Do seasonal growth patterns explain carbon and water fluxes?

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Overview

dry sclerophyll eucalypt forests:

- 200 – 1000 m asl
- 550 – 1000 mm precipitation

→ important carbon stores on a national level

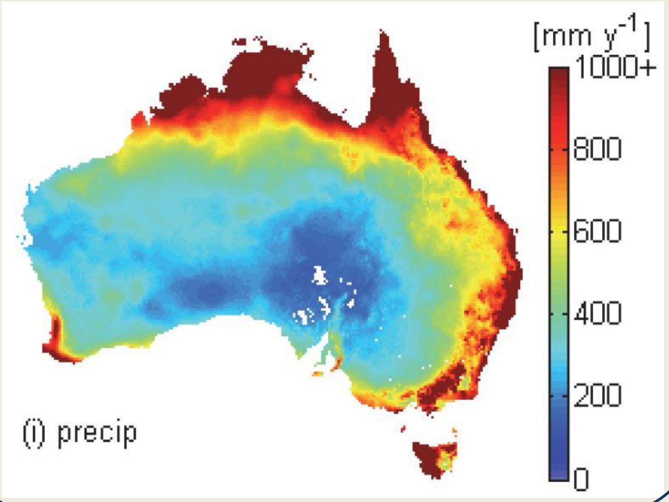


Fig. 1: Mean annual precipitation from 1990 – 2011. (Haverd et al., 2012)

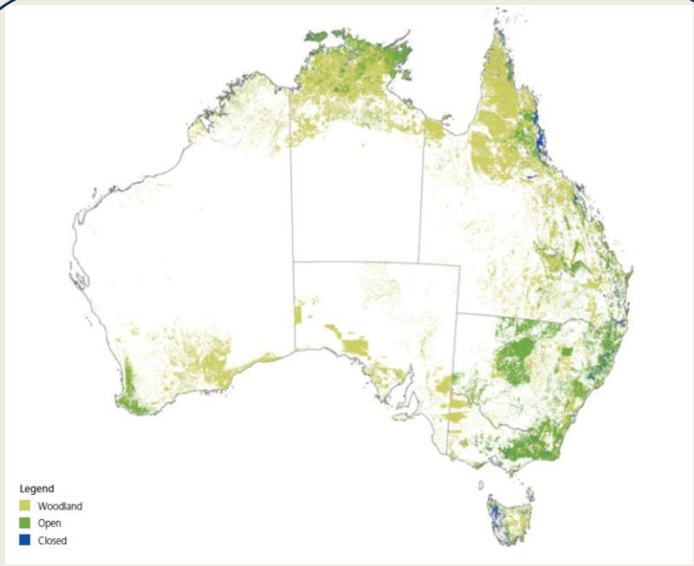


Fig. 2: Forest distribution in Australia.
(Australia's state of the forest report, 2008)

Study design

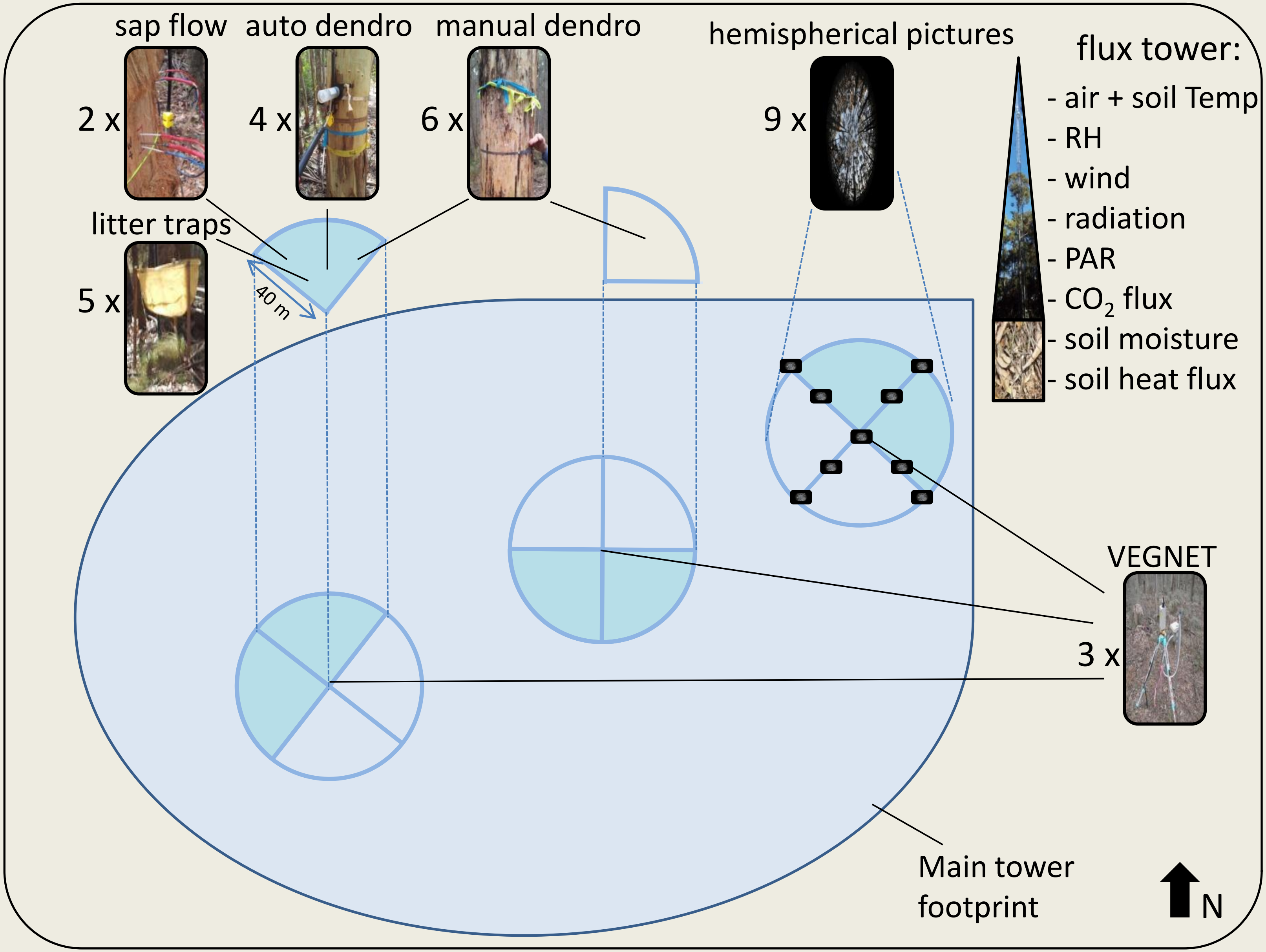


Fig. 3: PhD study design at the Wombat Forest Research Site

Project objectives I – carbon flux detection

Wombat Forest Research Site:

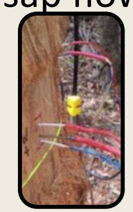
Q1: How well does the combination of new ground-based lidar technology and well established measurements detect forest structure and dynamics?

along a continental rainfall gradient:

Q1b: How applicable is this combination to describe forest structure and quantify above ground biomass in various forest types?

diameter variations

sap flow



auto dendro

band dendro

- carbon allocation in stems
- stems contain most biomass in a tree
- closely linked to tree water use
- growth signal difficult to detect

crown dynamics

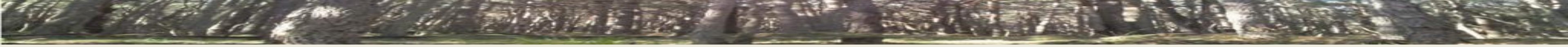
VEGNET

hemi pictures

litter traps

- carbon allocation in branches and foliage
- canopy structure strongly affects NPP
- vertical forest structure

plus additional site survey



Project objectives II – seasonality of growth

Wombat Forest Research Site:

Q2: Can seasonal carbon fluxes be partitioned into leaf, stem and below ground fluxes and how are they linked to environmental variables?

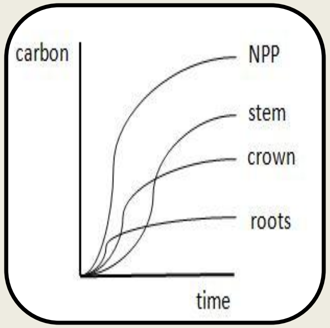


Fig. 4: Stylised representation of carbon allocation to pools.

diameter variations

sap flow

auto dendro

band dendro

- stem dynamics
- tree scale

crown dynamics

VEGNET

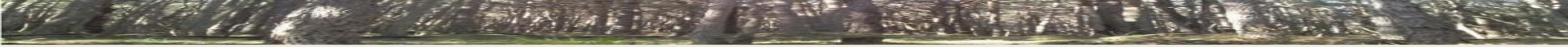
hemi pictures

litter traps

- leaf dynamics
- plot scale

- ecosystem scale
- environmental variables
- ecosystem dynamics

⇒ carbon allocation dynamics & in-situ carbon fluxes



Project objectives III – structural dynamics

Wombat Forest Research Site:

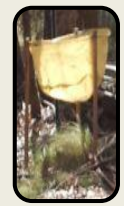
Q3: Are changes in forest structural dynamics related to changes of NEP, NPP and stand-level water fluxes?

Leaf Area Index

VEGNET

hemi pictures

litter traps



diameter variations

auto dendro

band dendro

water fluxes

sap flow

NPP and NEP

environmental variables

flux tower + sensor network

Project objectives IV – carbon & water linkages

Wombat Forest Research Site:

Q4: At what temporal scale are carbon and water fluxes linked?

carbon dynamics

water fluxes

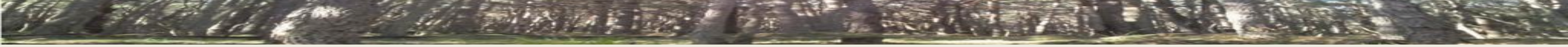
- carbon allocation in stems and foliage from sensor network
- NEP from flux tower

- carbon fluxes from tree to stand-level

- tree water use from sensor network
- precipitation and evapotranspiration from Wombat flux tower

- water fluxes from tree to stand-level

water and carbon fluxes measured by the same instrument



Project objectives V - modeling

Wombat Forest Research Site:

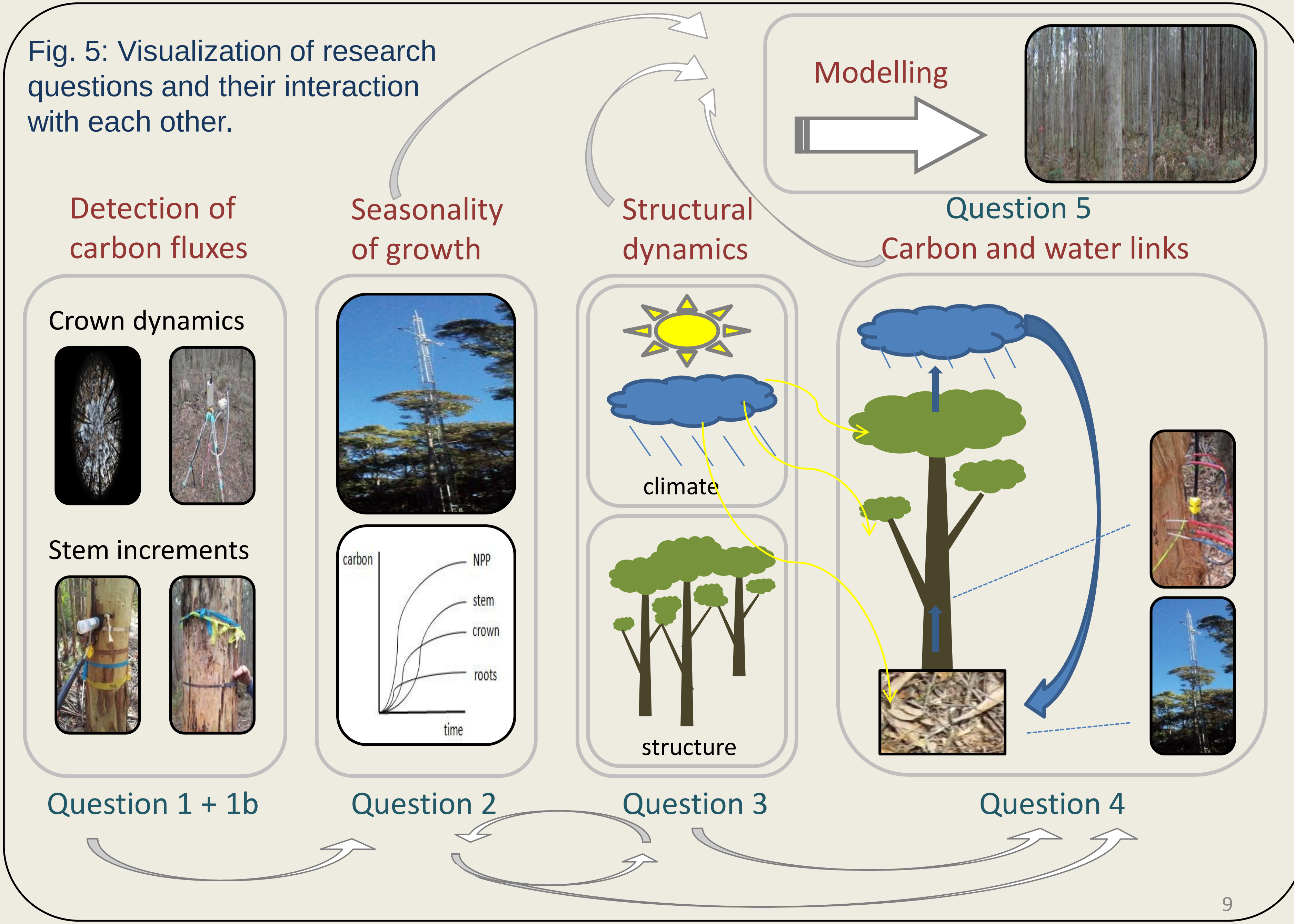
Q5: Which model type represents most accurately the growth of this temperate eucalypt forest?
Q5b: Will this forest likely continue as a carbon sink under climate change?

Climate change

- evaluation of existing growth models
- improvement of existing models for:
  - vertical crown dynamics/changes in LAI
  - coupling of carbon and water fluxes

- future predictions of forest growth:
  - structural dynamics on a longer time scale
  - impact of changes in climate

Fig. 5: Visualization of research questions and their interaction with each other.

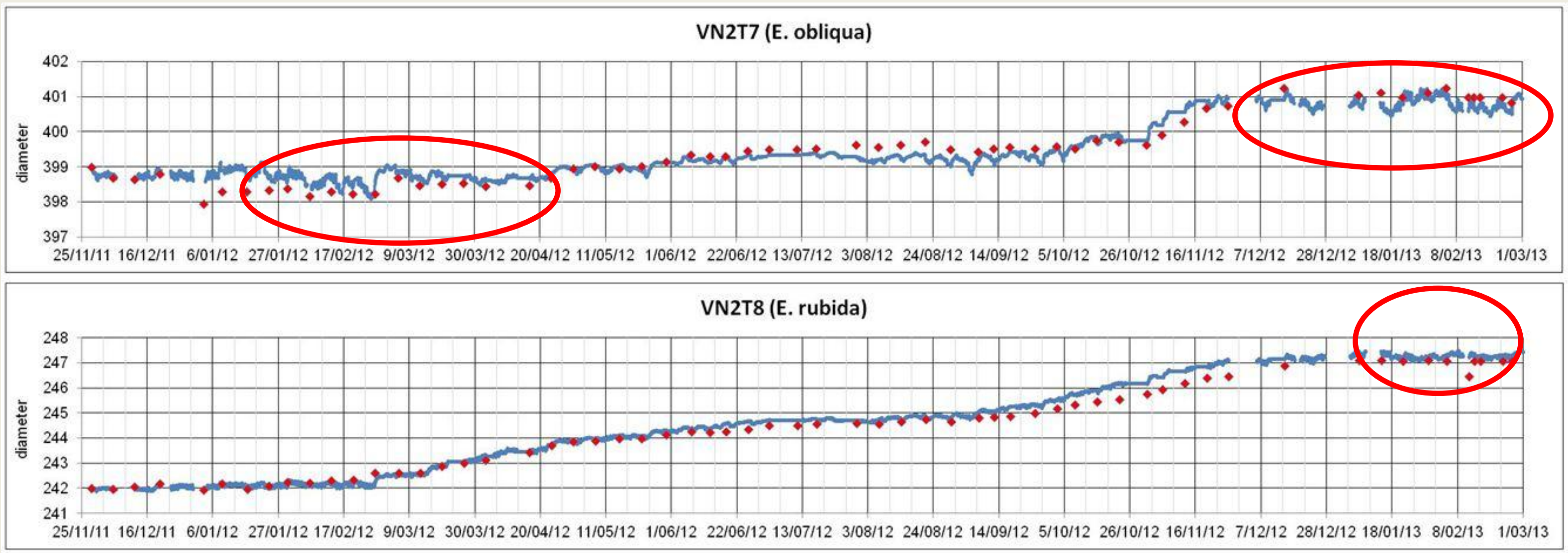


Example data: dendrometer

data gaps & settling in / readjusting bands

November 2011 – February 2013

noisier signal in summer



outlier: loose bark

Fig. 6: Automated dendrometers compared to manual bands

automated dendrometer

manual band dendrometer

Example data: dendrometer

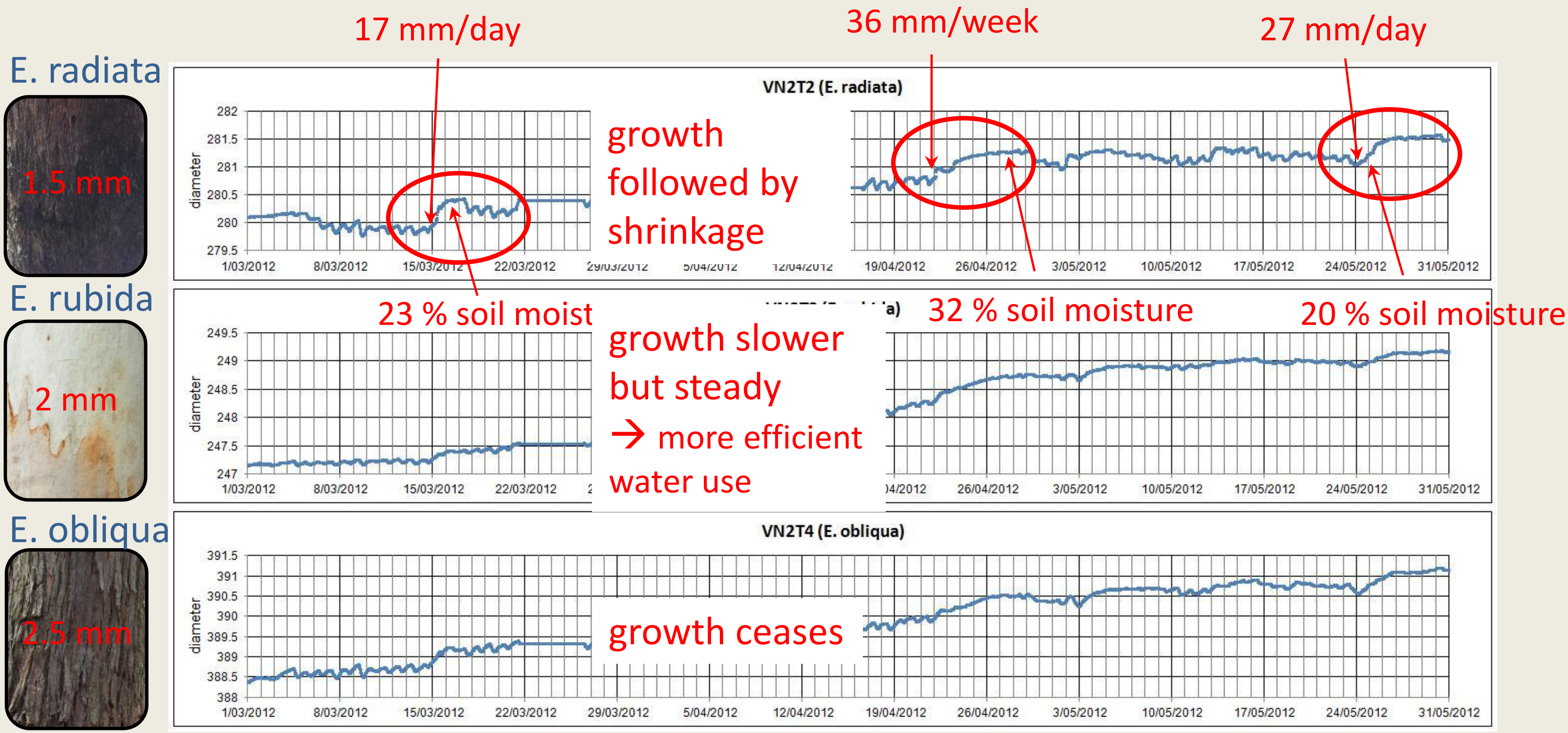


Fig. 7: Seasonal trends and interspecies comparisons

- 3 months of data (autumn 2012)
- growth triggered by rain events

Example data: tree water use

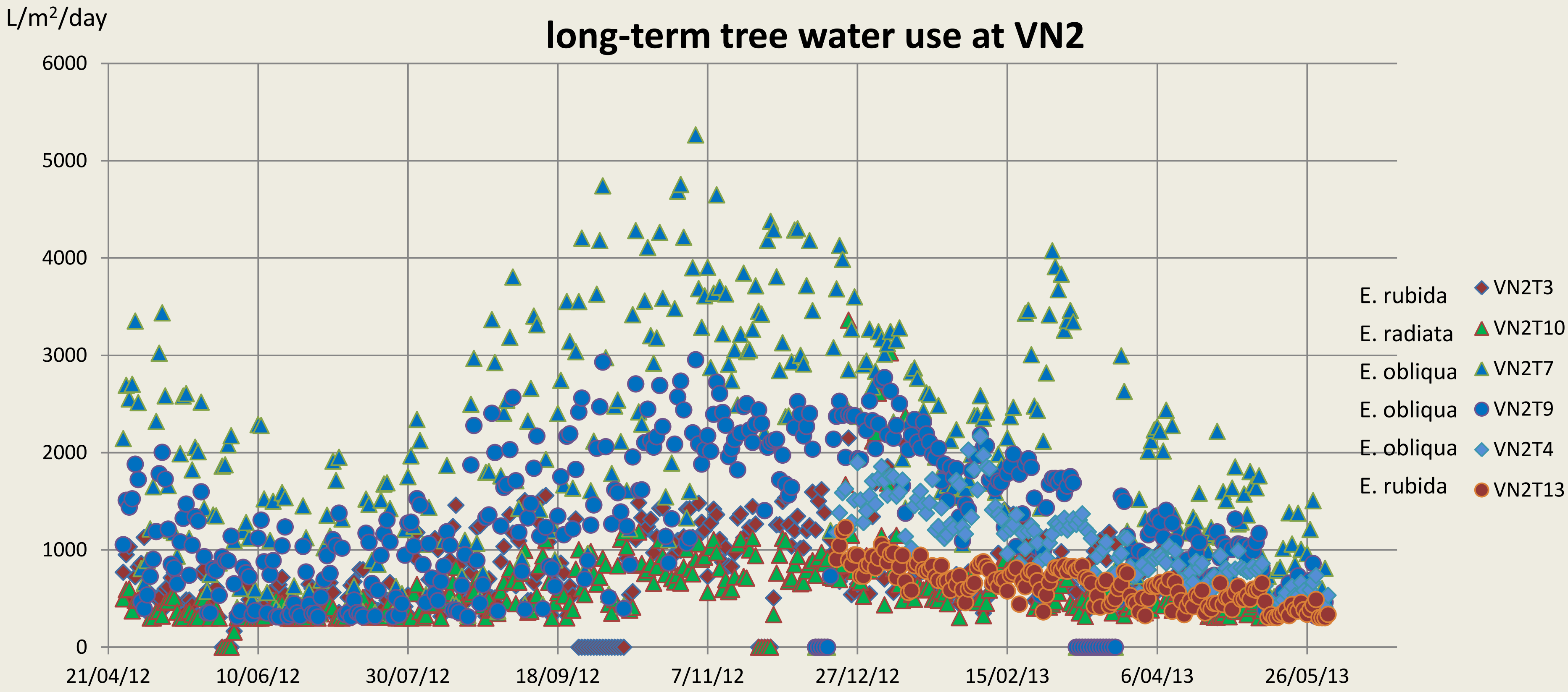
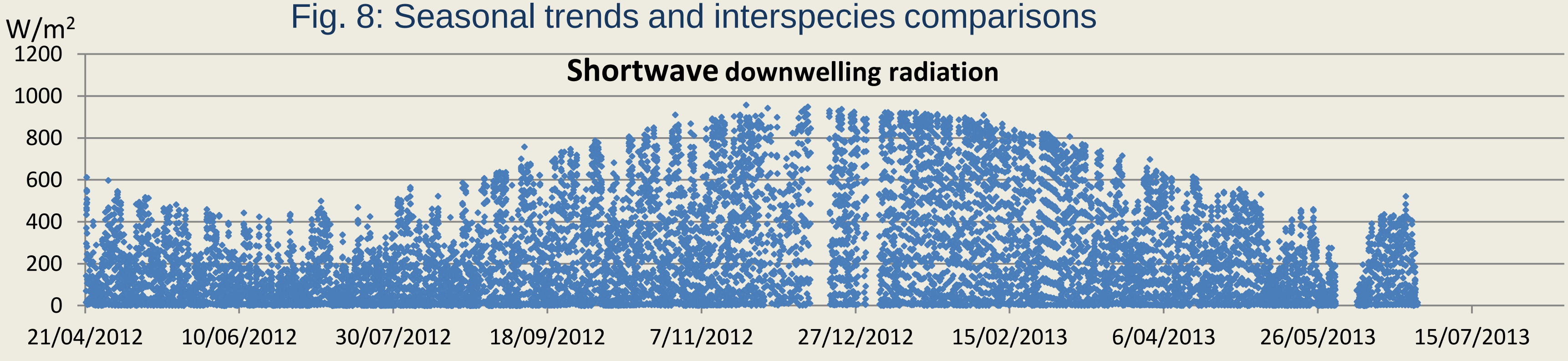
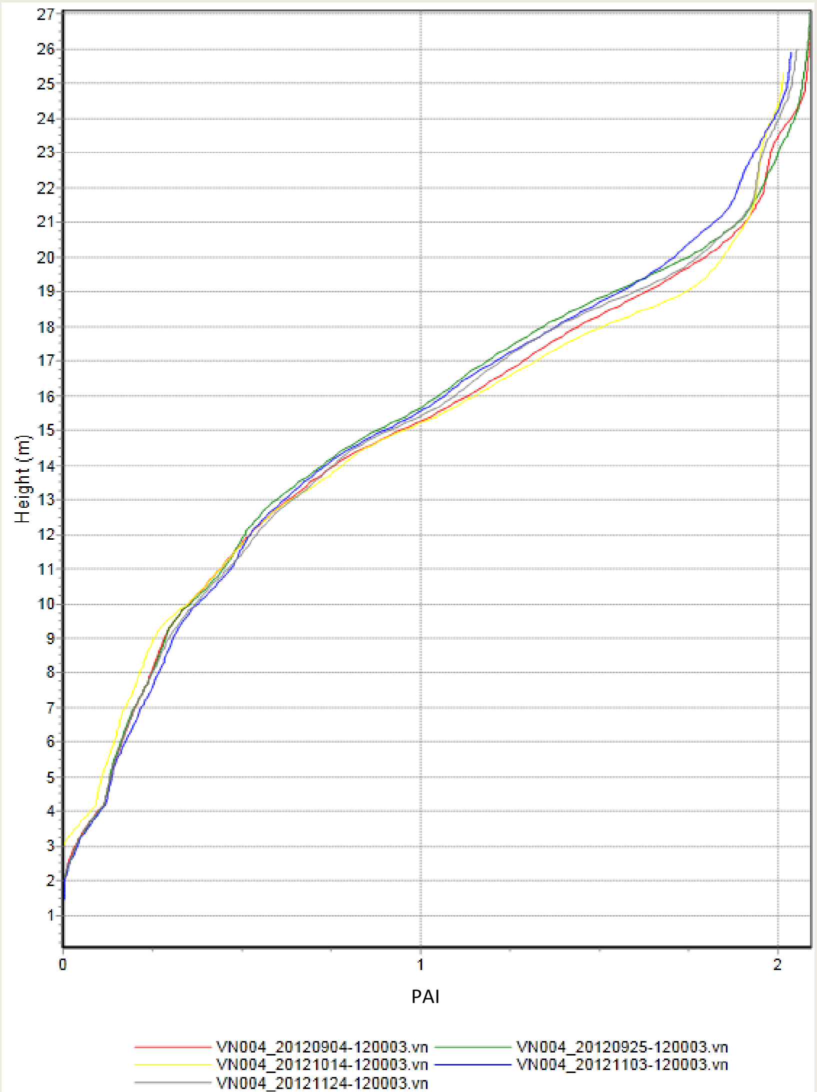


Fig. 8: Seasonal trends and interspecies comparisons

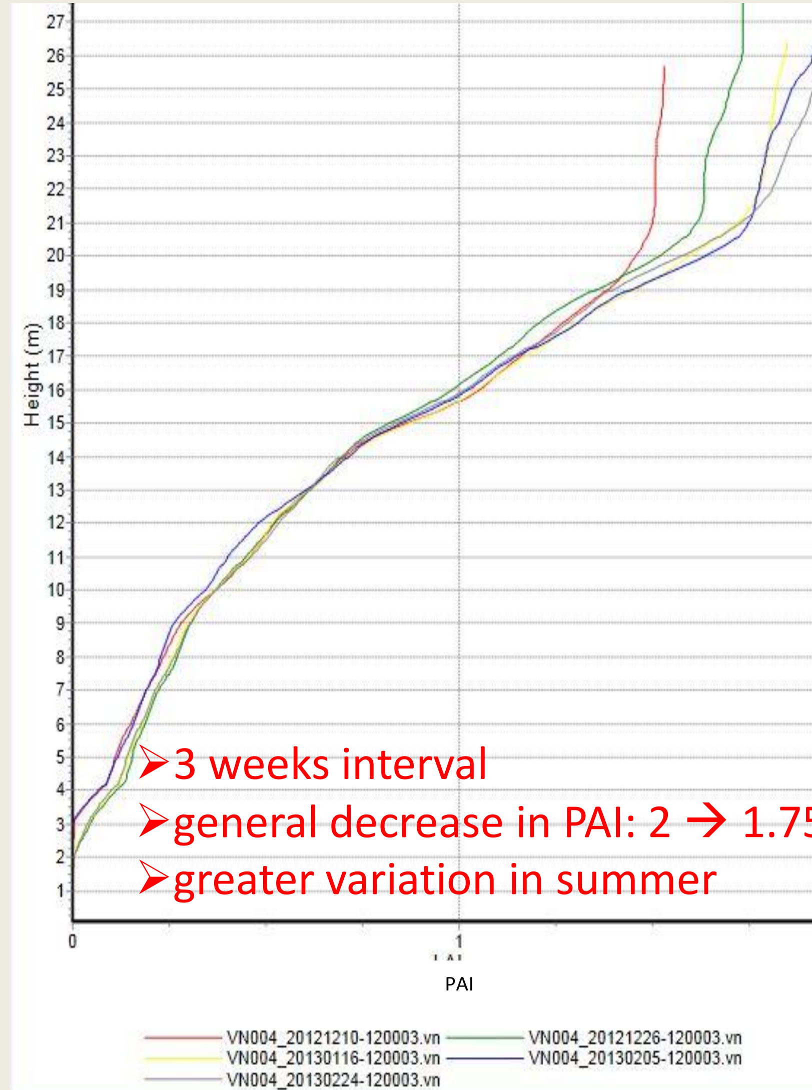


Example data: VEGNET

PAI spring 2012



PAI summer 2013



- 3 weeks interval
- general decrease in PAI: 2 → 1.75
- greater variation in summer

Fig. 9: Two seasons of plant area index (PAI) measured with VEGNET sensors.

Example data: VEGNET

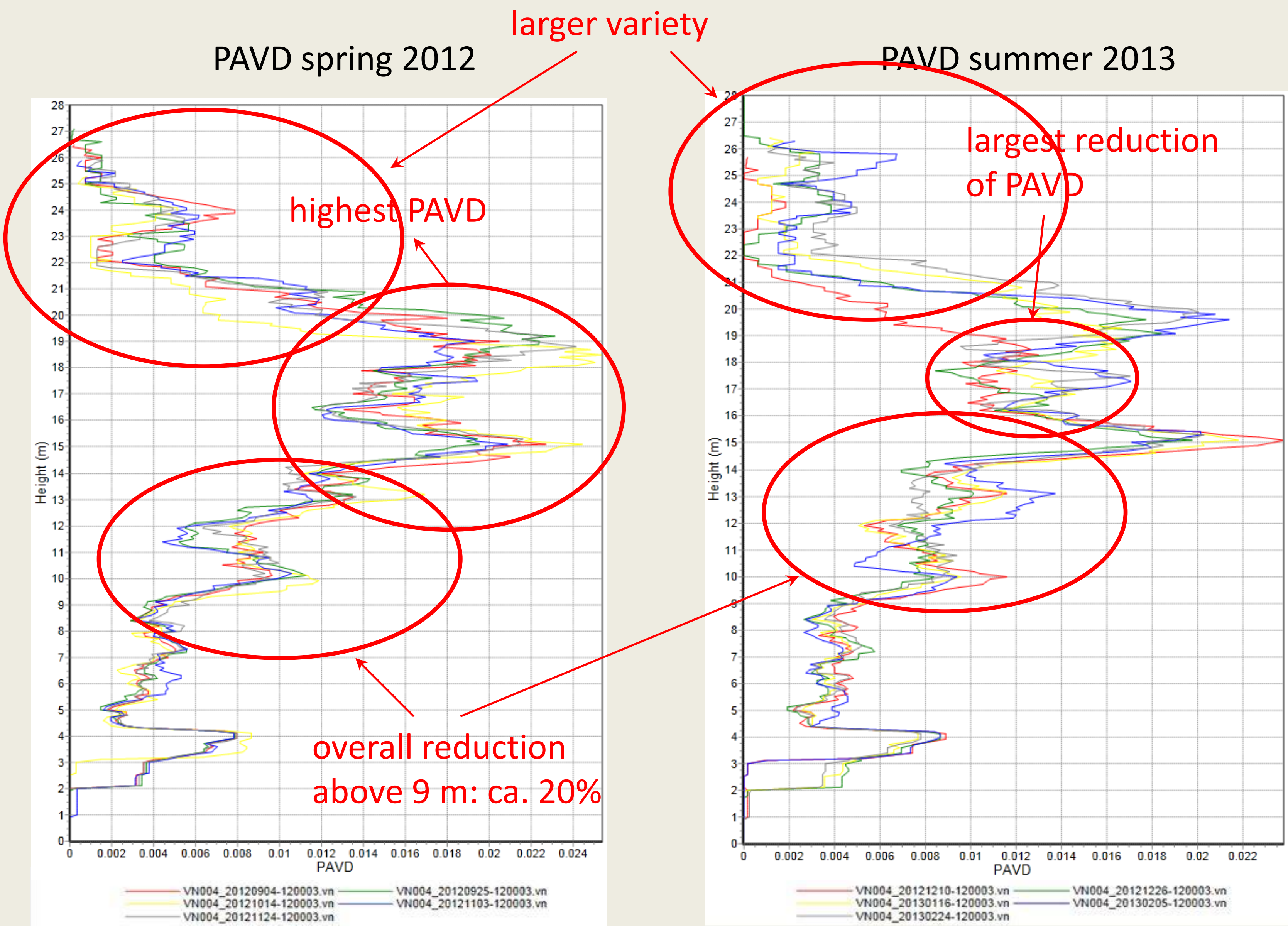


Fig. 10: Two seasons of plant area volume density (PAVD) measured with VEGNET sensors.

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- Daniel

Questions?!

Climate change

Question 5
Carbon and water fluxes

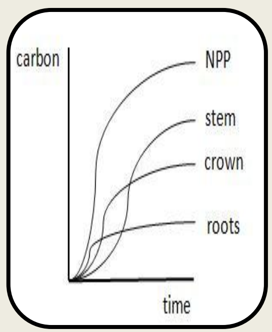
Detection of carbon fluxes

Crown dynamics

Stem increments

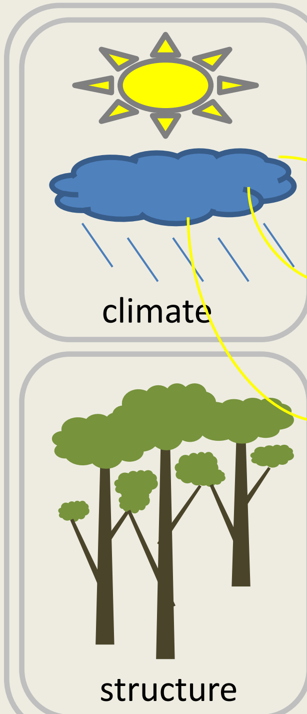
Question 1 + 1b

Seasonality of growth

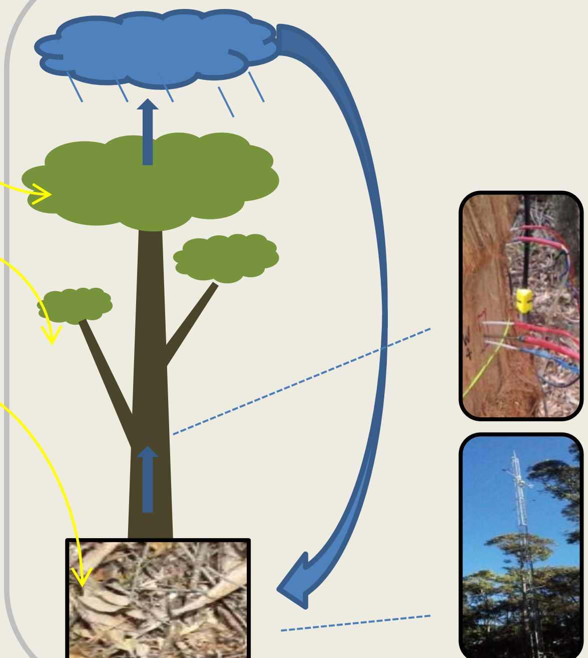


Question 2

Structural dynamics



Question 3



Question 4