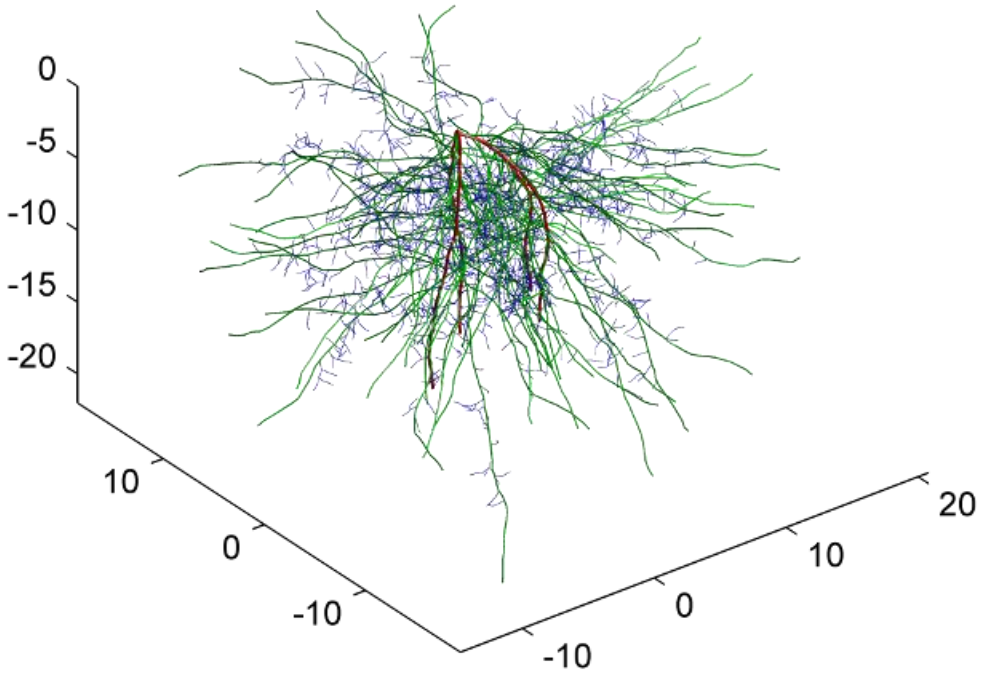


Root Architecture Modelling : ROOTBOX

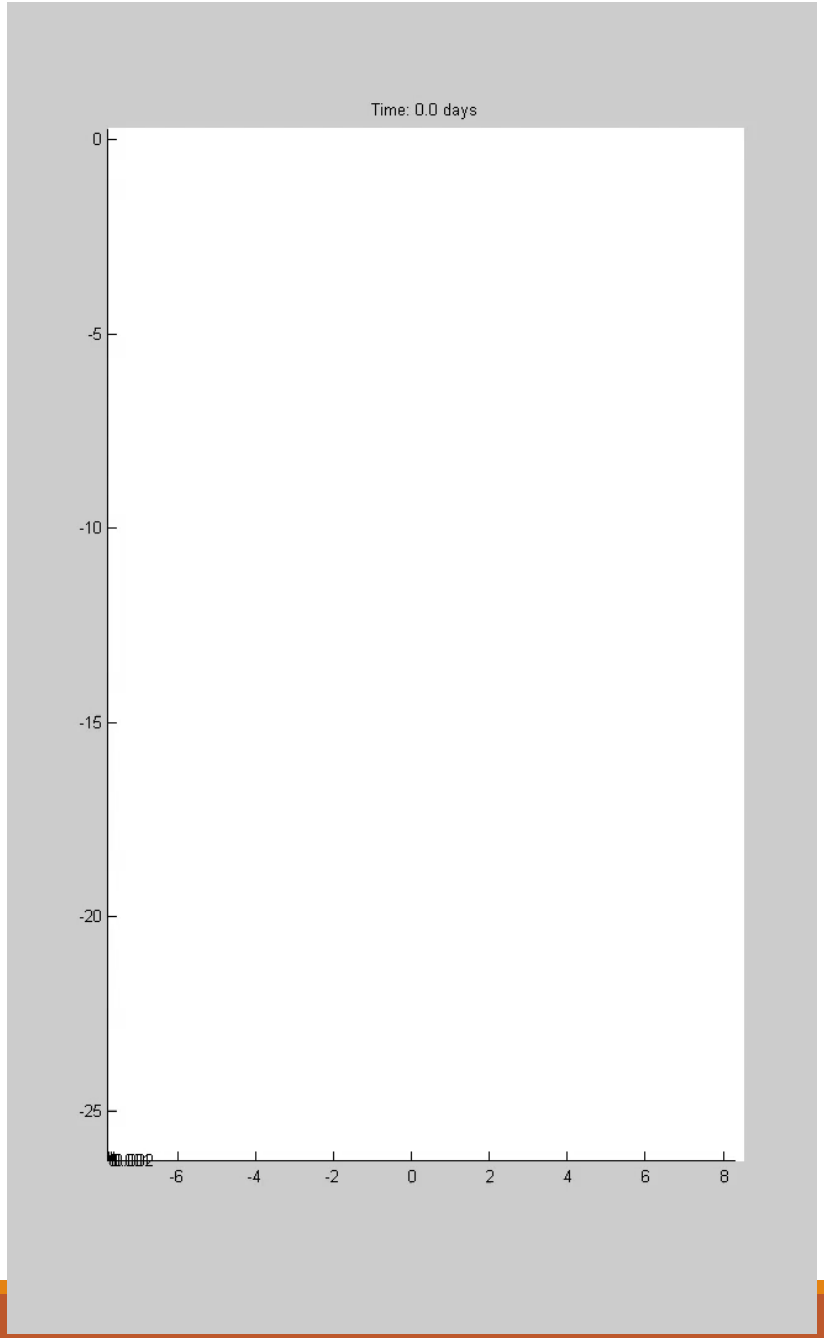
CARESTIA GABRIEL

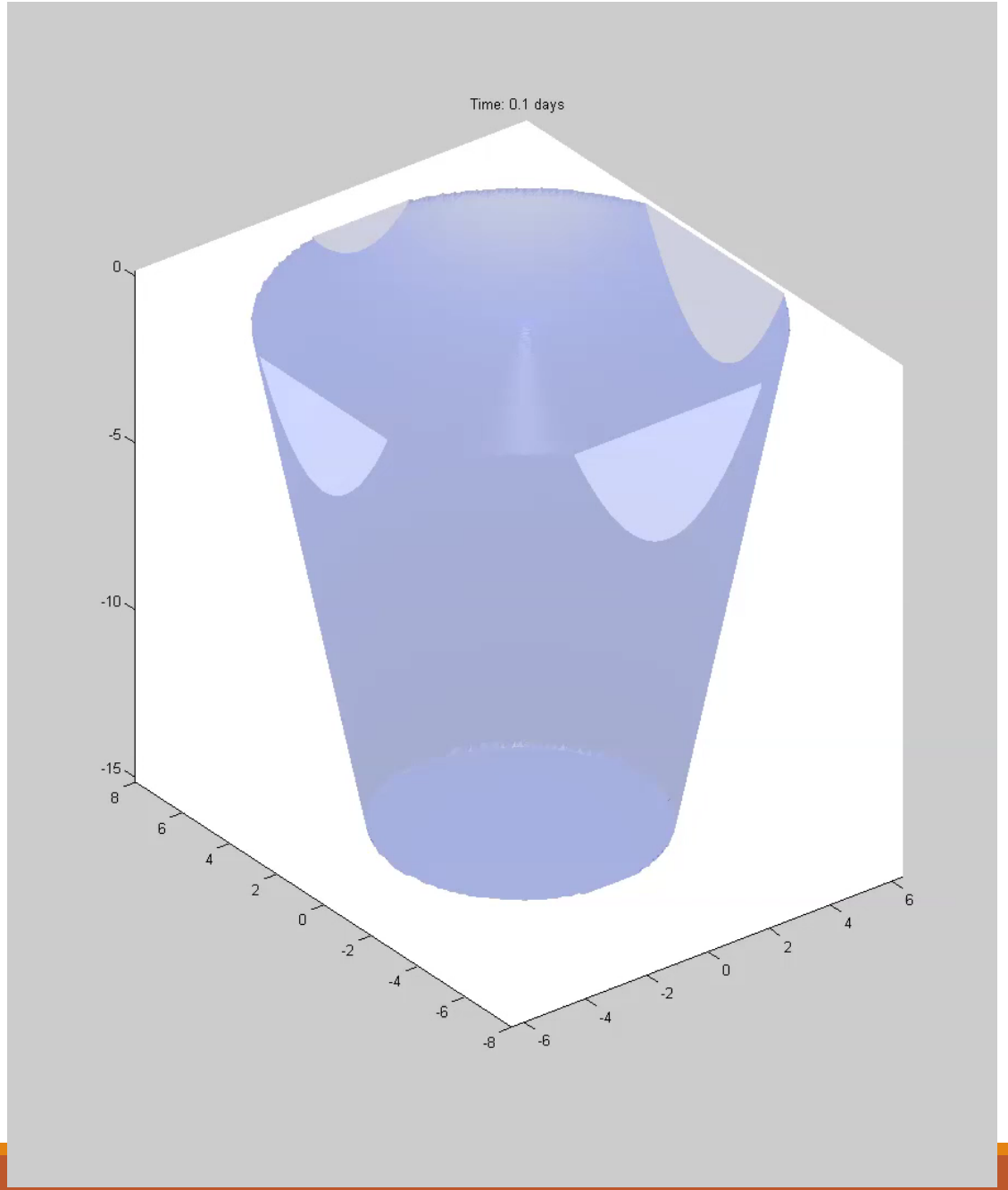
CLÉMENT TIMOTHÉE

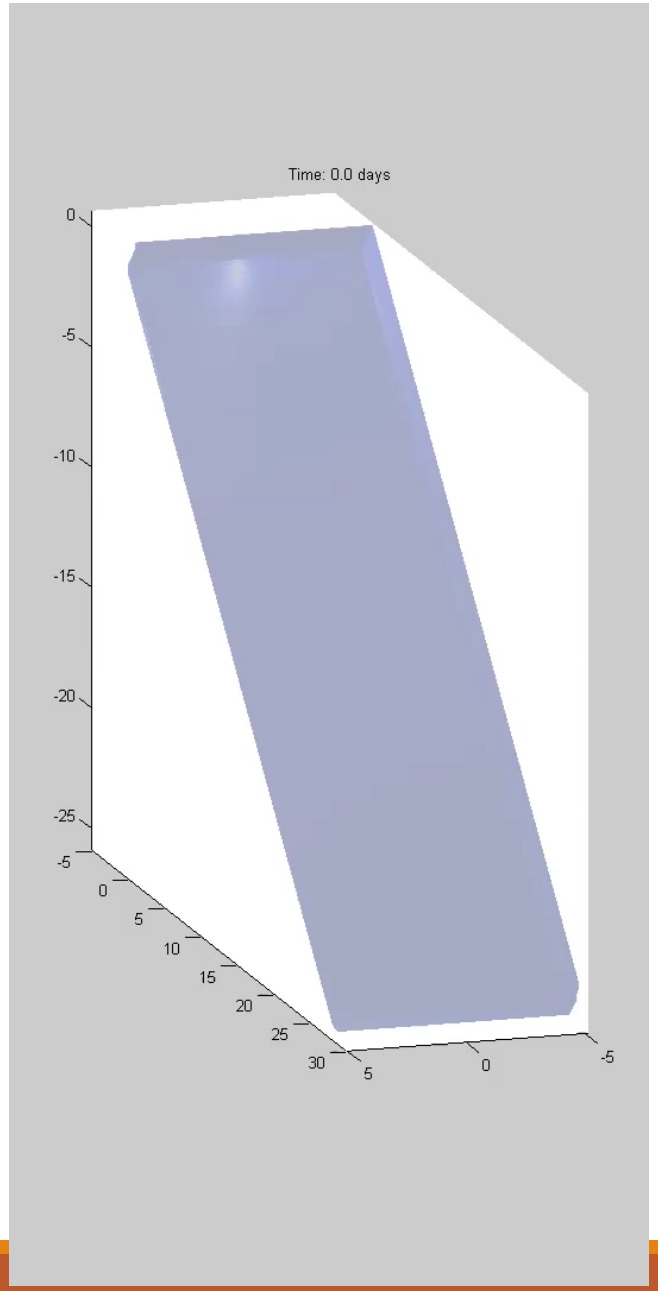
FERON THOMAS

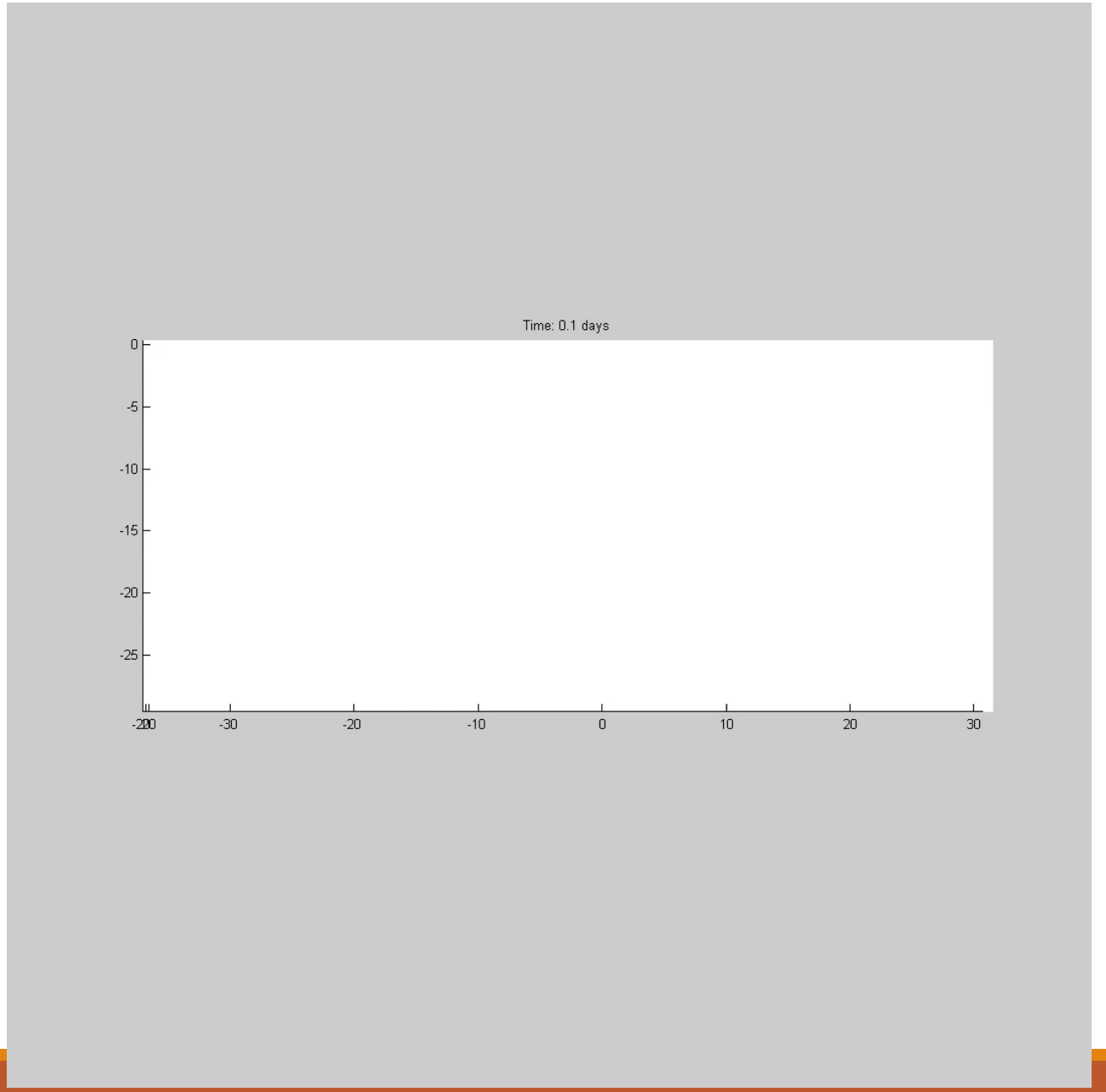
Modélisation de systèmes biologiques

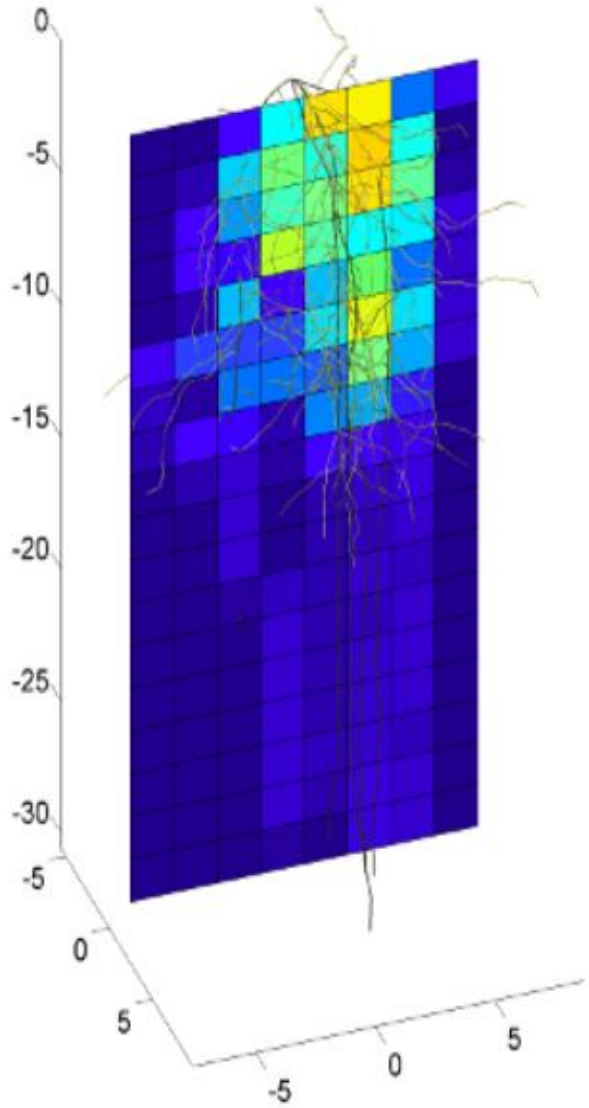
LBRAI2219 2017-2018 *Louvain-la-Neuve*

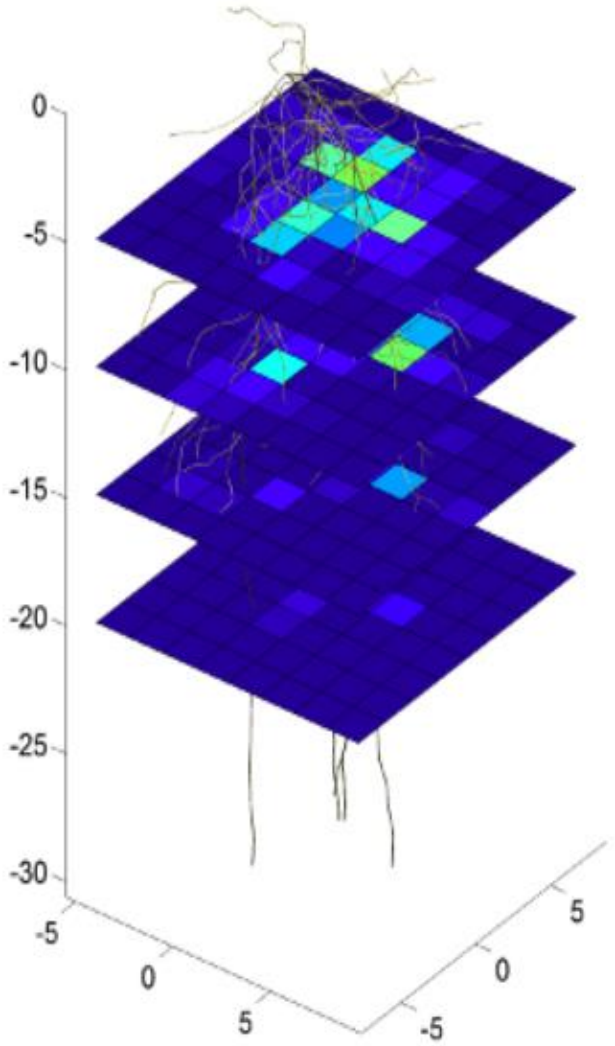

Time: 0.0 days
0
-5
-10
-15
-20
-25
-6
-4
-2
0
2
4
6
8

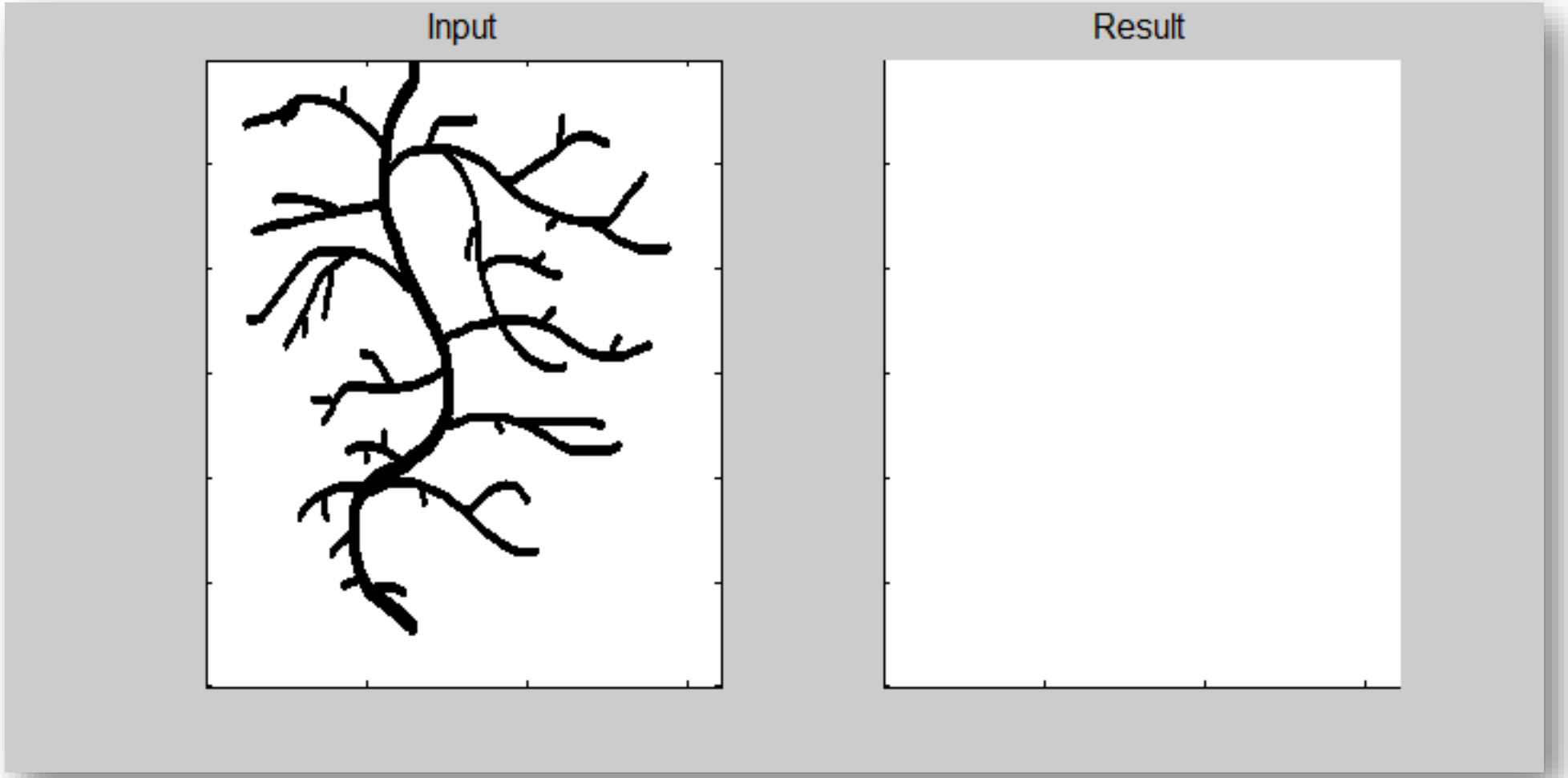

Time: 0.1 days
0
-5
-10
-15
8
6
4
2
0
-2
-4
-6
-8
-6
-4
-2
0
2
4
6

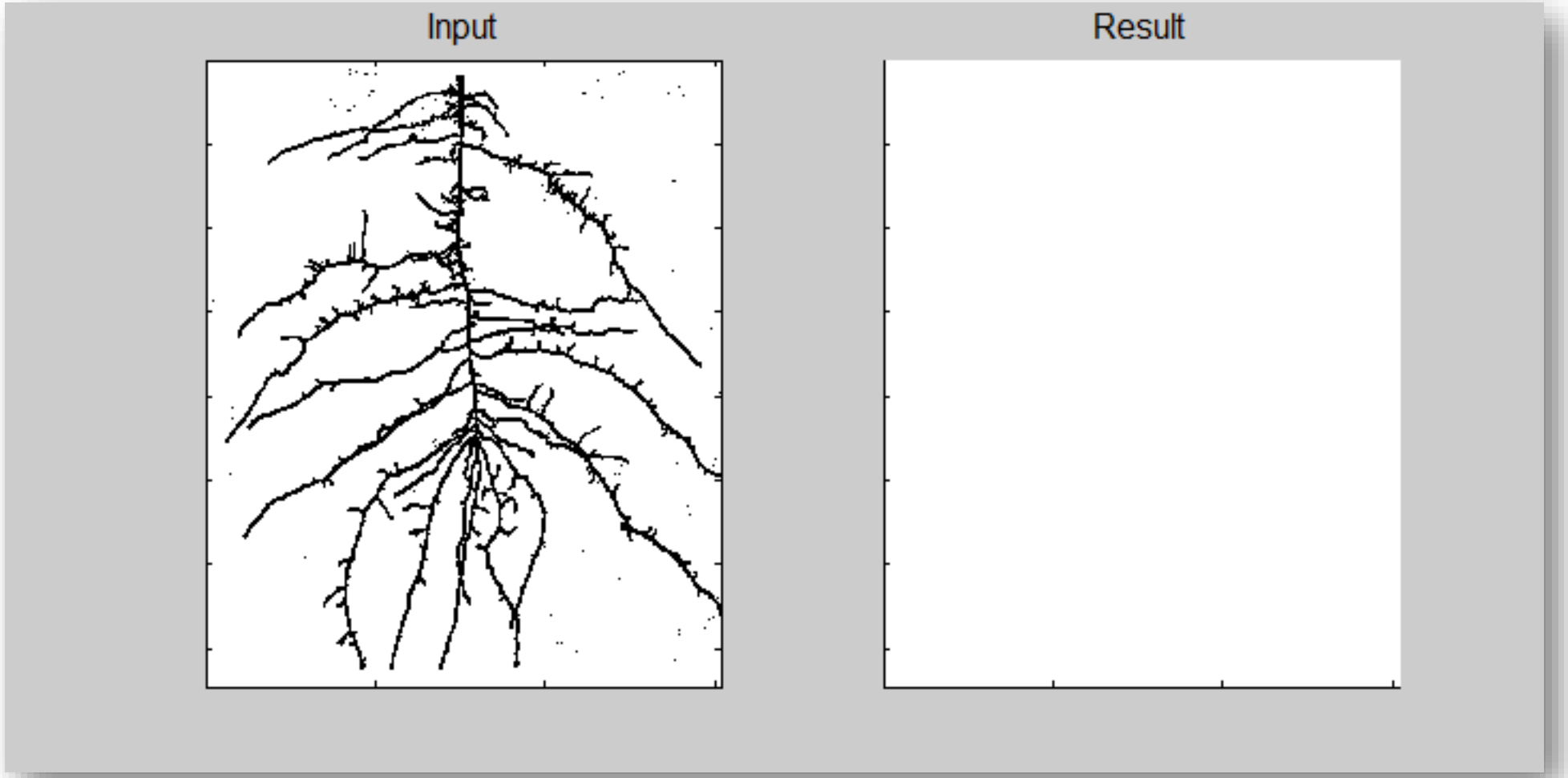

Time: 0.0 days
0
-5
-10
-15
-20
-25
-5
0
5
10
15
20
25
30
5
0
-5

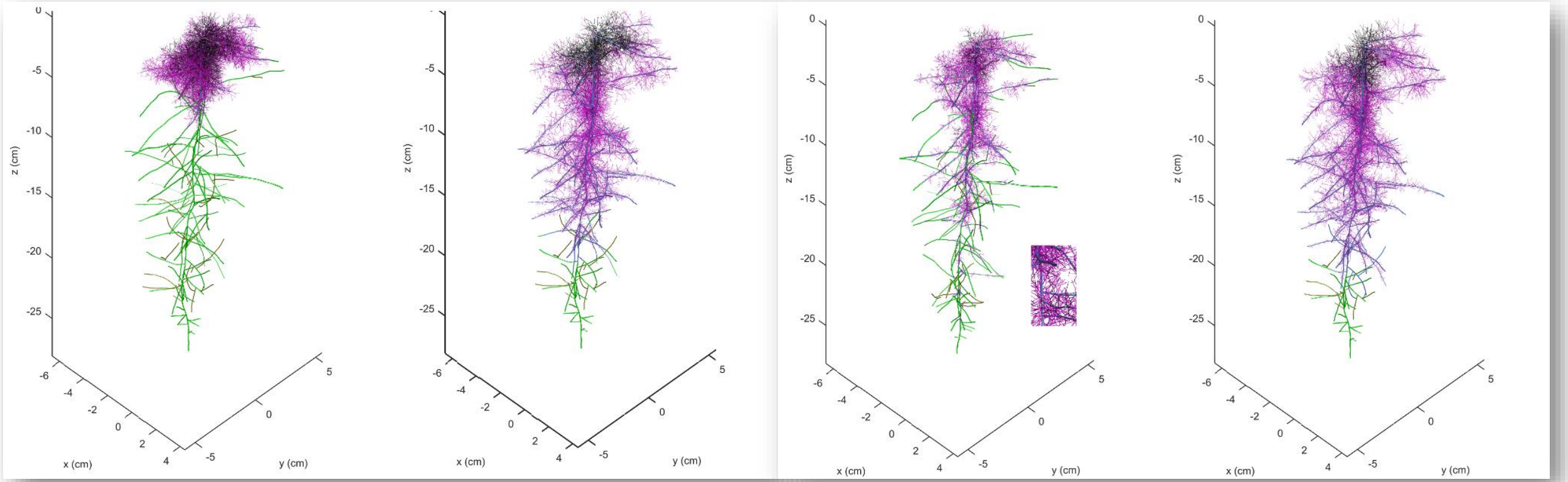

Time: 0.1 days
0
-5
-10
-15
-20
-25
-30
-20
-10
0
10
20
30

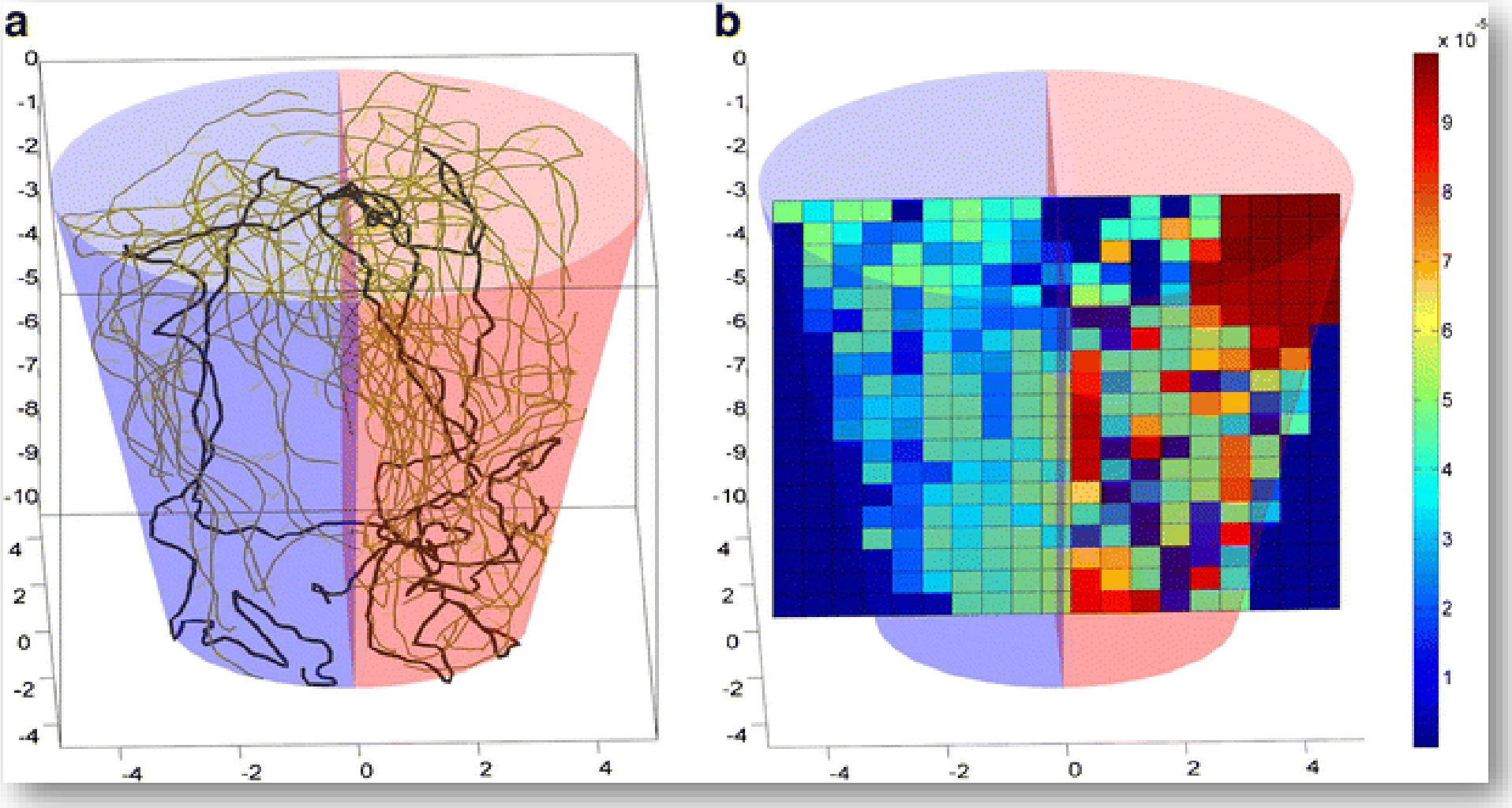

0
-5
-10
-15
-20
-25
-30
-5
0
5
-5
0
5


0
-5
-10
-15
-20
-25
-30
-5
0
5
-5
0
5


Input
Result


Input
Result

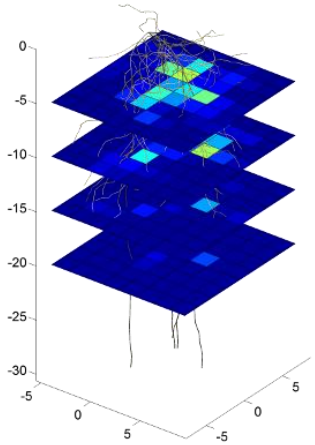

z (cm)
x (cm)
y (cm)
z (cm)
x (cm)
y (cm)
z (cm)
x (cm)
y (cm)
z (cm)
x (cm)
y (cm)



- Modelling Phosphorus Dynamics in the Soil–Plant System (Andrea Schnepf et al., 2010)

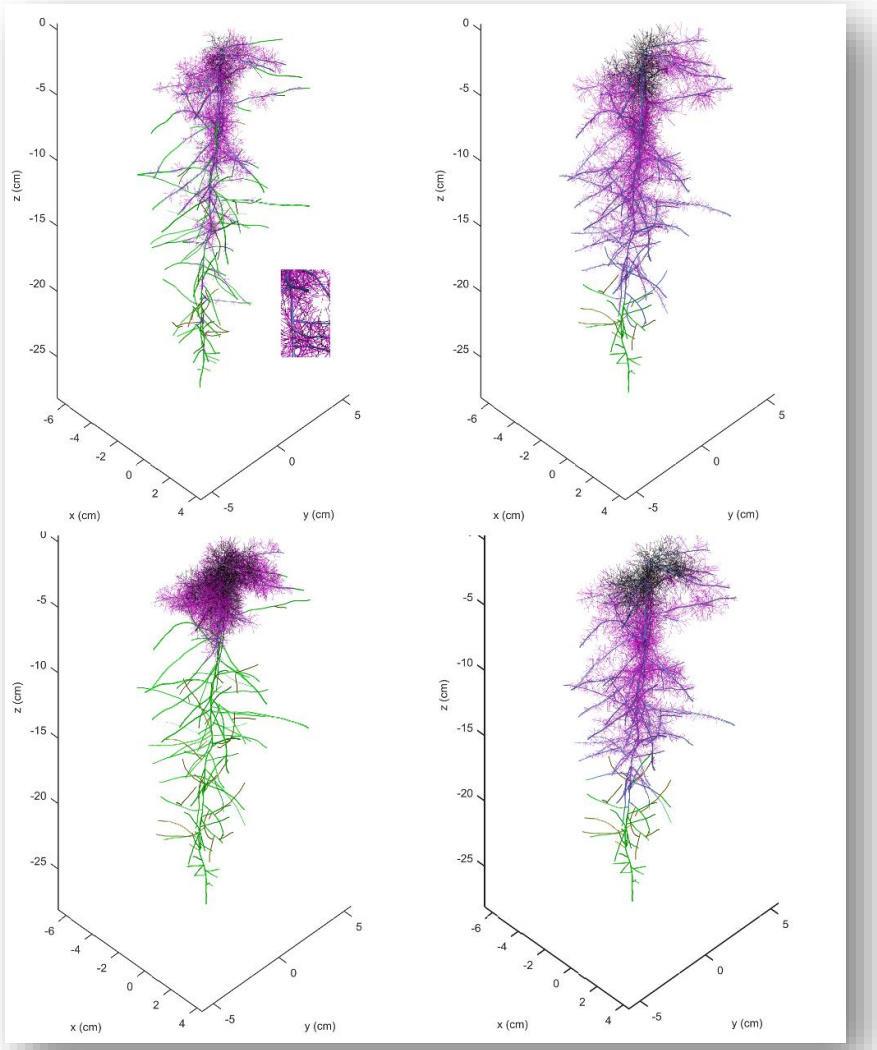
Progression : Choix d'un modèle

MATLAB



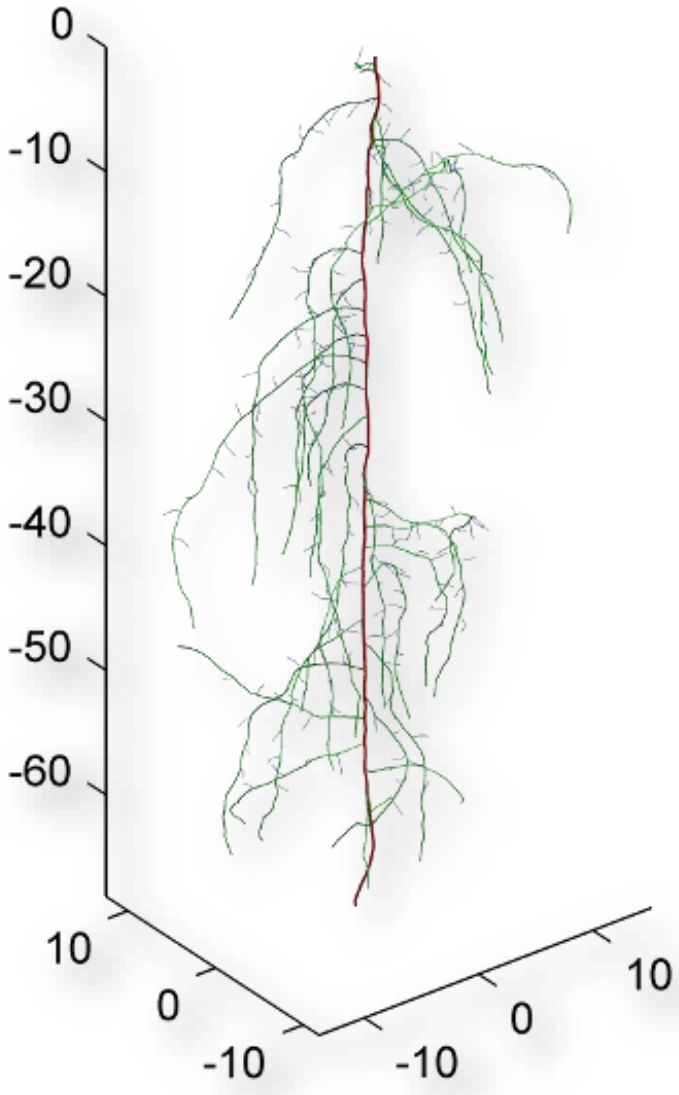
JÜLICH
FORSCHUNGSZENTRUM

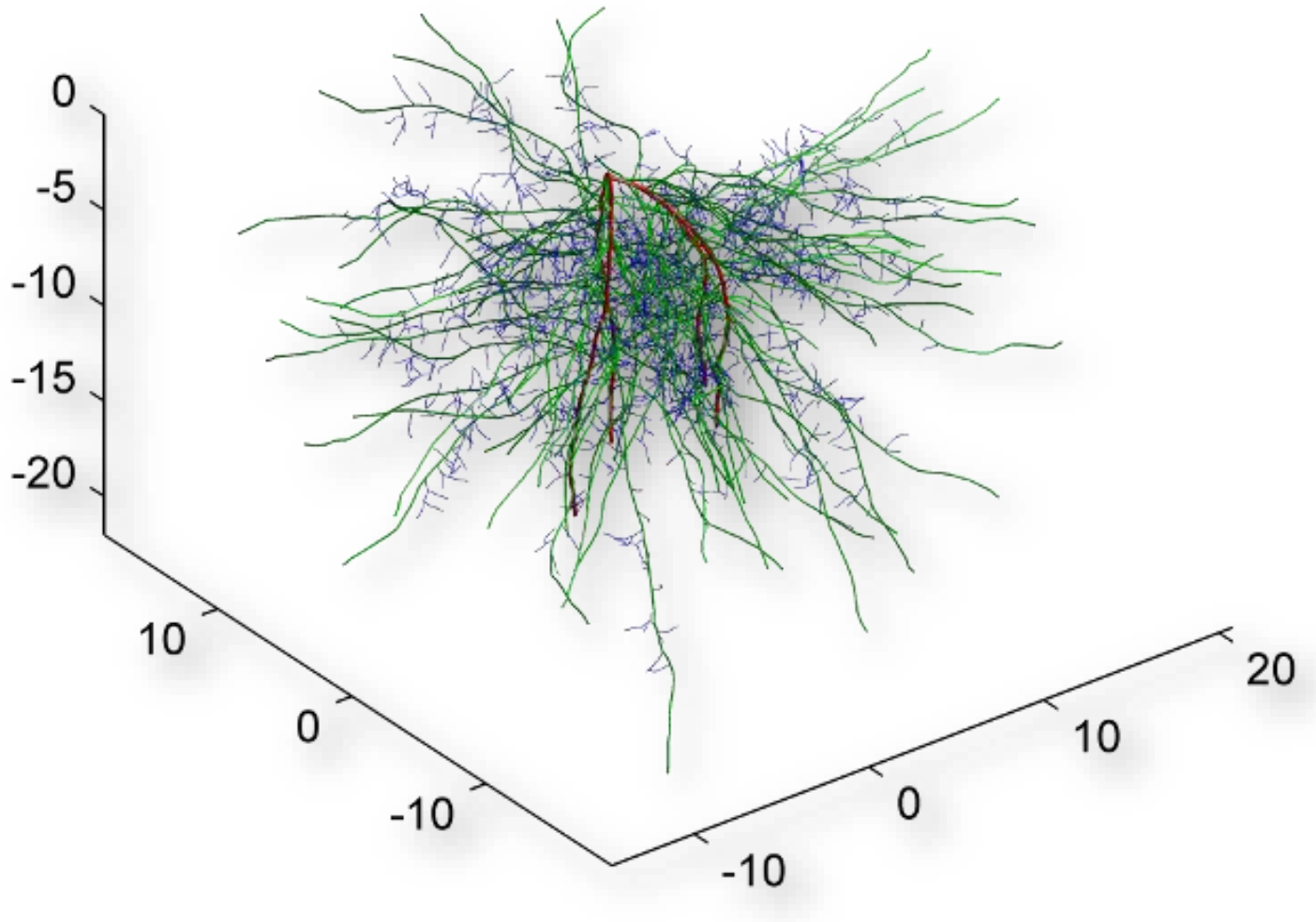
universität wien



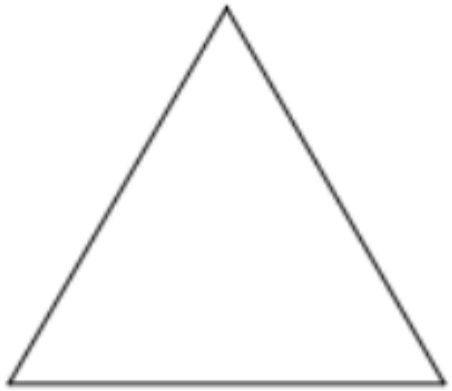
1ère tentative : Mycorrhizes

2e tentative : Ravageurs


0
-10
-20
-30
-40
-50
-60
10
0
-10
-10
0
10

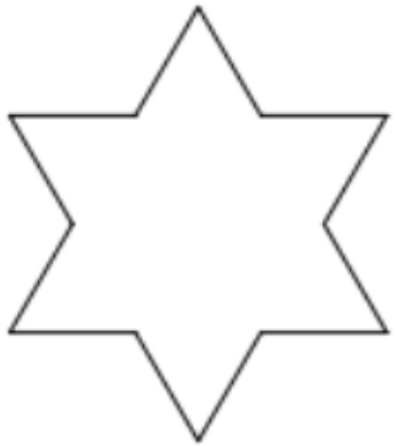

0
-5
-10
-15
-20
10
0
-10
-10
0
10
20

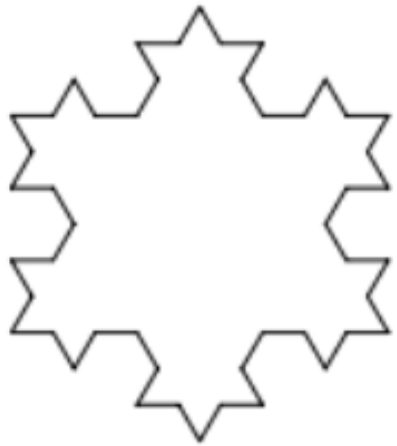
L-SYSTEM

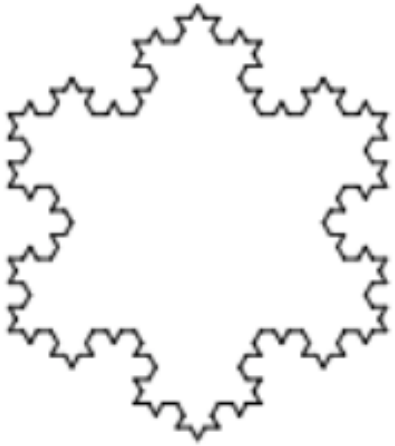


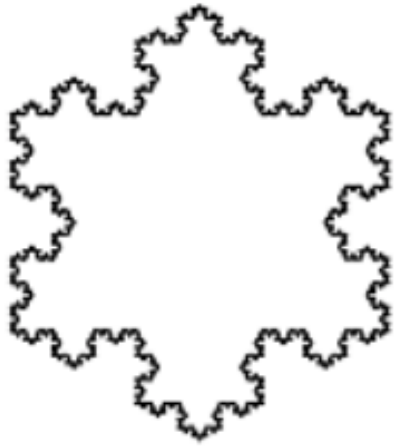
initiator

generator



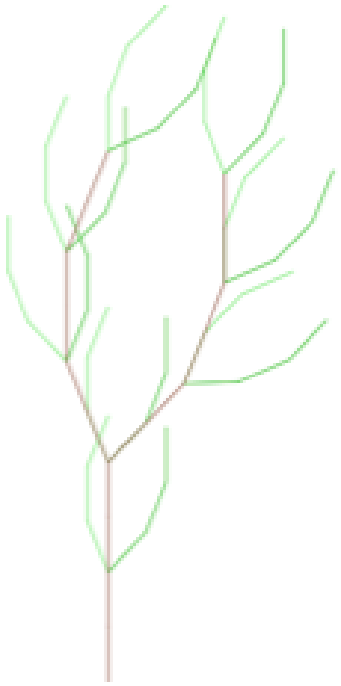


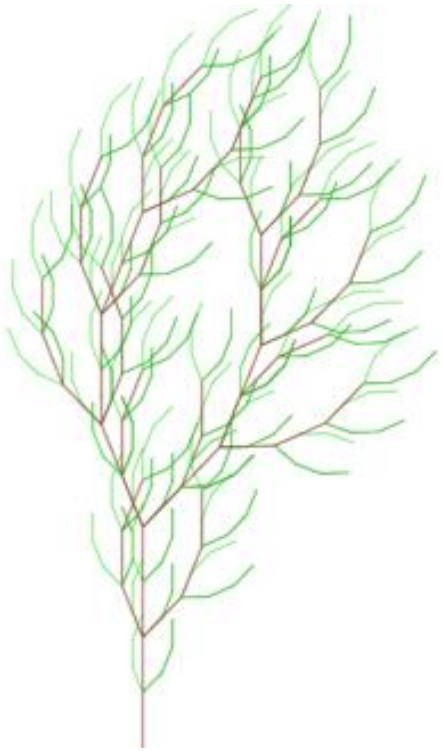


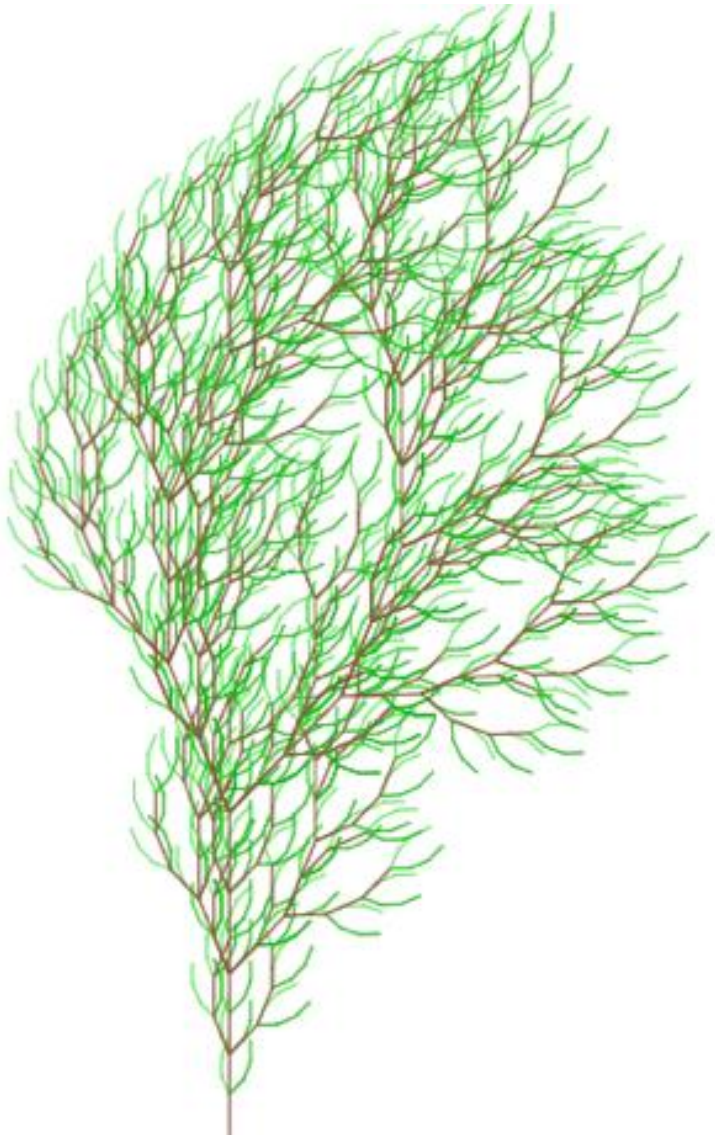


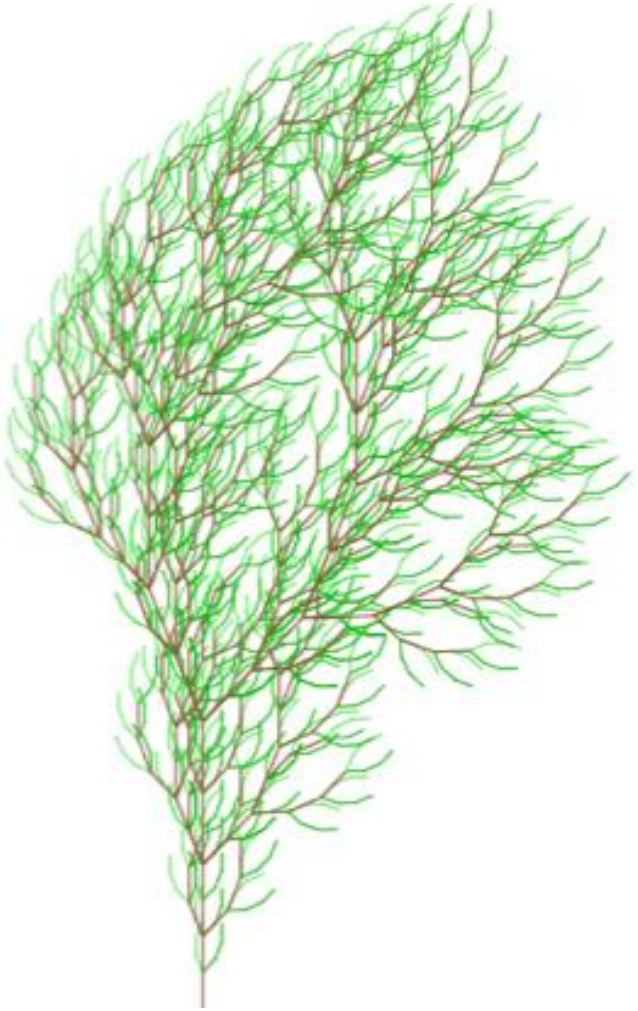
L-SYSTEM

Itération : 4
Angle : 22°
Axiome : F
Règle : F=C0FF-[C1-F+F+F]+[C2+F-F-F]



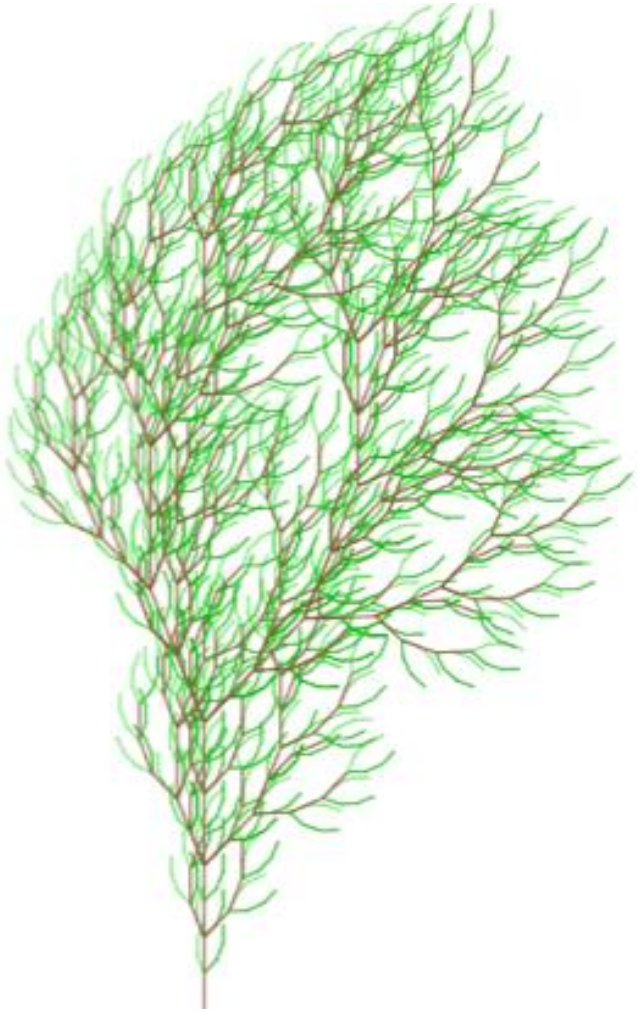






22°

12°

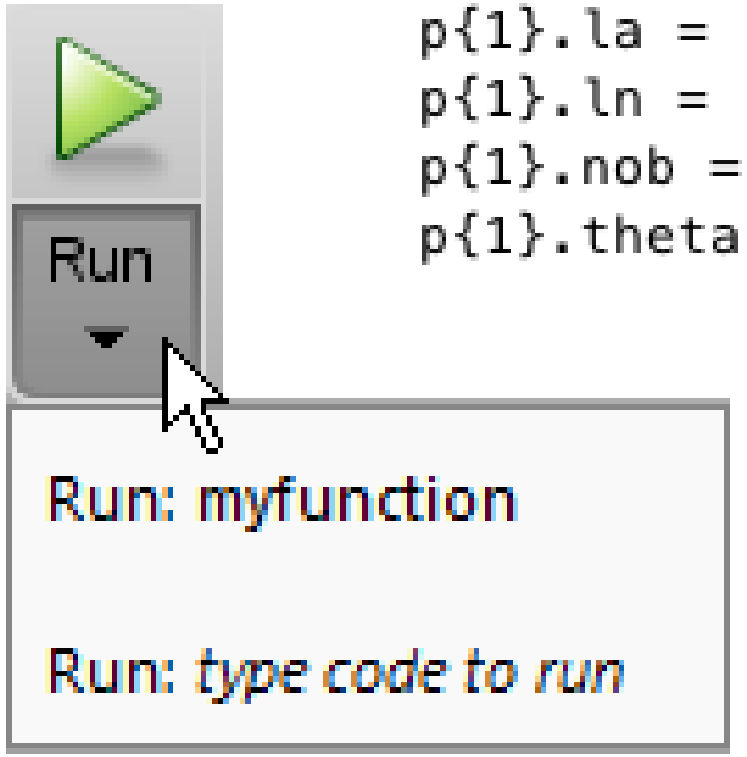


F=C0FF-[C1-F+F+F]+[C2+F-F-F]

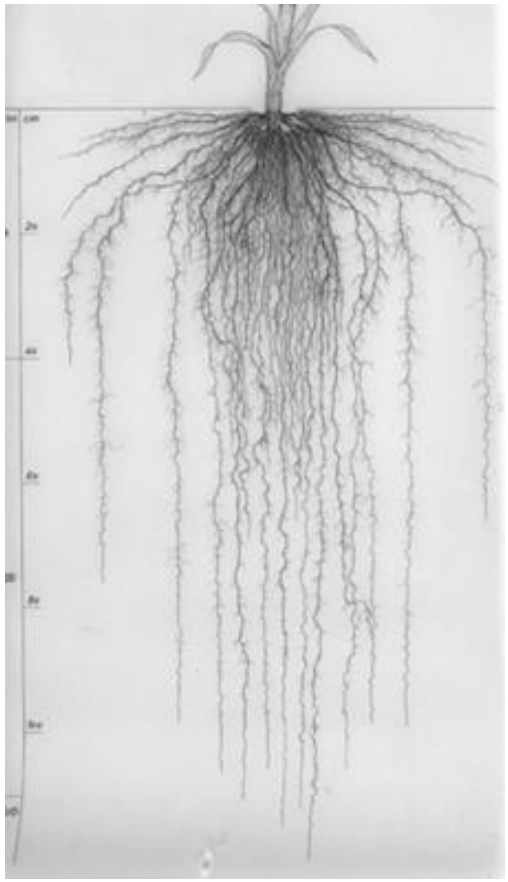
F=C0FF-[C1+F+F+F]+[C2+F-F-F]

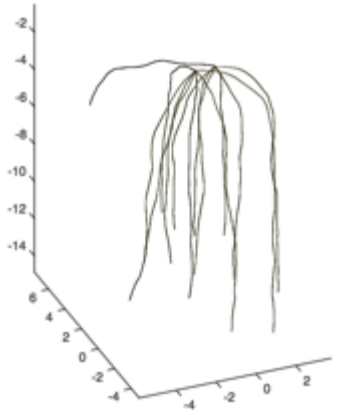
```
% 'F' Forward
% 'f' Noline forward
% 'C' Color
% '#' Diameter
% '[' Push turtle state
% ']' Pop turtle state
% '+' Turn left
% '-' Turn right
% '&' Pitch up
% '^' Pitch down
% '\' Roll left
% '/' Roll right
% '|' Turn around
% 'r' Roll and turn

% 300 Section growth
% 301 Delay
% 302 Branching
% 303 Create root
% 304 Create successor
% 305 Root tip that stopped growing
```

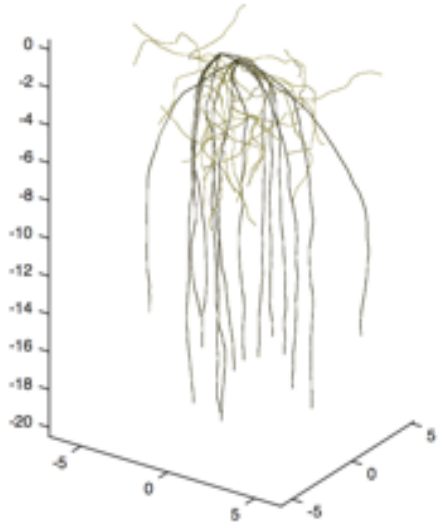
```
p{1}.r = [3, 0]; % Initial elongation rate (cm/day)
p{1}.a = [0.4, 0]; % Root radius (cm)
p{1}.lb = [15, 0]; % Length of basal zone (cm)
p{1}.la = [15, 0]; % Length of apical zone (cm)
p{1}.ln = [5, 0]; % Length between laterals (cm)
p{1}.nob = [10, 0]; % Maximal number of laterals (1)
p{1}.theta = [0, 0]; % Insertion angle(rad)
```

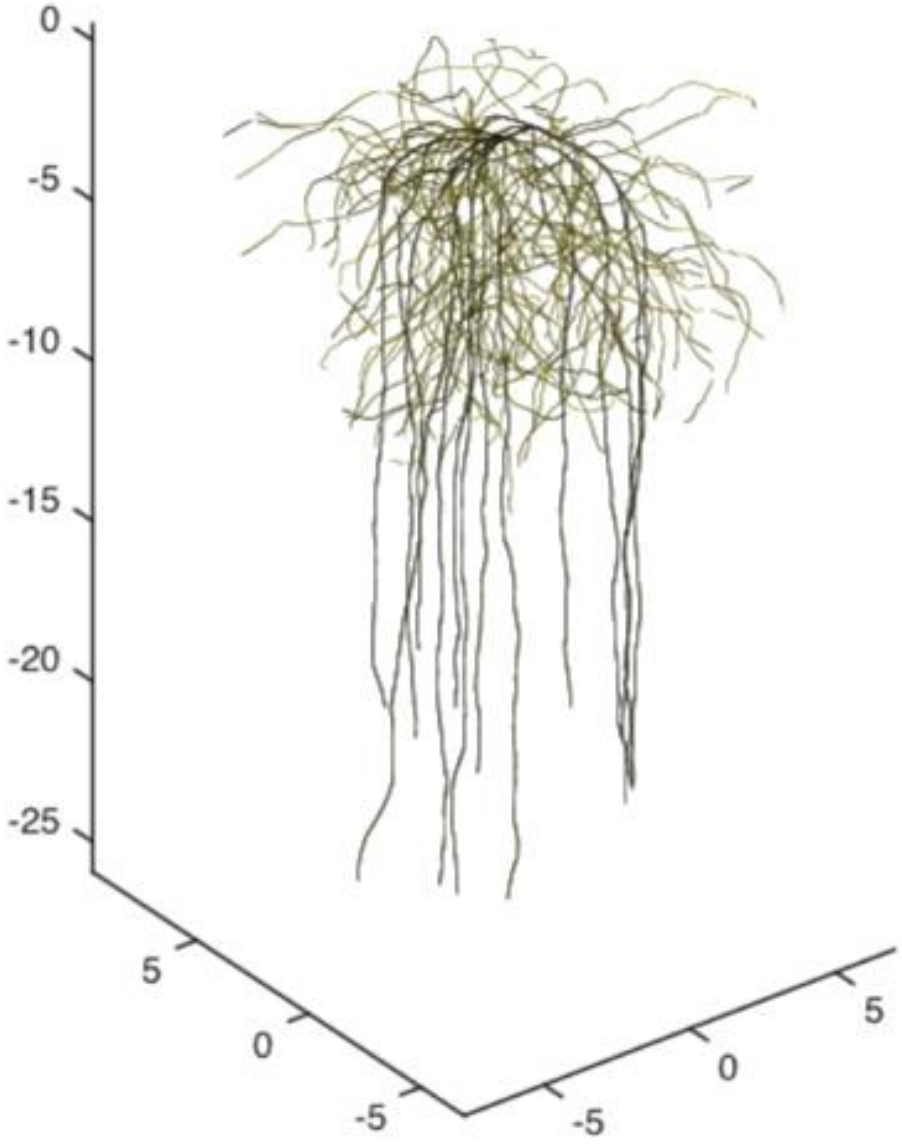


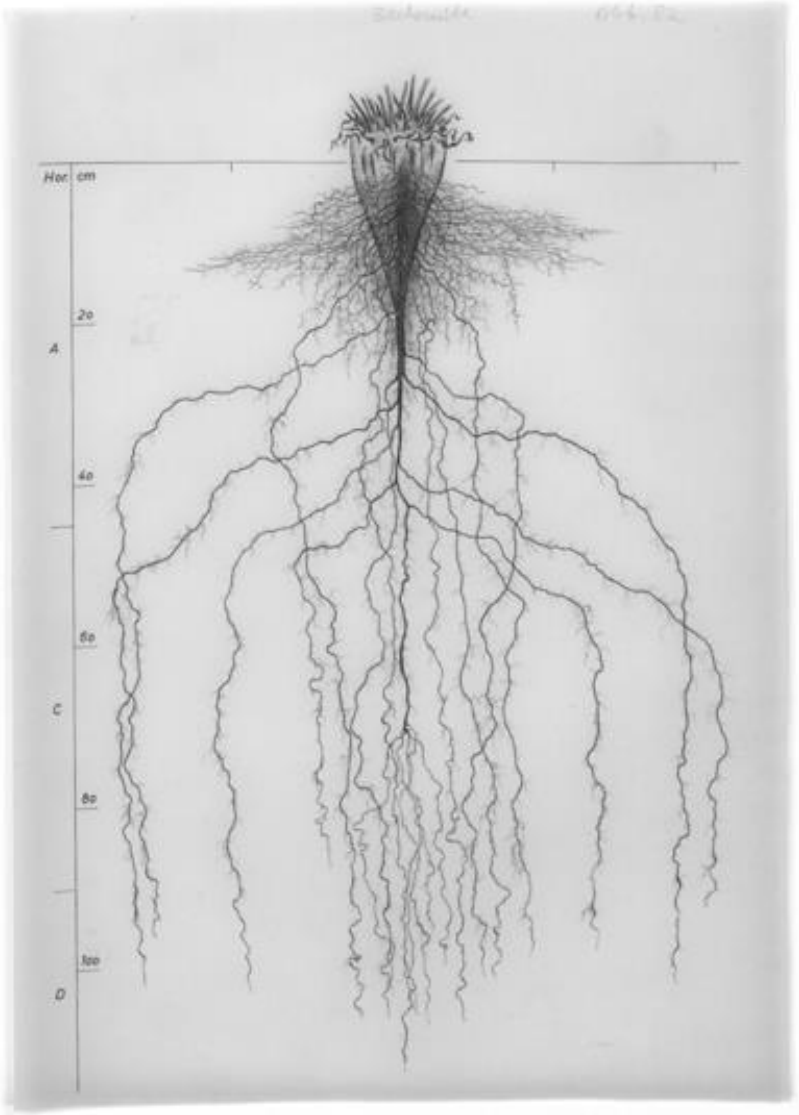
ZEA MAYS

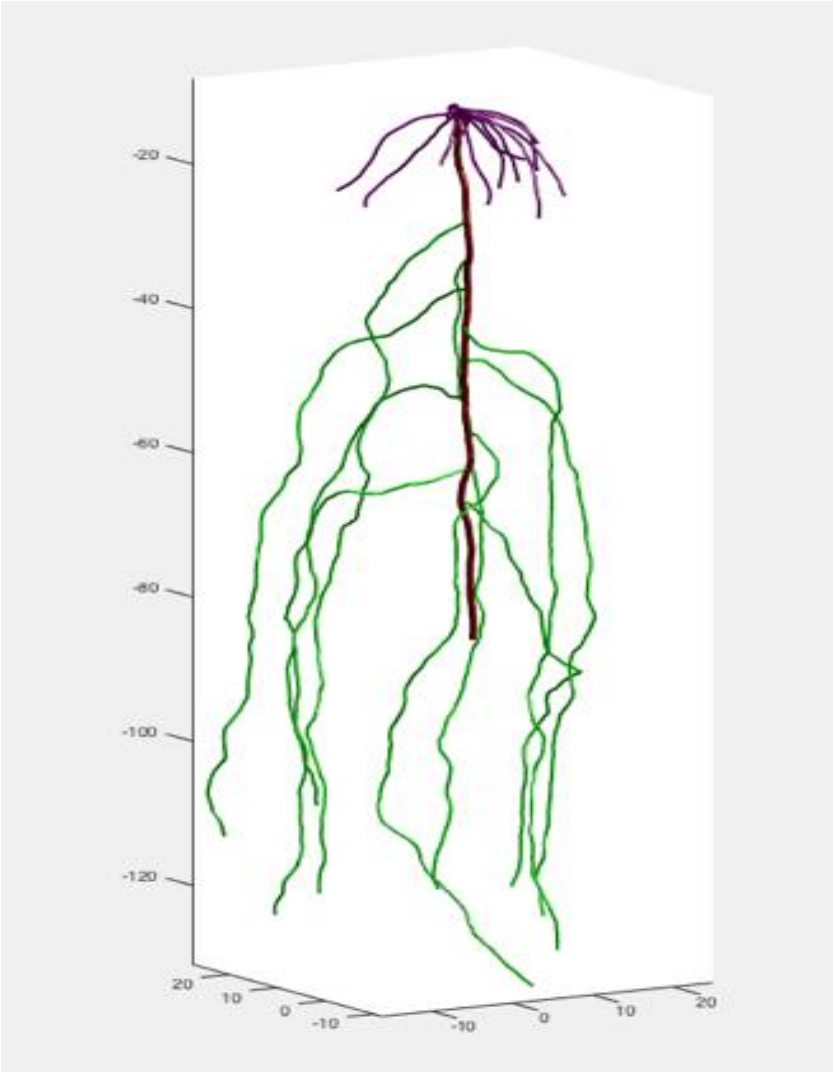






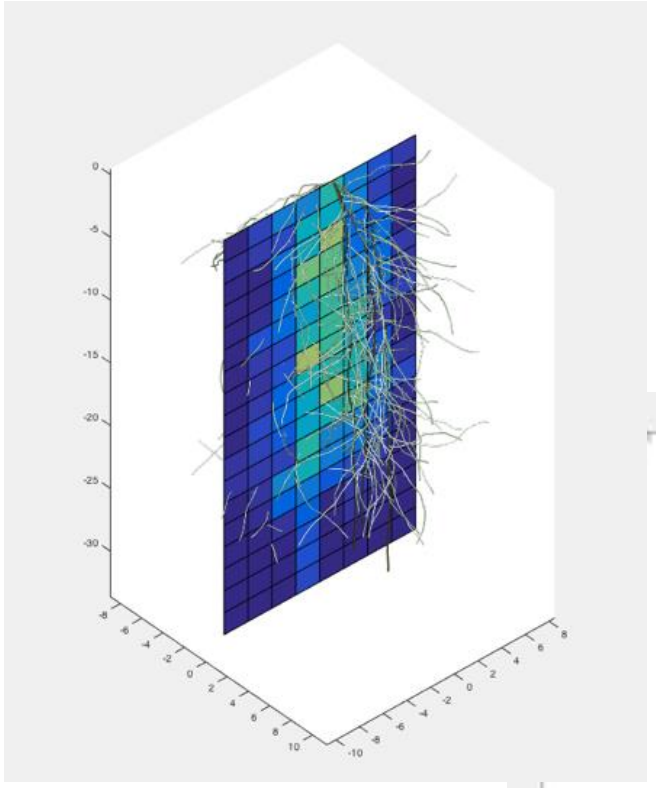


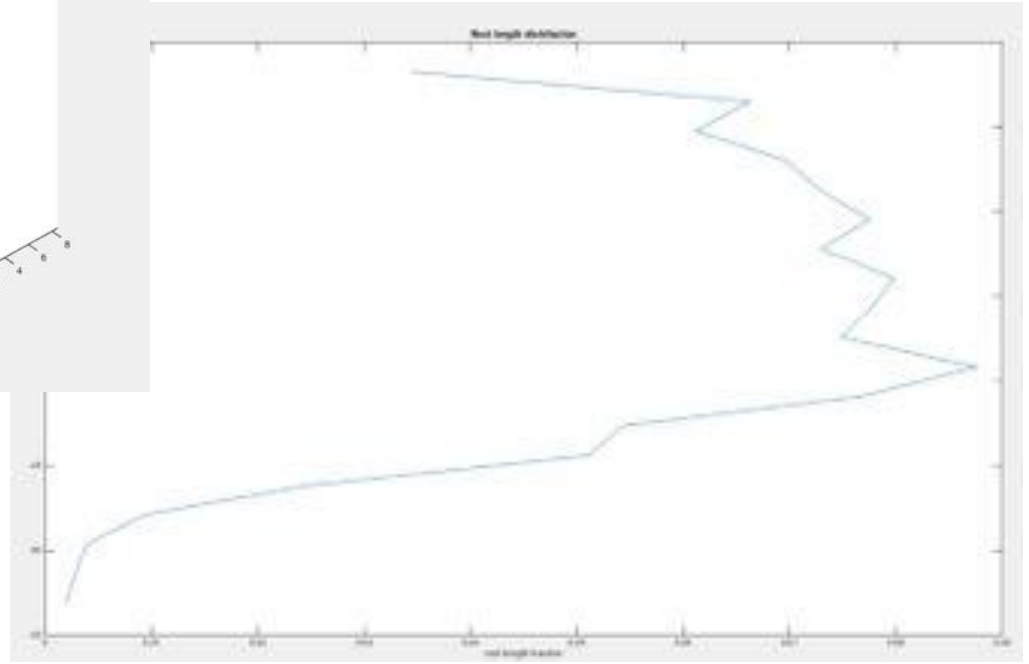

Hor
cm
A
C
D


-20
-40
-60
-80
-100
-120
20
10
0
-10
-10
0
10
20

```
function [map,total] = getDensity(str,X,Y,Z,mode,D,GC,TI,TY)
```

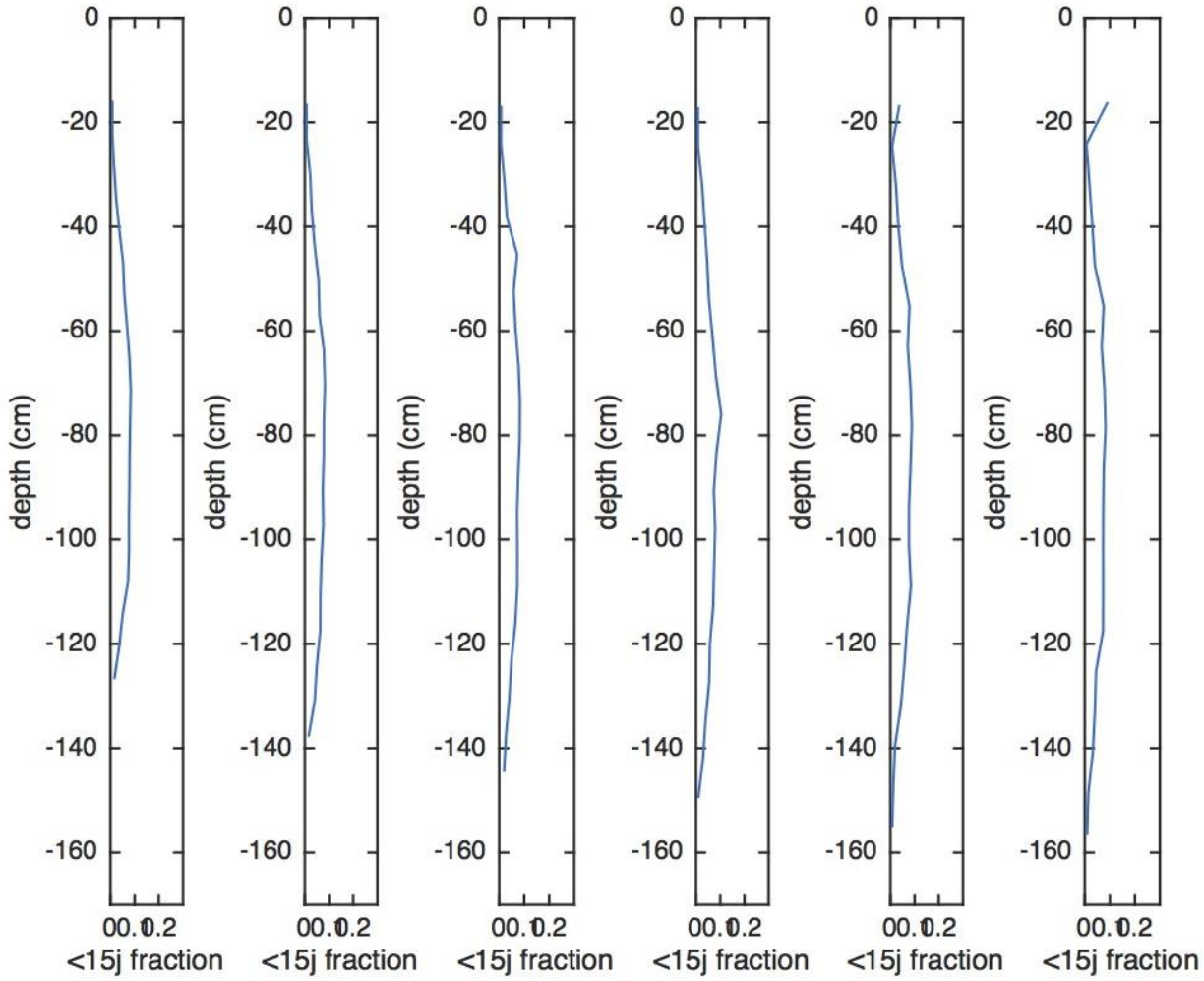
- applyRules.m
- completeParameters.m
- createDicotRS.m
- createMonocotRS.m
- createRootSystem.m
- Dicot.fig
- Dicot.m
- distPot.m
- distRhizotron.m
- Example_Anagallis.m
- Example_Chemotropism.m
- Example_Densities.m
- Example_Densities_BeetRoot.m
- Example_Densities_BeetRoot_Inf15_ElonNorm.m
- Example_Fitter.m
- Example_Maize.m
- Example_MaizeCoupling.m
- Example_Rhizotron.m
- Example_Sorghum.m
- get_simtime.m
- getBounds.m
- getDensity.m
- getFitter.m
- getGraph.m
- getGraph2.m
- getPolylines.m
- getSegments.m
- getTotal.m
- growthFunction.m
- letter.m

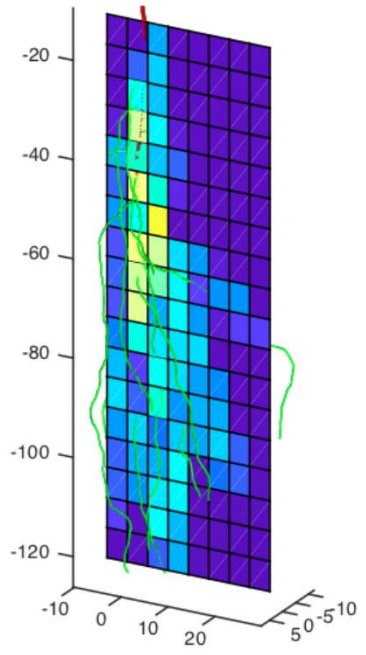




```
% Parameters:
% str                 l-system string
% X,Y,Z               a rectangular mesh
% (mode)              'v' :volume, 's' :surface, 'l' :length, 't' :tips;
%                     capital letters to exclude dead root segments (with
%                     color = [0,0,0]). (default mode='s')
% (D)                 diameter classses, default D = [-inf inf].
% (GC)                grey scaled color classes, default GC = [-inf inf].
% (TI)                time classes, default = [-inf inf].
% (TY)                type classes, default = [-inf inf].
```

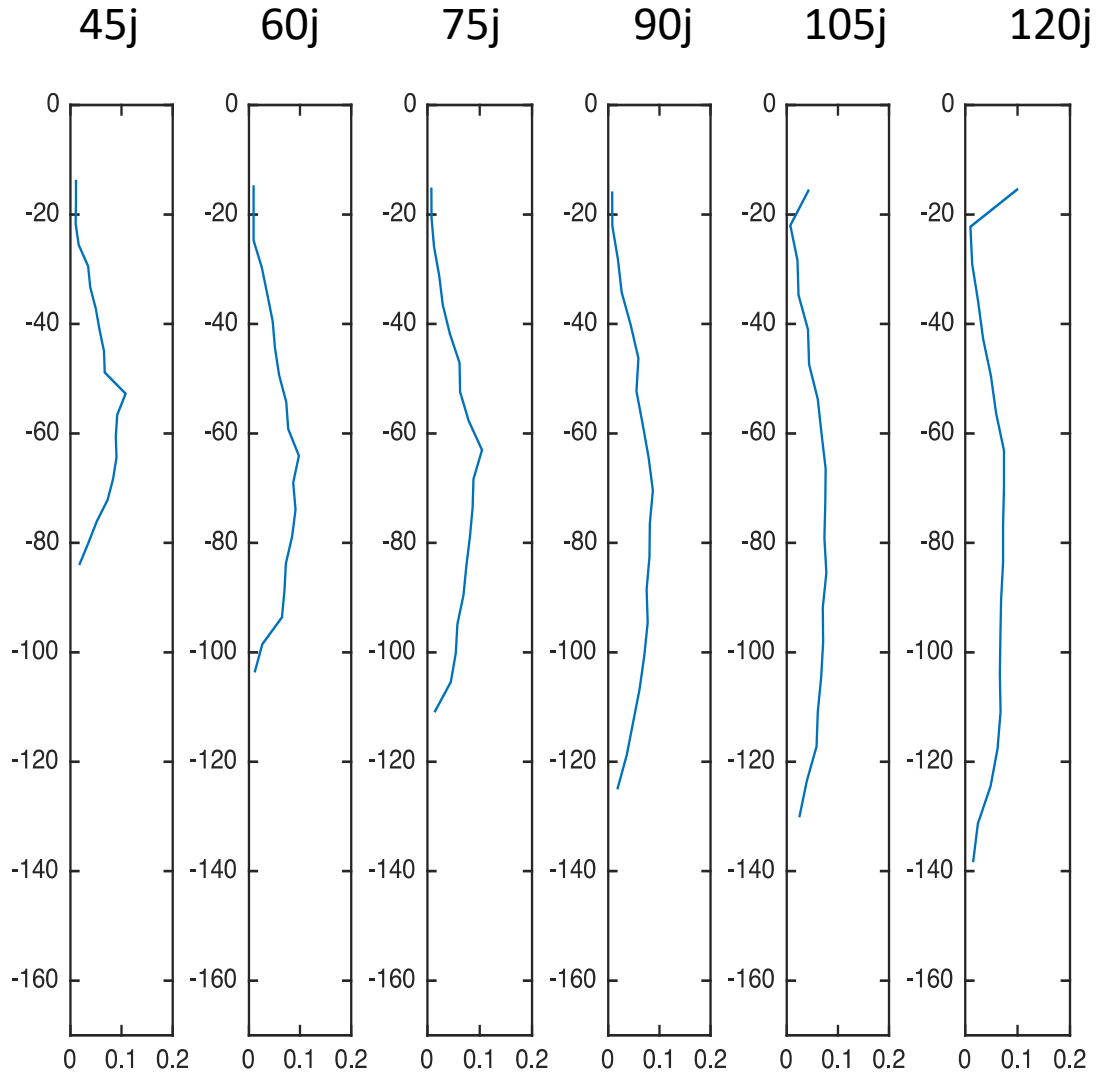
```
TI = [simtime-15 simtime]
```





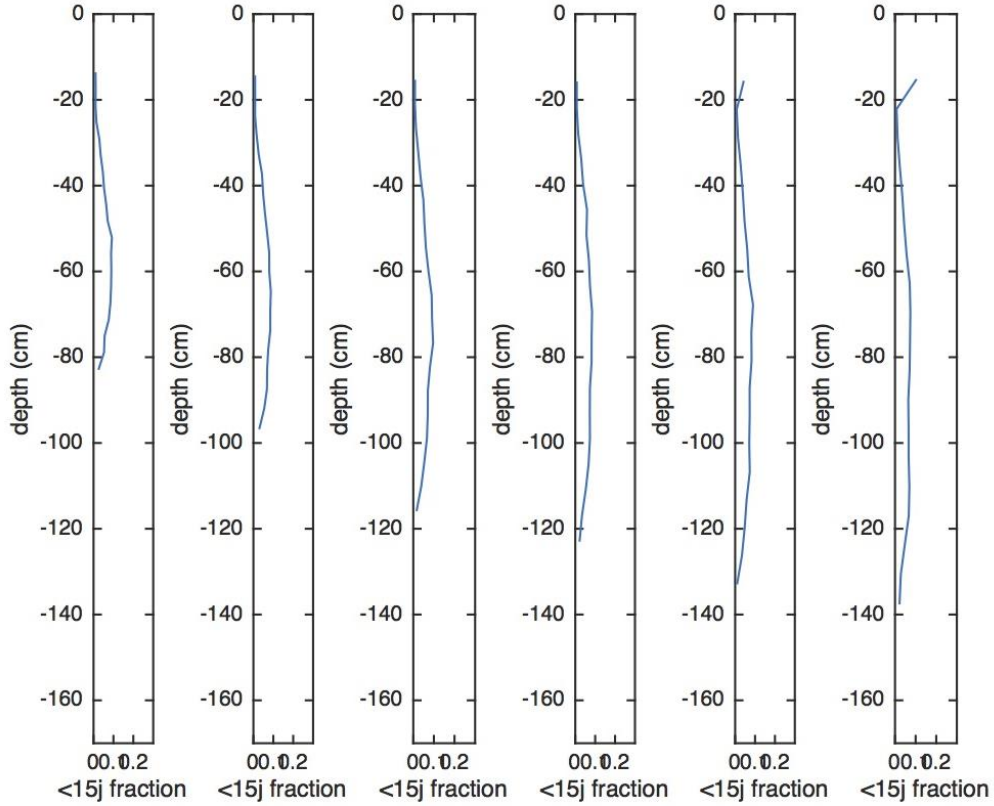
Résultats obtenus

Zone exempte de nématodes

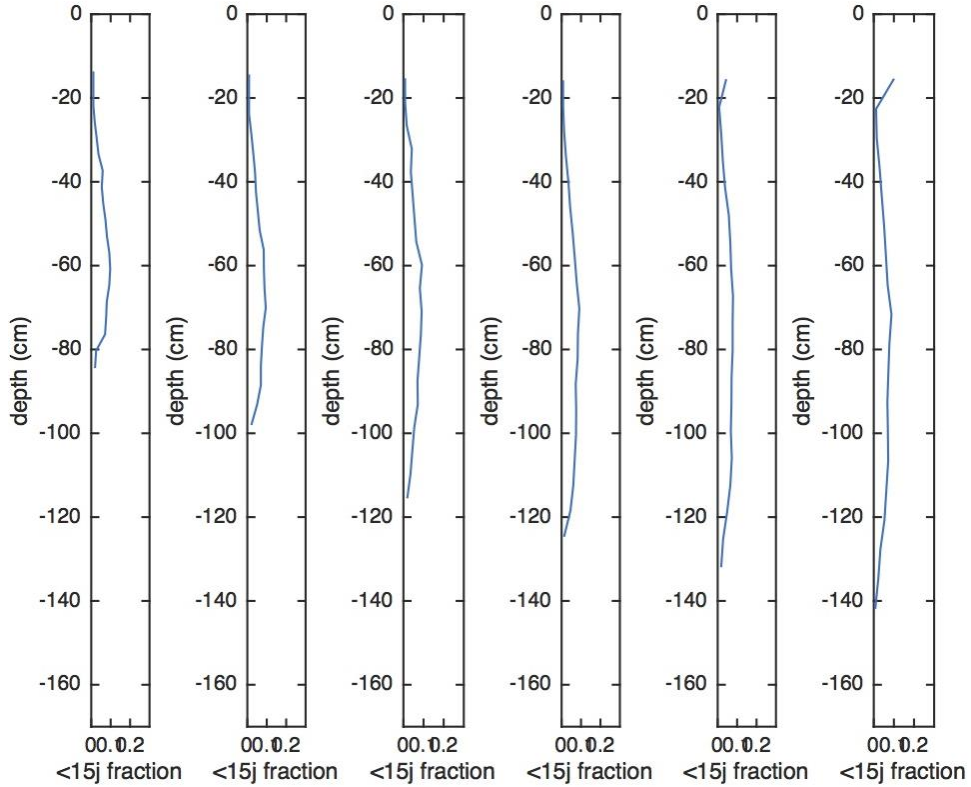


Proportion croissante

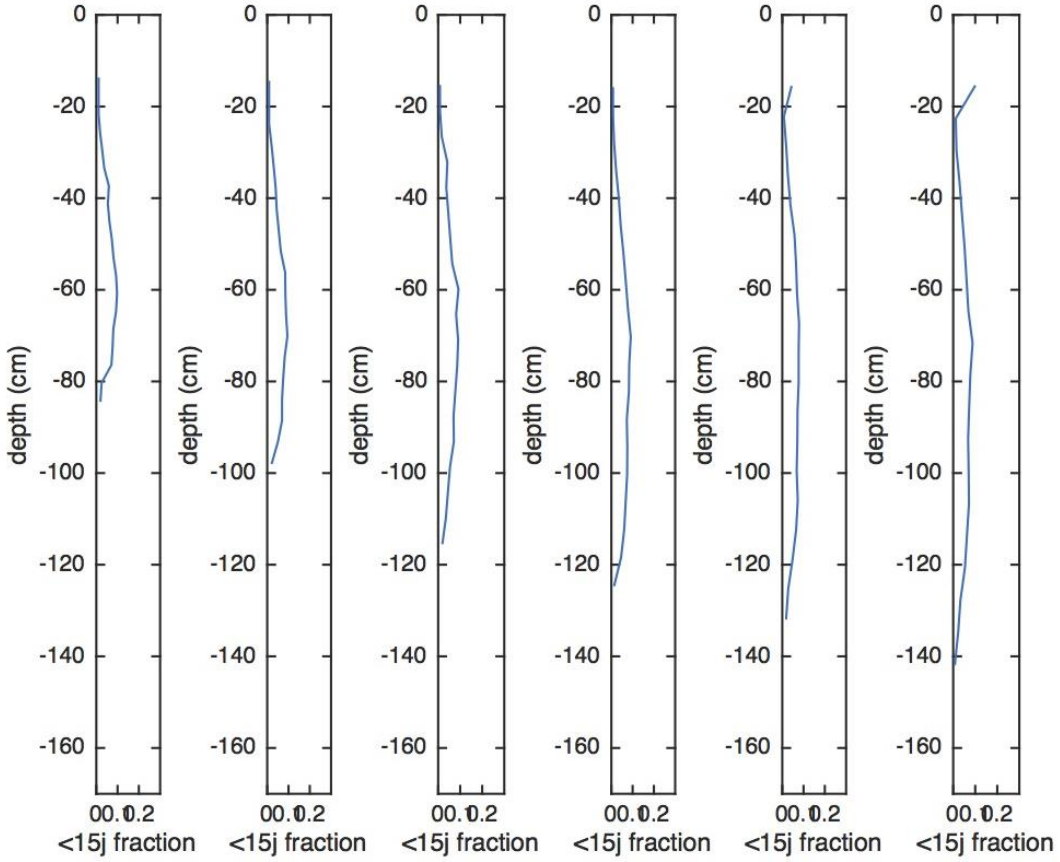
SIMTIME - 10



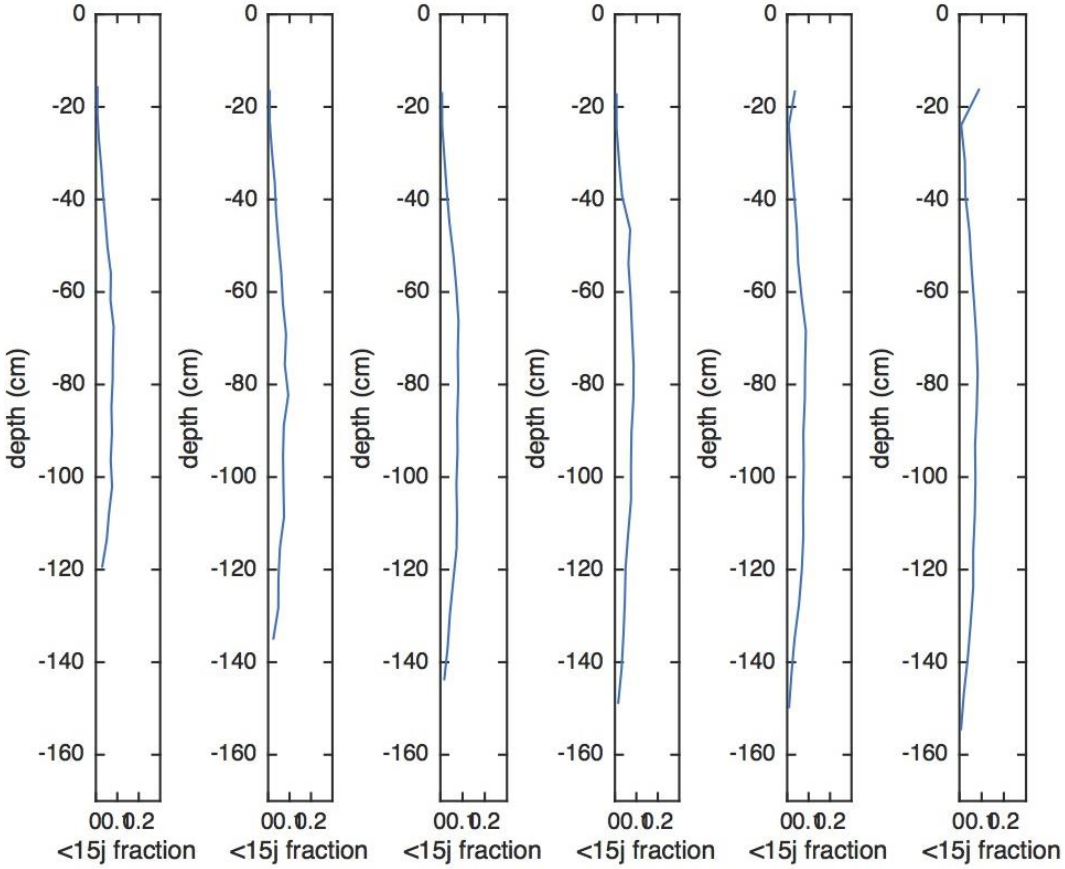
SIMTIME -15

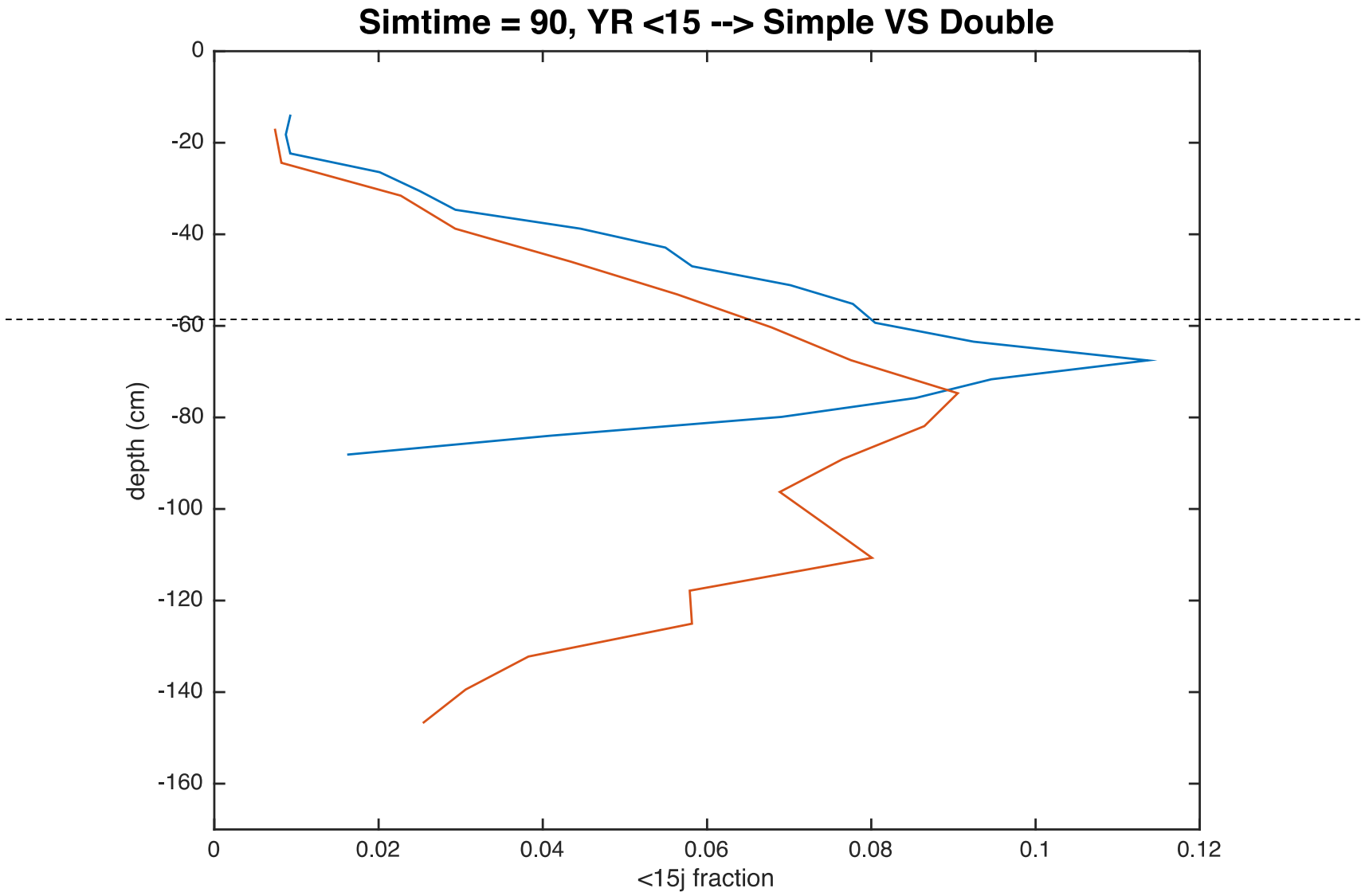


Taux d'élongation **normal** pour Simtime - 15



Taux d'élongation **double** pour simtime - 15




Simtime = 90, YR <15 --> Simple VS Double
0
-20
-40
-60
-80
-100
-120
-140
-160
depth (cm)
0
0.02
0.04
0.06
0.08
0.1
0.12
<15j fraction

Critiques du projet

- Paramétrisation
- Évolution du taux d’élongation
- Interaction betterave-nématode

Critiques du modèle

Caractéristique	Rootbox
Espèces	Au choix
Contexte	Multiples
Tige	NON
Transfert carbohydrates	NON
Croissance secondaire	NON

Critiques du modèle

Facteurs influençant l'architecture racinaire:

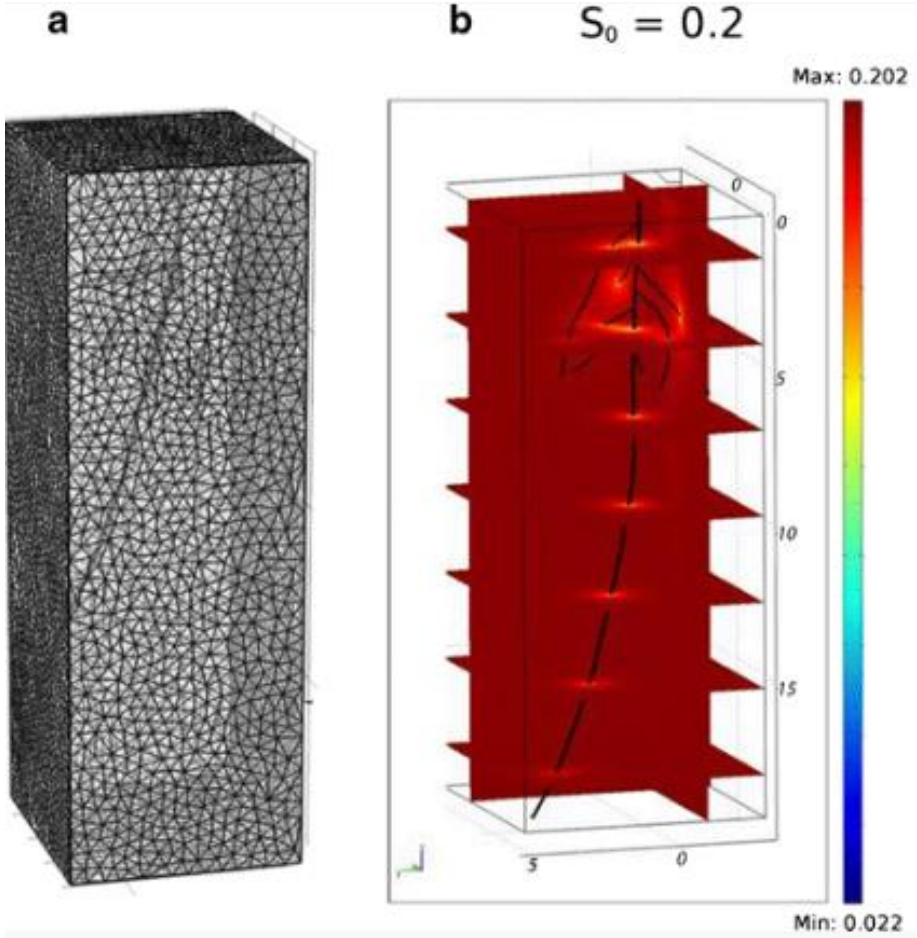
- eau
- nutriments
- ~~température sol~~
- ~~impédance sol~~
- ~~système aérien~~

Critiques du modèle

Caractéristique	Rootbox
GUI	OUI
Flexibilité interne	OUI
Disponible publiquement	OUI
Flexibilité externe	OUI

Critiques du modèle

- Rootbox -> …



Perspectives

- CRootBox