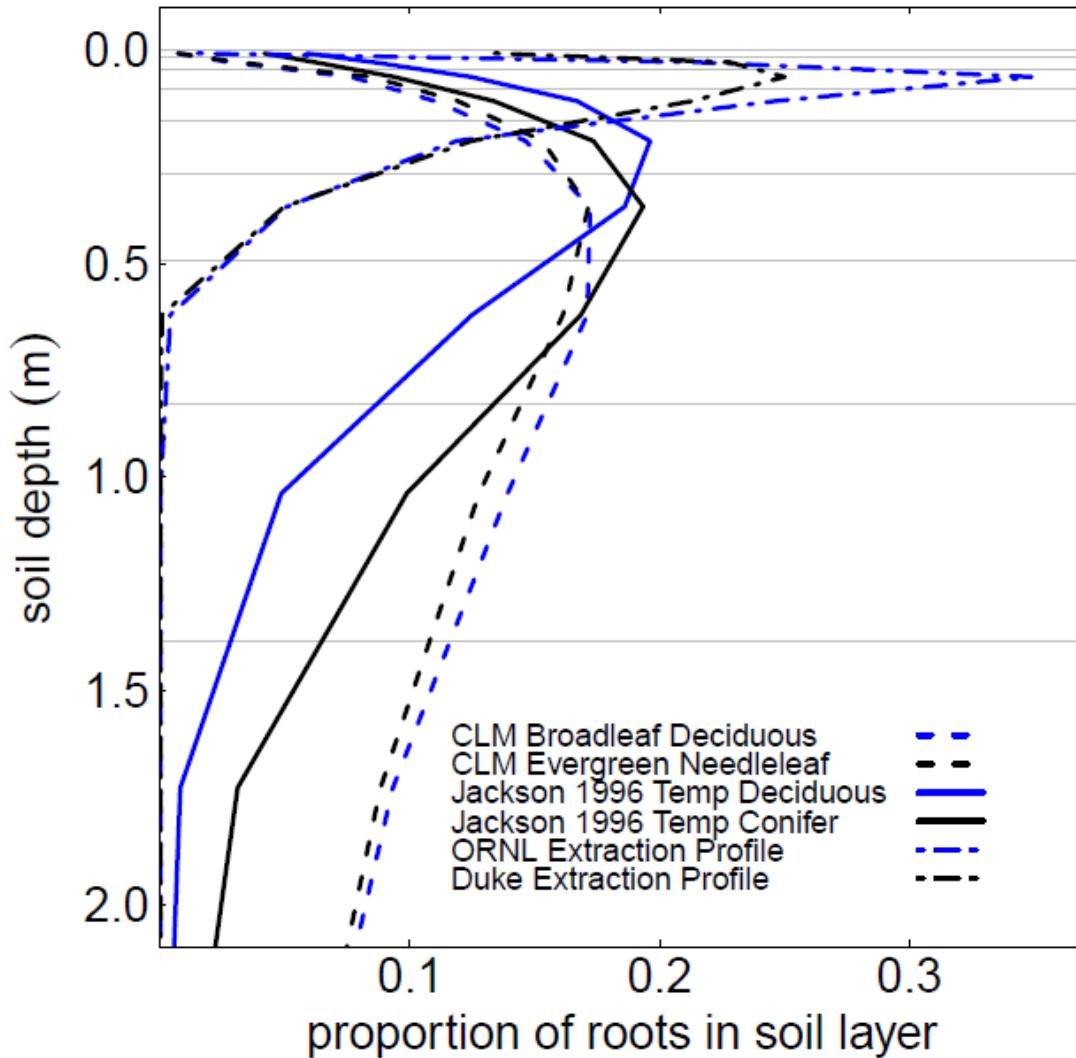
3 parameterisations of root depth distributions for broadleaf deciduous (blue) & evergreen needleleaf (black). Extraction profile based on model of Schenk et al. (2008).

Parameterisations are more similar that the PFT.

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# Root allocation – affected C storage response to eCO$_2$ at two US FACE sites
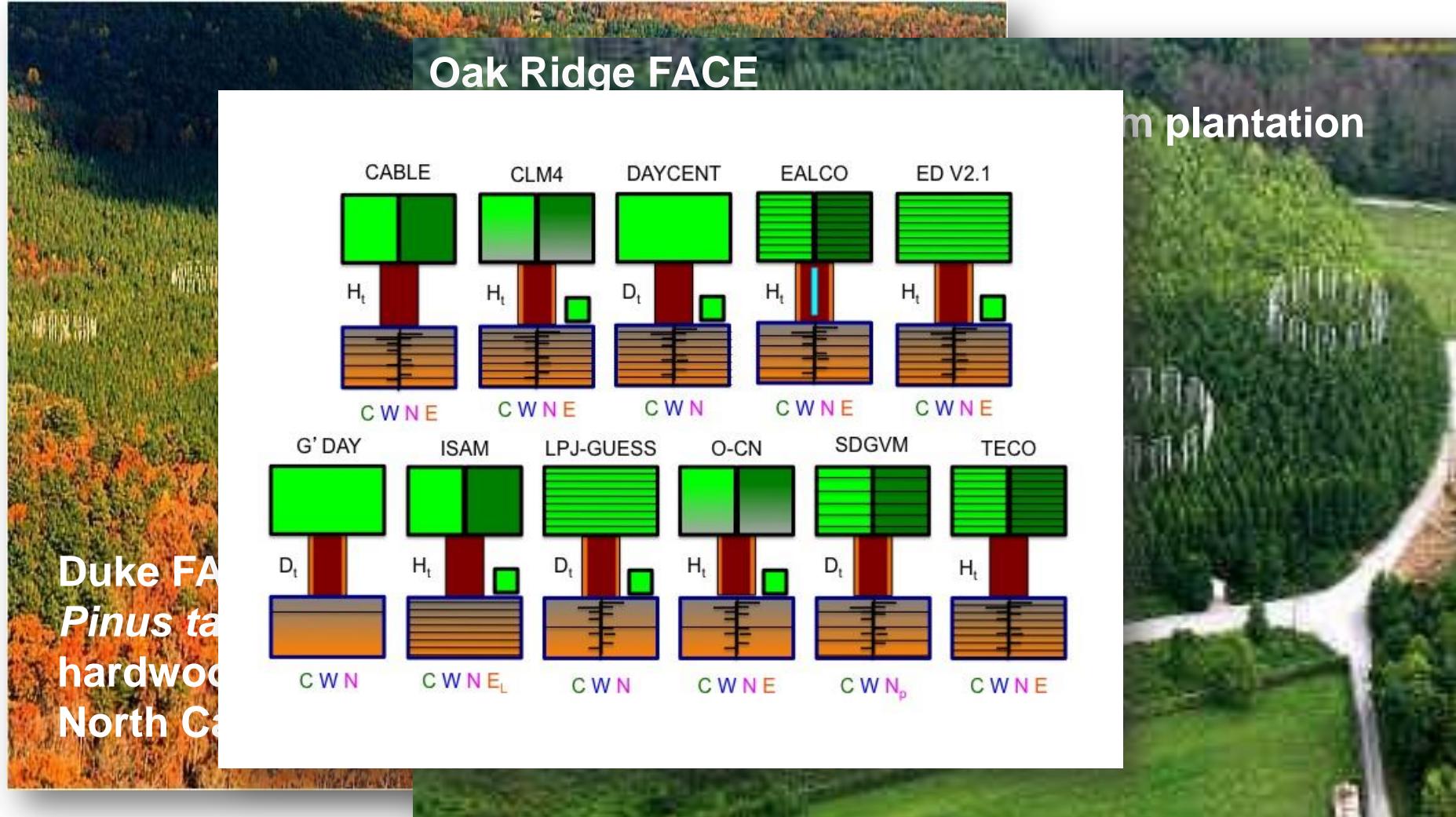
Root allocation – affected C storage response to eCO$_2$ at two US FACE sites
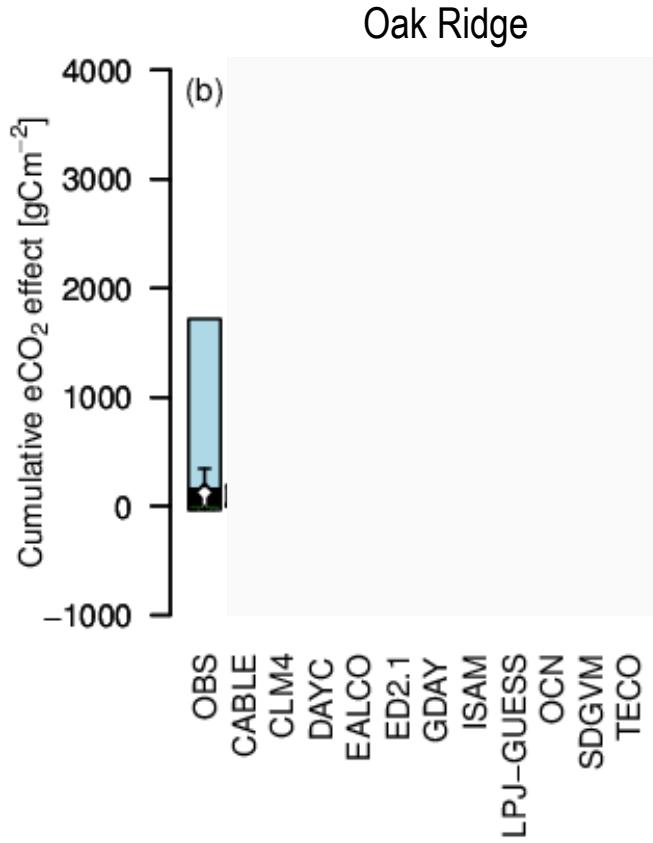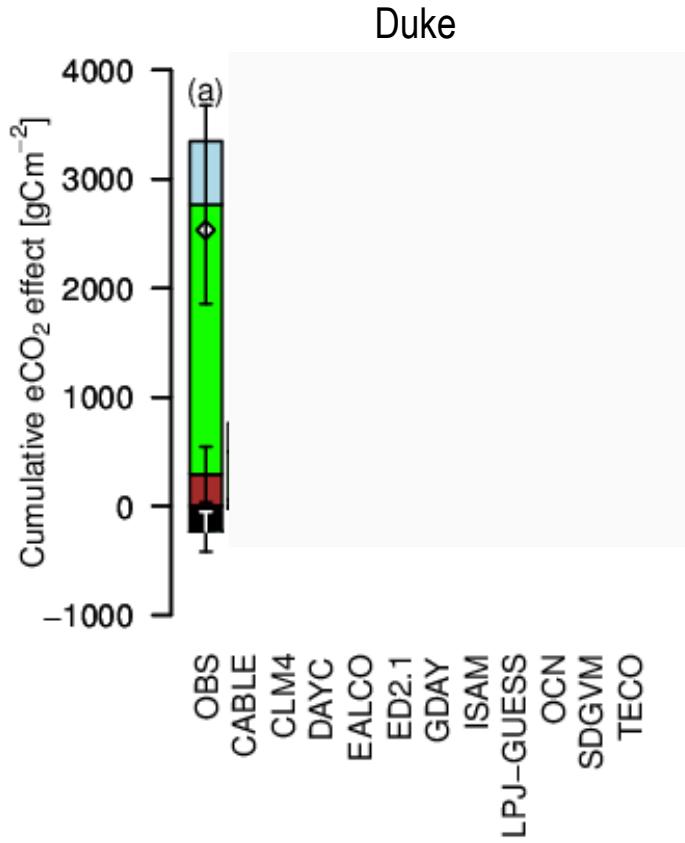
De Kauwe *et al.* (2014)

An example of sensitivity to root phenology & nutrient demand in CLM4.0

300 year simulations with CLM4.0 of response to elevated CO_2

Evergreen Forest

response to eCO_2 [%]

5 30 100 295   5   30 100 295   5   30 100 295

Years after start of CO_2 enrichment

Deciduous Forest

response to eCO_2 [%]
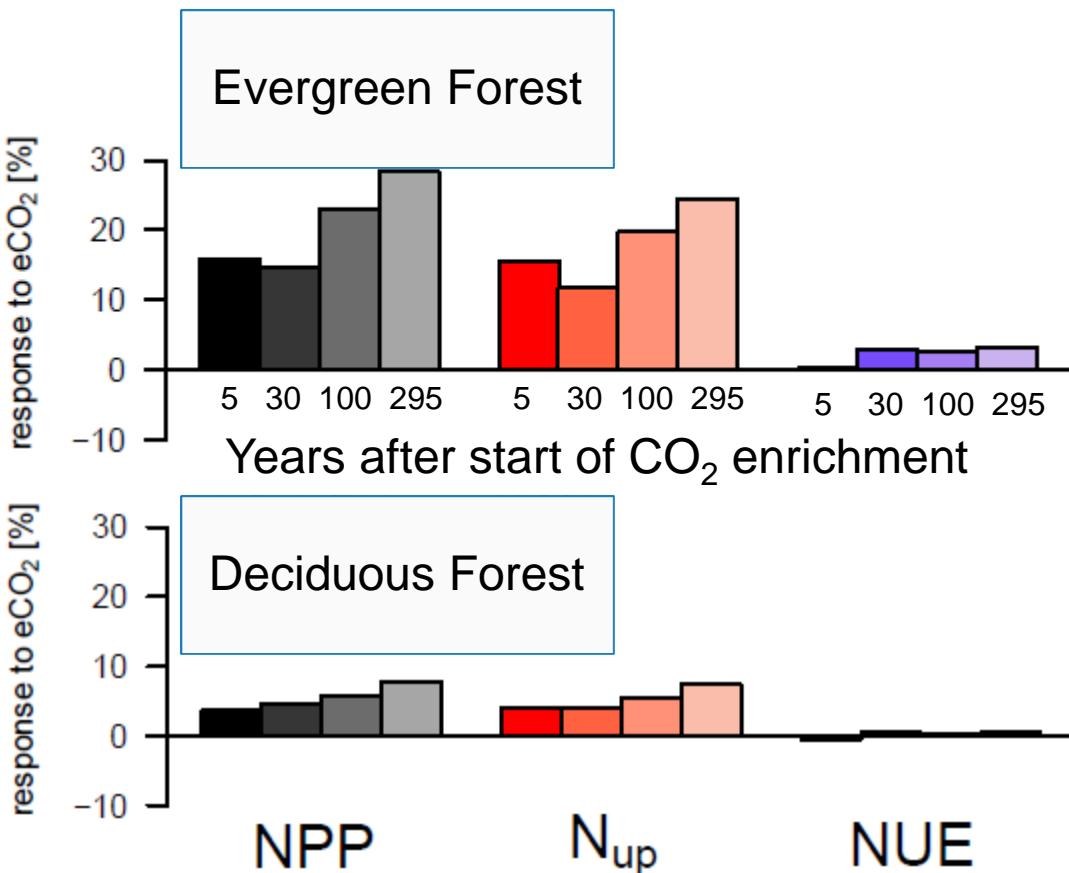
NPP N_{up} NUE

$$NPP = N_{up} \times NUE$$

NPP – Net Primary Productivity (C units)
N_{up} – Nitrogen uptake (N units)
NUE – Nitrogen Use Efficiency (C:N units)

Walker et al.
(in review)

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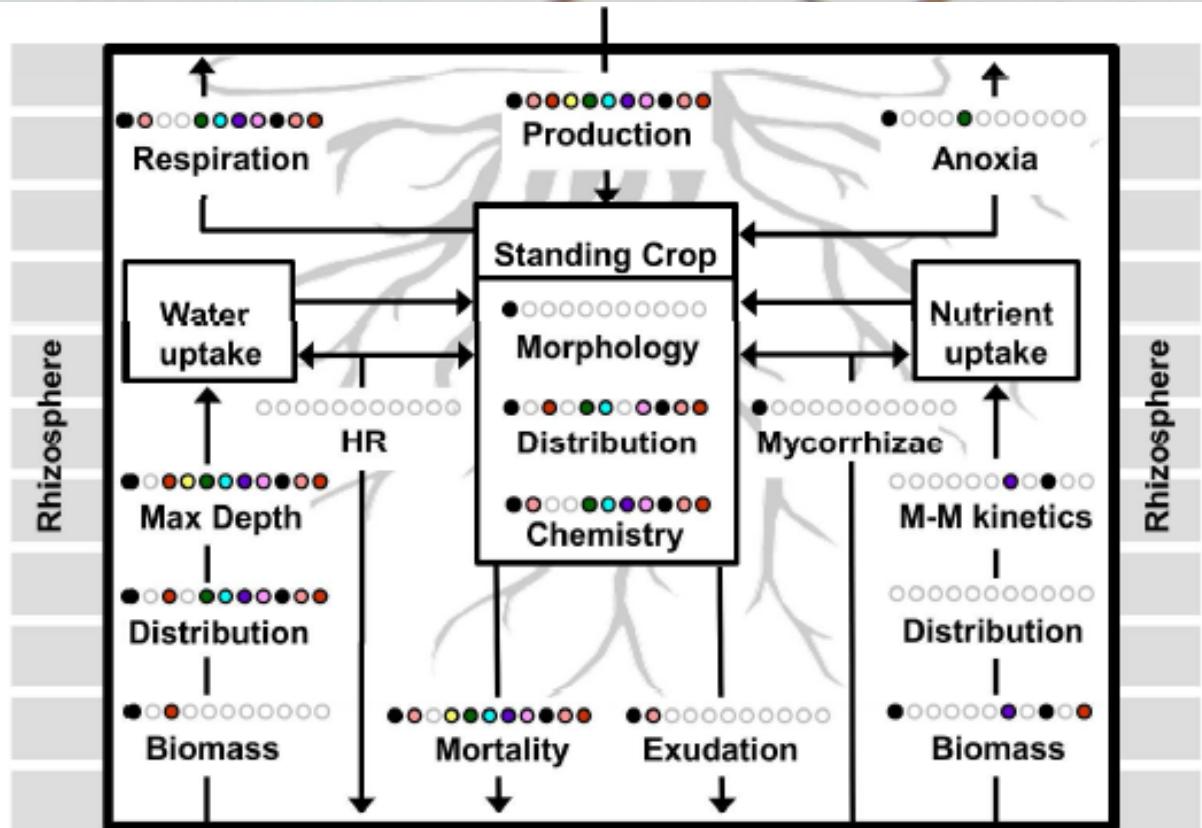
Warren *et al.*
(in press)

In summary:
Roots in TBMs need attention

- Depth distribution – dynamic in response to water/nutrient supply/demand

- Allocation

- Phenology

- Aerenchyma

- Correctly scaled root function
  - Water uptake & transport
  - Hydraulic redistribution
  - Nutrient uptake

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Thanks …

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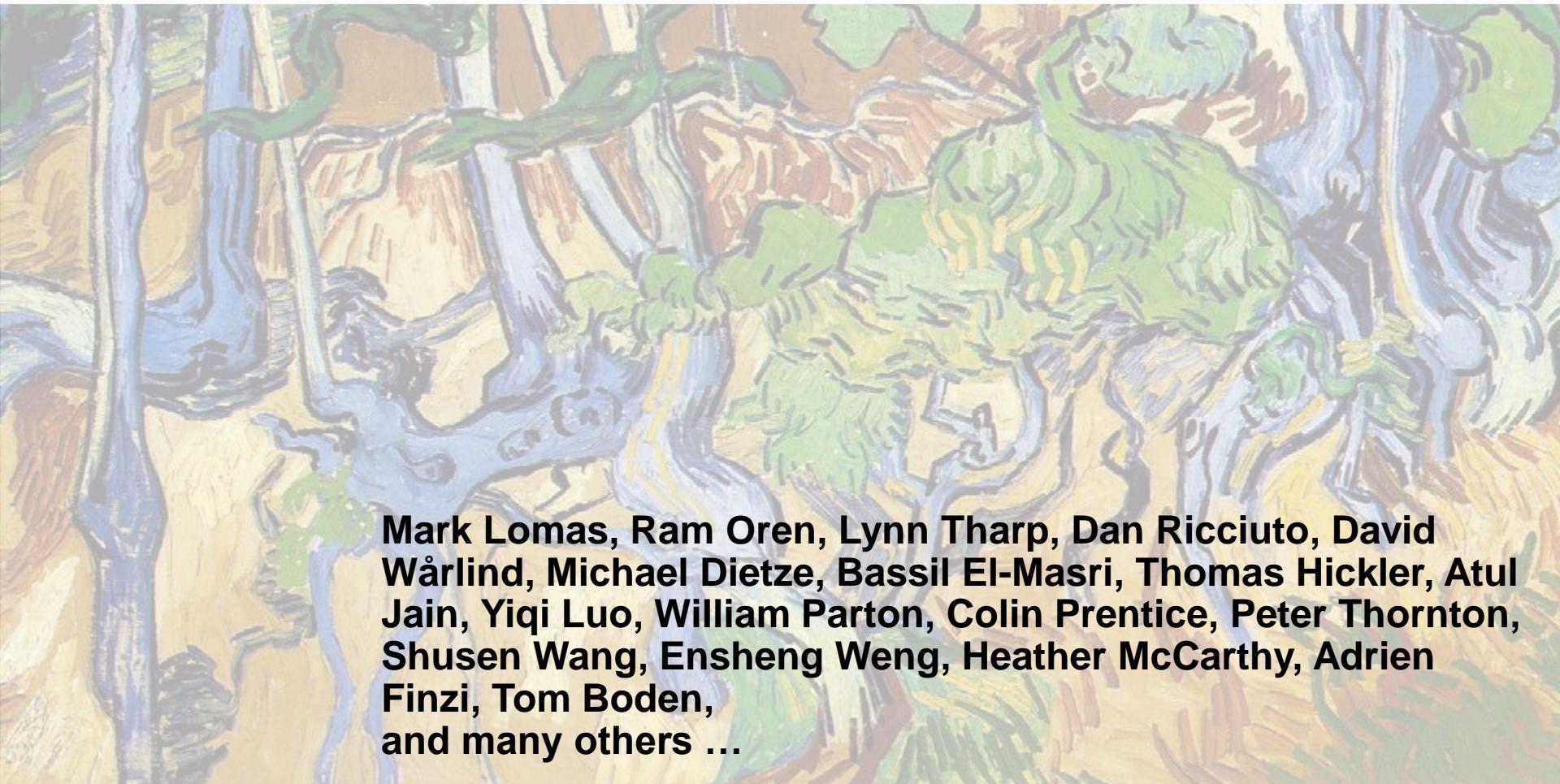
Mark Lomas, Ram Oren, Lynn Tharp, Dan Ricciuto, David Wårlind, Michael Dietze, Bassil El-Masri, Thomas Hickler, Atul Jain, Yiqi Luo, William Parton, Colin Prentice, Peter Thornton, Shusen Wang, Ensheng Weng, Heather McCarthy, Adrien Finzi, Tom Boden,
and many others …

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