ROOT ANATOMICAL FEATURES DRIVE CARBON AND WATER FLOW AT THE WHOLE PLANT LEVEL.

A MODELLING PERSPECTIVE

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INTRODUCTION

The interaction between carbon and flows within the vasculature is at the centre of most growth and develop-mental processes. Understanding how these fluxes influence each other, and how they respond to heterogeneous environmental conditions, is important to answer diverse questions in agricultural and natural ecosystem sciences.

Here we present a computational framework to (1) explicit consider both **carbon and water flow** within the plant arcitecture and (2) understand how these flows are largly influenced by local **root anatomies**

ANATOMY AND WATER

The distribution and range of **root hydraulic properties** (radial and axial conductances) have a large influence on the **root water uptake.** These properties have been shown to be locally defined, in part, by the **root anatomies** (Heymans et al 2019). In addition, they are largely variable within a single root system, eiher along a single root, or between roots of different types (Heymans 2020, fig A).

There is therefore a real interest in combining root anatomies, hydraulic properties and architecture into a **single analysis framework.** Here, we combined the anatomical models (GRANAR/MECHA) with and architectural model (CPlantBox) and a 1D soil model (HYDRUS) to analysis the effect of anatomical features on the global plant water uptake.

Preliminary results highlight the importance of the **synchronisation** between **xylem maturation** and the formation of **hydrophobic barriers** at the single root level (fig B)

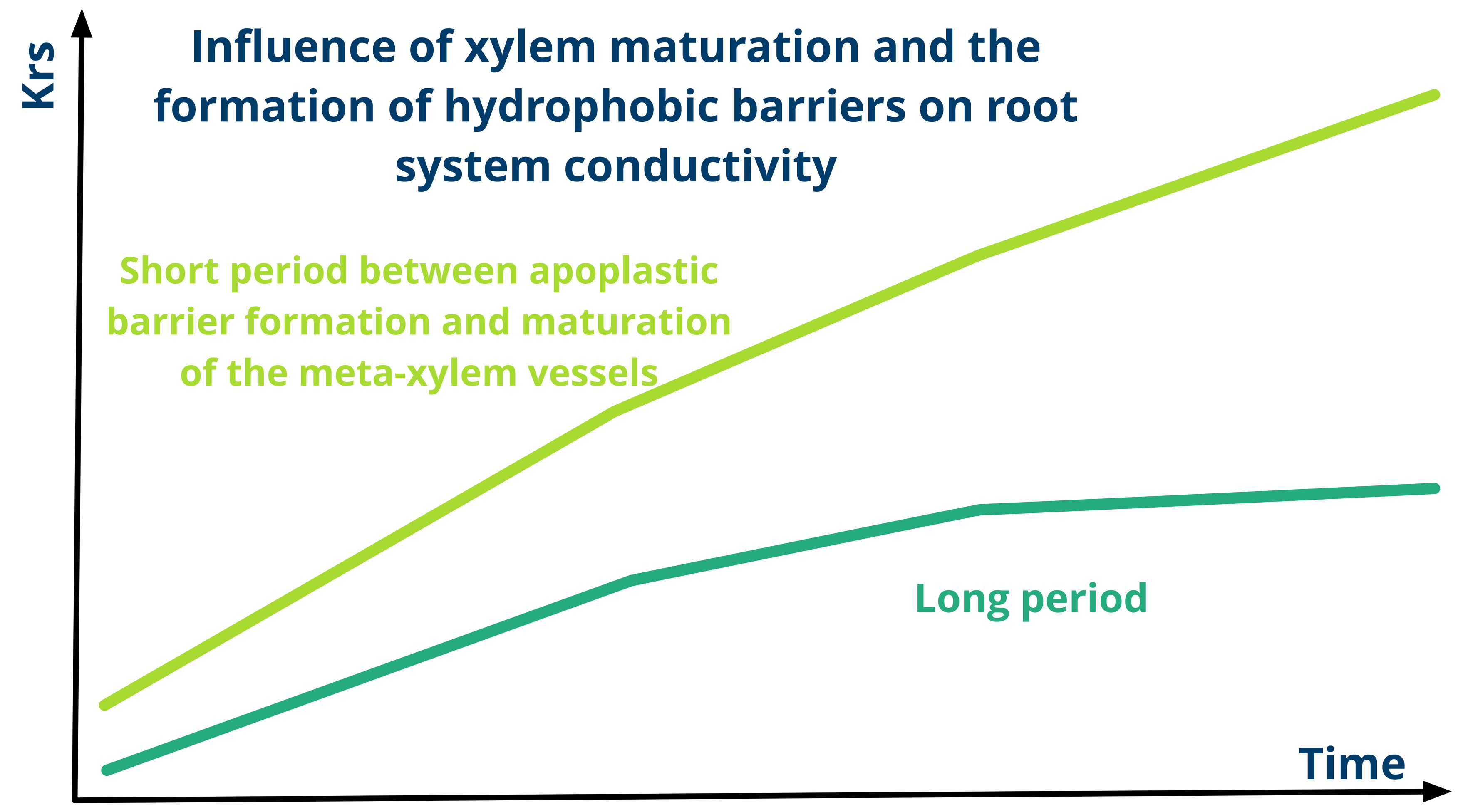
ANATOMY AND CARBON

Carbon flow within the plant is infuenced, in part, by the axial conductivity of phloem vessels. the distribution of these conductivities within the plant will define preferential path for the phloem sap and create specific carbon allocation patterns. Here we combined the whole plant model CPlantBox with a solver of carbon and water flow PiafMunch.

Preliminary results show that changes in **root anatomies** (e.g. number of phloem poles) has the potential to influence the formation the root system architecture. Tin roots are less conductive and transport less carbon toward they apexes. As a result, these roots stop their growth earlier than larger ones, creating **heterogeneity** with the root system (fig. C).

CONCLUSION

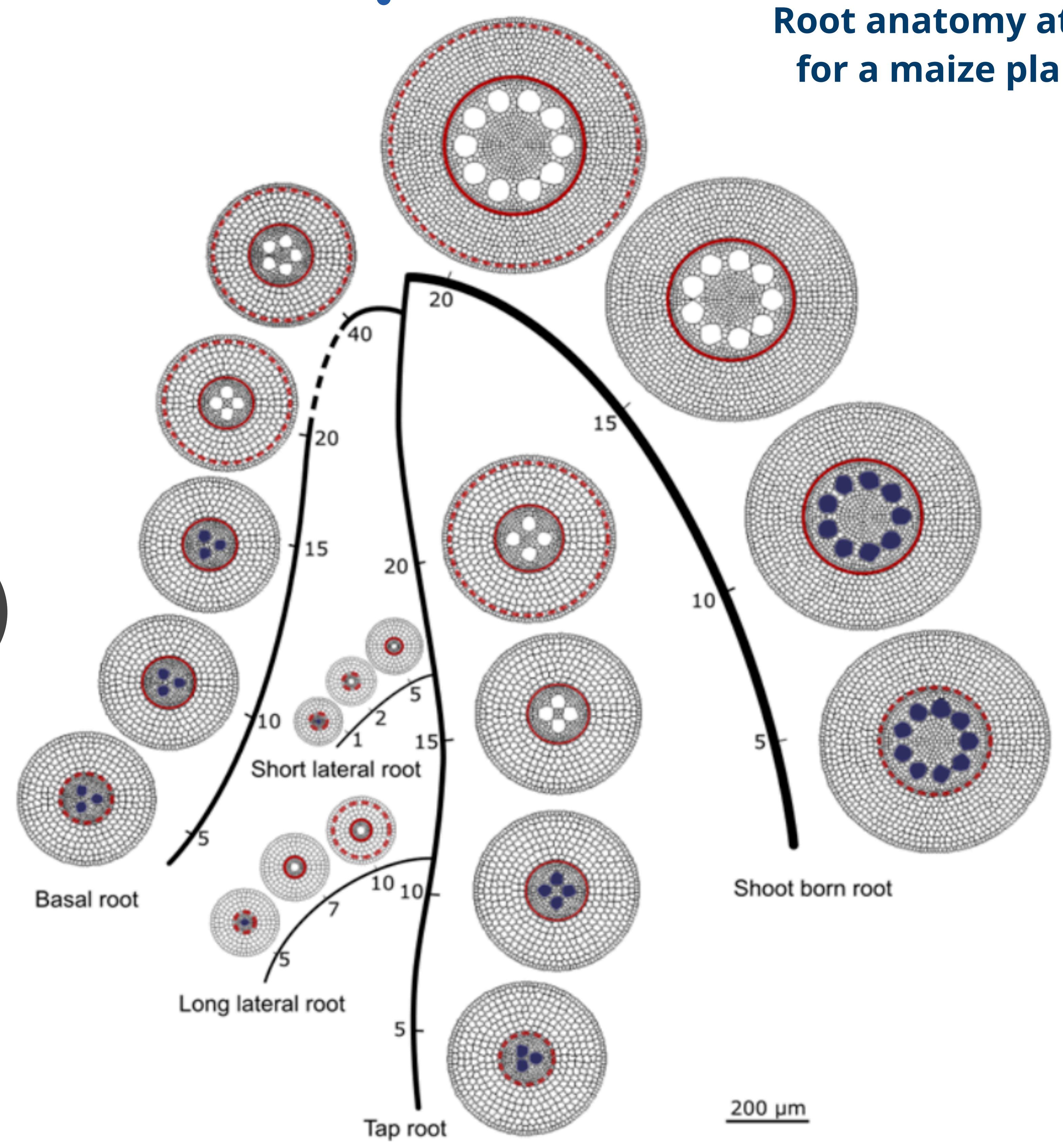
Our aim is to build a modelling framework to quantify a **multiscale** - organ & plant - **bidirectional** - water & carbon - **plant** - root & shoot - **hydraulic architecture.** Such networks will be able to predict how local root properties (anatomies) influence water and carbon flows within a growing plant, in heterogeneous environmental conditions.



B

WATER

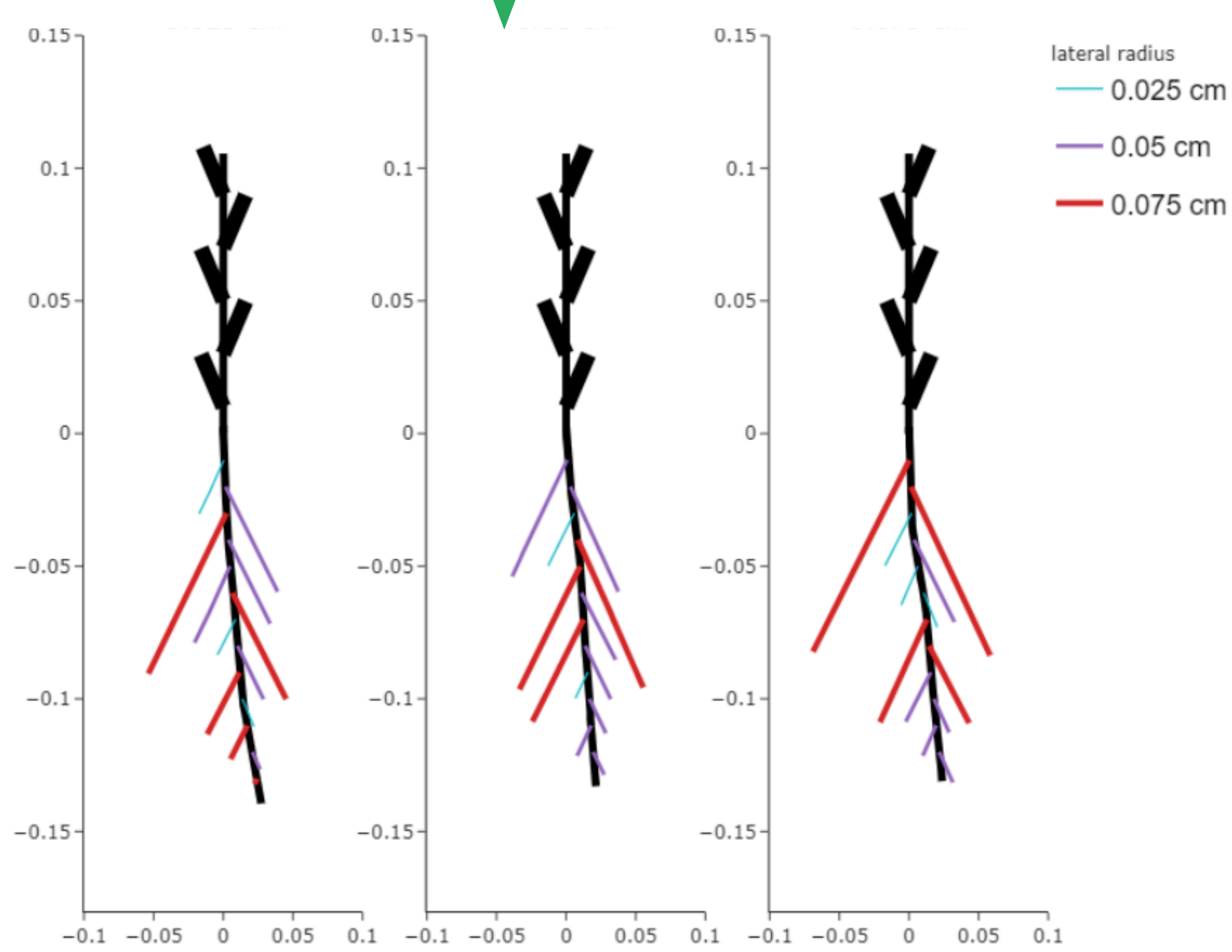
Root anatomy atlas for a maize plant



A

C

CARBON



The diameter and anatomy of lateral roots influence their growth rate and final size

MORE ABOUT THIS WORK

CPlantBox: Zhou et al 2020 (http://dx.doi.org/10.1093/insilicoplants/diaa001)
GRANAR: Heymans et al 2019 (http://dx.doi.org/10.1104/pp.19.00617)
Root altsa: Heymans et al. 2020 (http://dx.doi.org/10.1101/2020.12.15.422825)

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