THE 1ST INTERNATIONAL SUMMER SCHOOL ON ADVANCED SOIL PHYSICS

MODELING WATER FLUXES IN THE SOIL-PLANT SYSTEM

MODELLING ROOT µHYDRAULICS - MECHA

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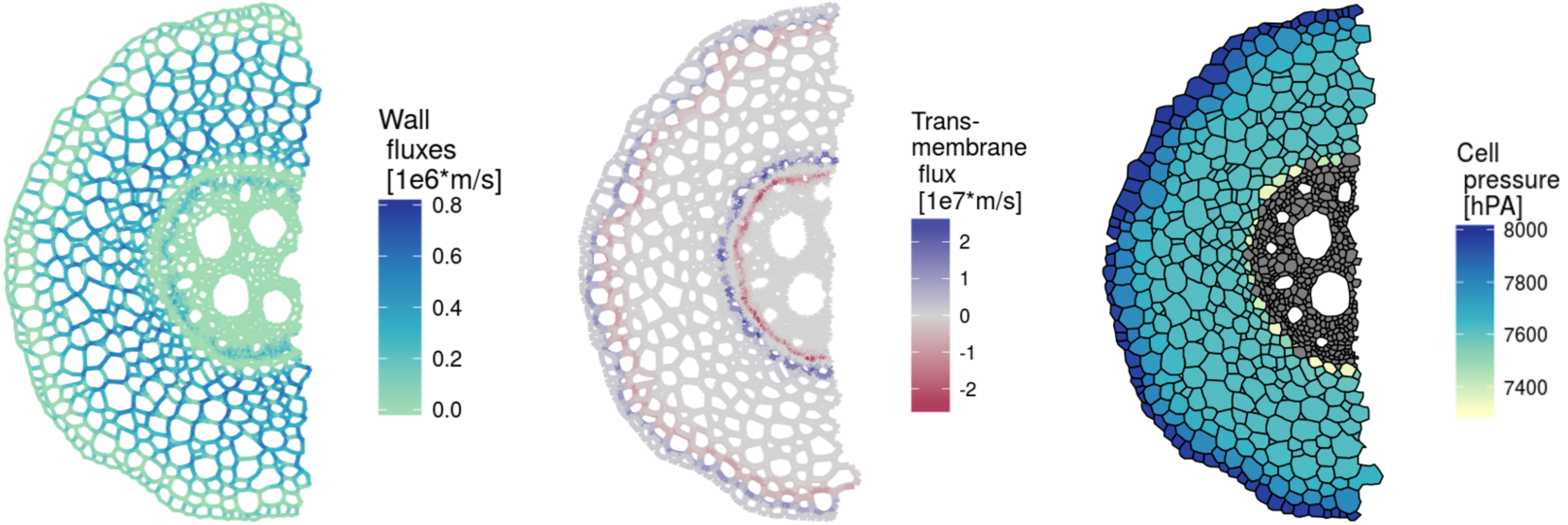
UCLouvain

ISMC International Soil Modeling Consortium

ENVITAM

MODELLING WATER FLOW AT THE ORGAN SCALE
- MECHA -



Open Source

mecharoot.github.io

RADIAL CONDUCTIVITY

AXIAL CONDUCTIVITY

Couvreur V, Faget M, Lobet G, Javaux M, Chaumont F, Draye X, Going with the Flow: Multiscale Insights into the Composite Nature of Water Transport in Roots, *Plant Physiology*, Volume 178, Issue 4, December 2018, Pages 1689–1703, https://doi.org/10.1104/pp.18.01006

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA - https://plantmodelling.shinyapps.io/mecha/

Valentin Couvreur, Marc Faget, Guillaume Lobet, Mathieu Javaux, François Chaumont and Xavier Draye

Université catholique de Louvain, Forschungszentrum Juelich GmbH

Choose plant | Change parameters | About

Choose a simulation to visualize

1. Select a plant type

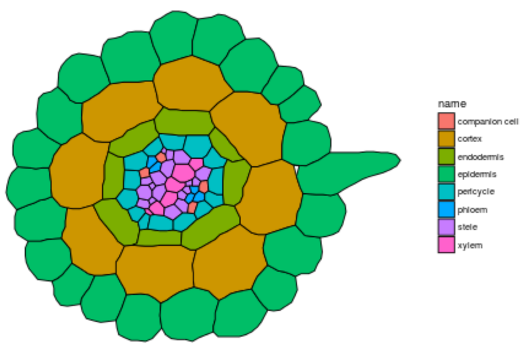
Arabidopsis1

MECHA was run for different cross section geometries and plant type. Te results were pre-processed to be easily visualised here.

UCL Université catholique de Louvain — JÜLICH FORSCHUNGSZENTRUM

Tissue layers

Visualisation of the different cell layers used in the simulation



Select the information to visualize

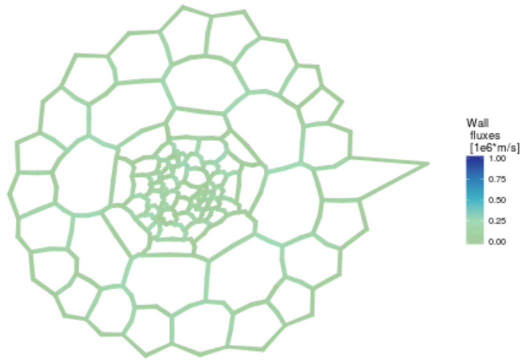
fluxes

Synthetic information about the simulation

param	value	unit
Cross-section height	0.01	cm
Cross-section perimeter	0.0304	cm
Cross-section radial conductivity	2.47e-04	cm/hPa/d
Xylem pressure potential	1100	hPa
Soil pressure potential	-100	hPa
Xylem osmotic potential	-1500	hPa
Soil osmotic potential	-200	to
Soil contact	0e+00	microns
Wall conductivity	0.0066	cm^2/hPa/d
Plasmodesmata conductivity	3.1e-11	cm^3/hPa/d
Aquaporin conductivity	4.3e-04	cm/hPa/d

Cell walls fluxes

Flows with the cell walls of the cross section.



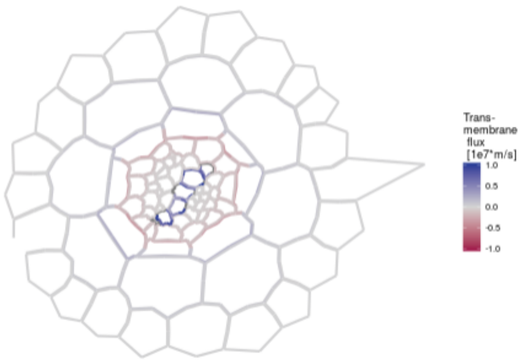
Display range:

0 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Transmembrane fluxes

Flows with the cell membranes of the cross section. Blue color indicates when the water is entering the cell. Red color indicates when the water is leaving the cell.



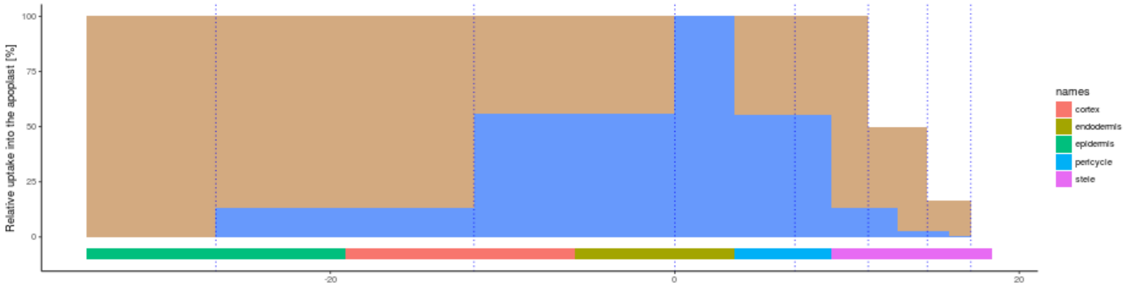
Display range:

0 — 1 — 3

0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3

Relative contribution of water pathways

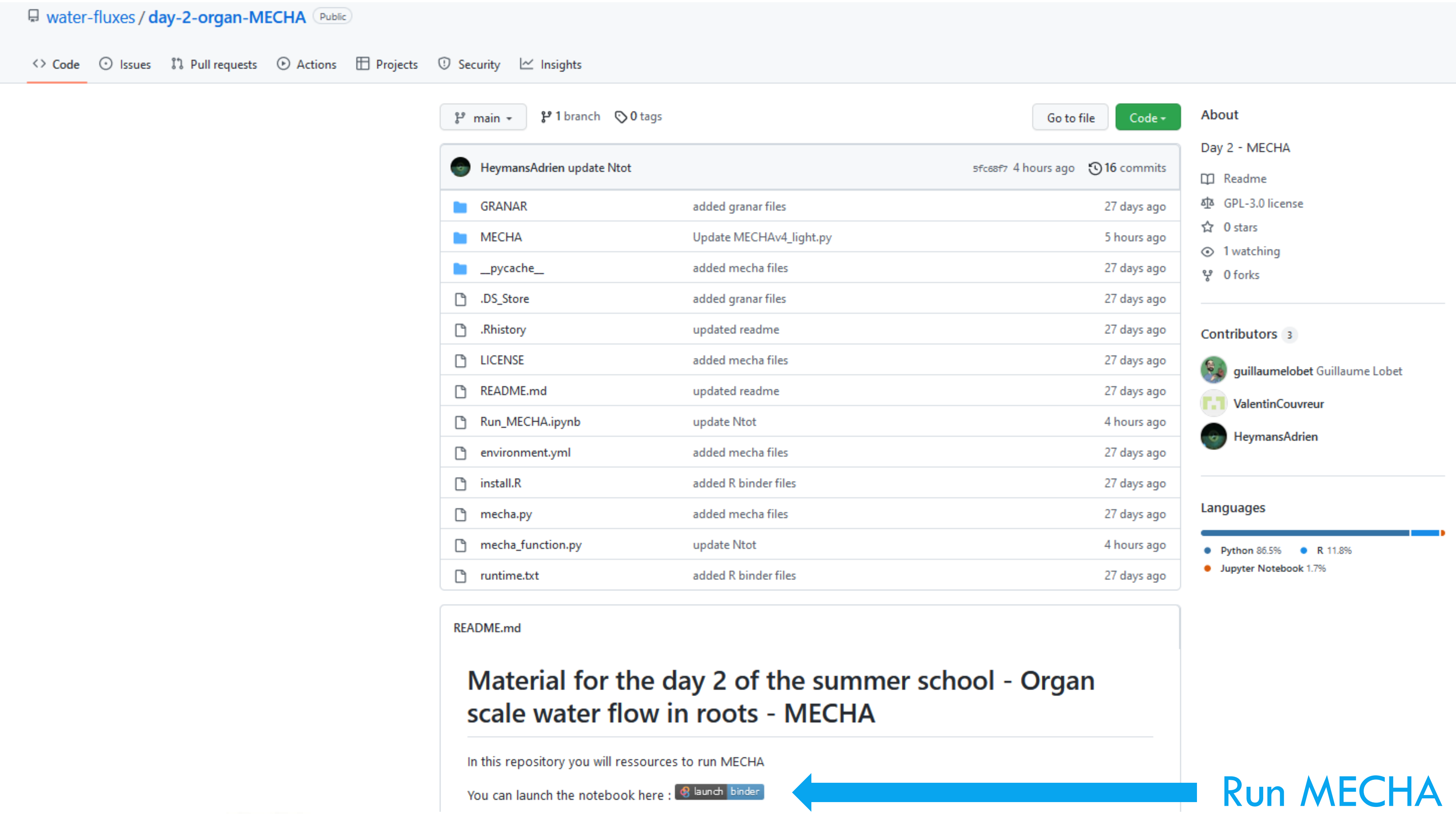
Visualisation of the relative contribution of the apolastic and symplastic pathways to the global water flow acrsoos the root crossection



MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

https://github.com/water-fluxes/day-2-organ-MECHA

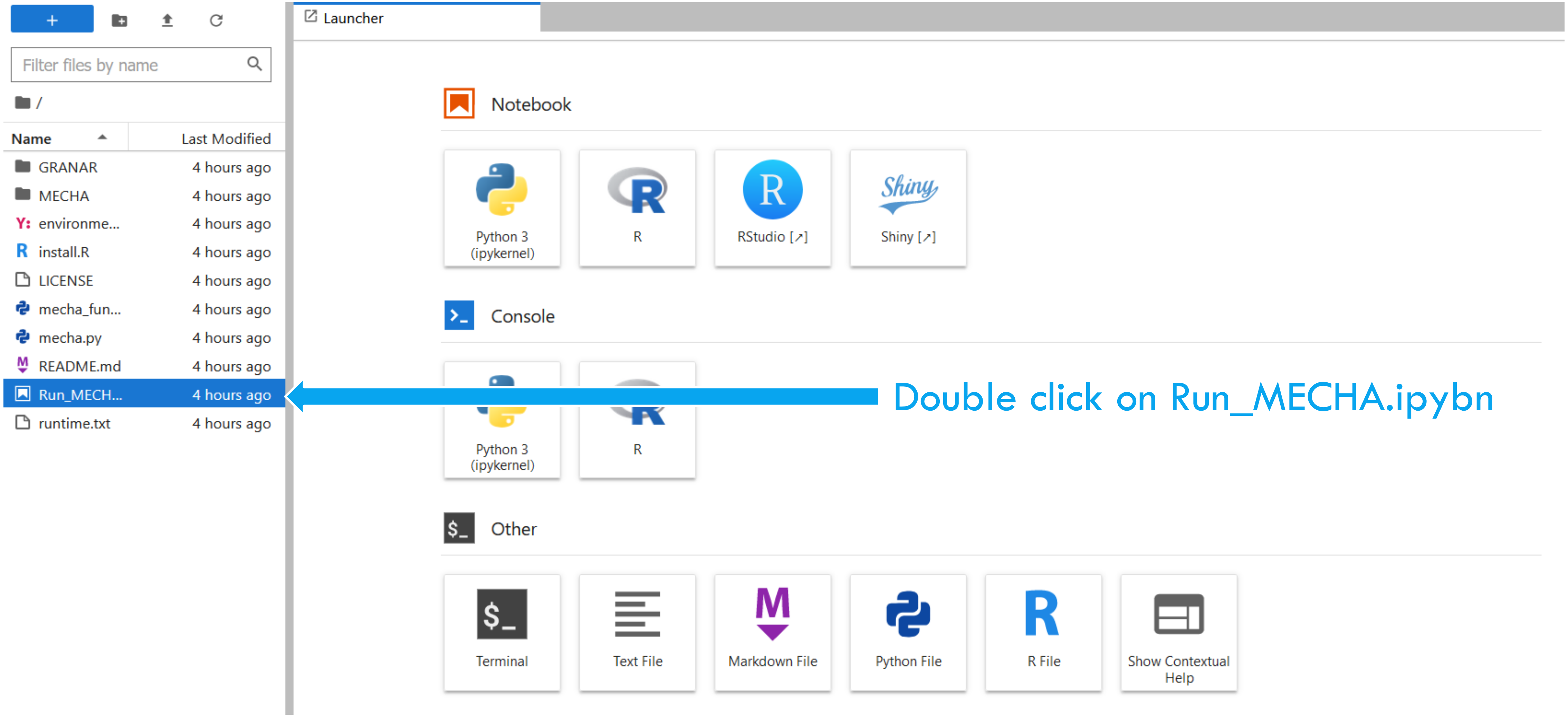


Run MECHA via Binder

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let’s open the Jupyter Notebook!

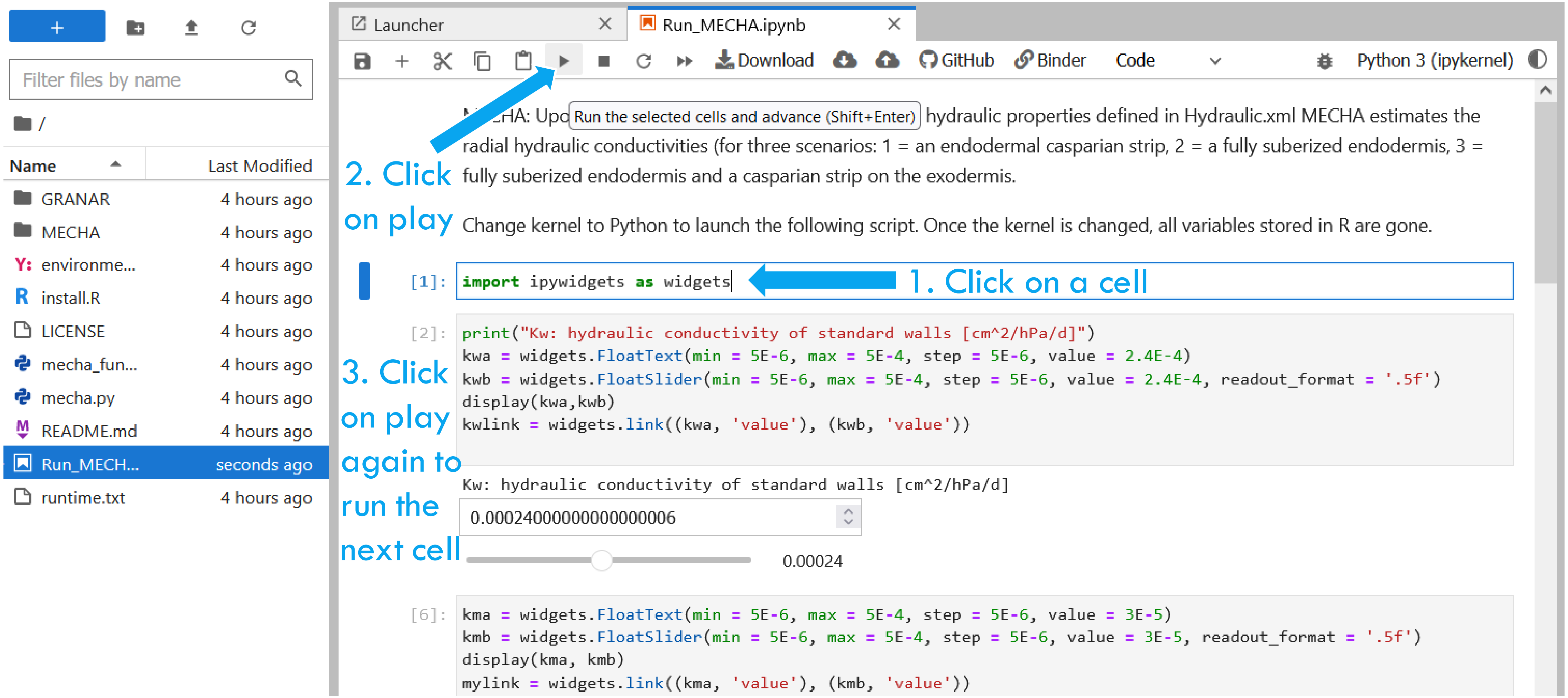


Double click on Run_MECHA.ipybn

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder/Jupyter Notebook… let's run MECHA!

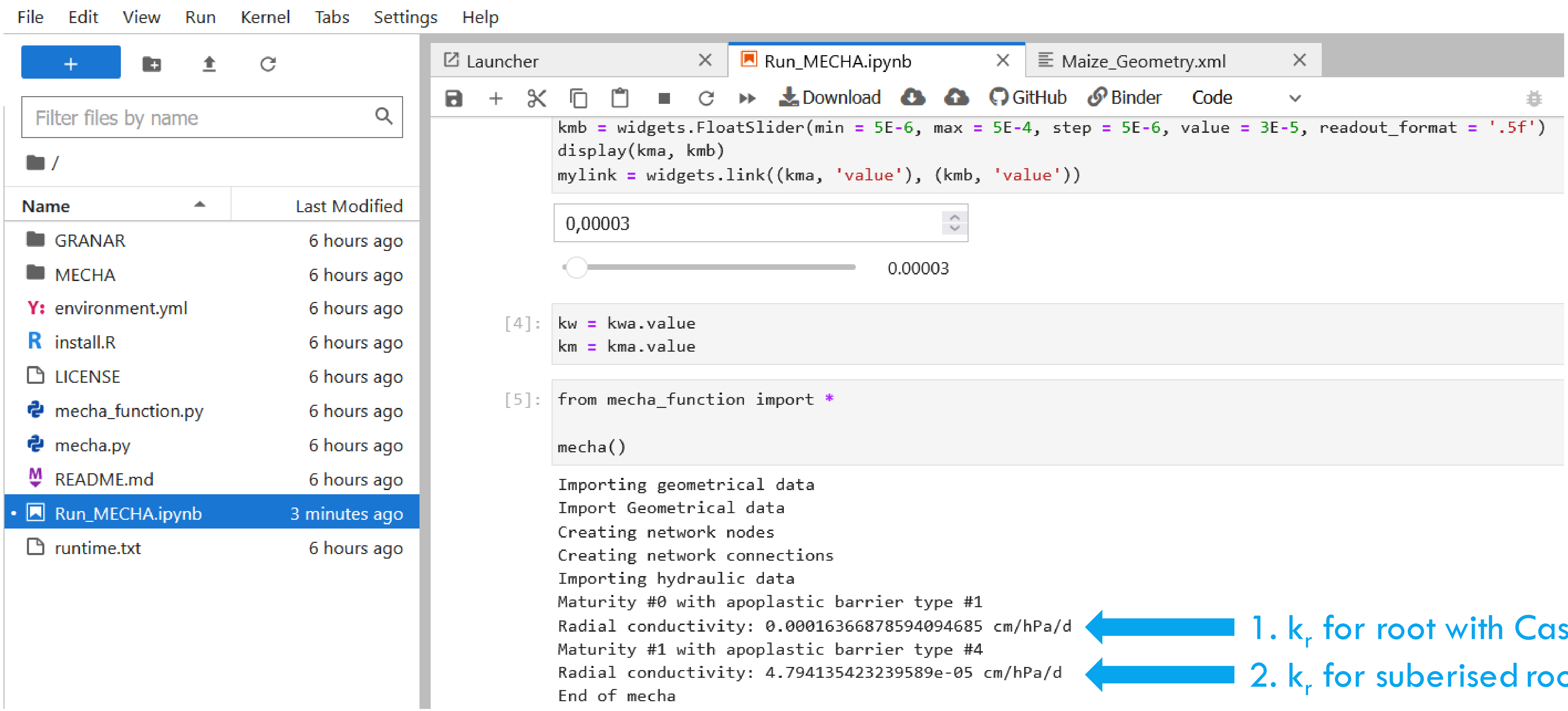


4. As a starter, run the script with default kwa and kma values. It'll take a few min.

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder/Jupyter Notebook… let's run MECHA!



1. k_r for root with Casp

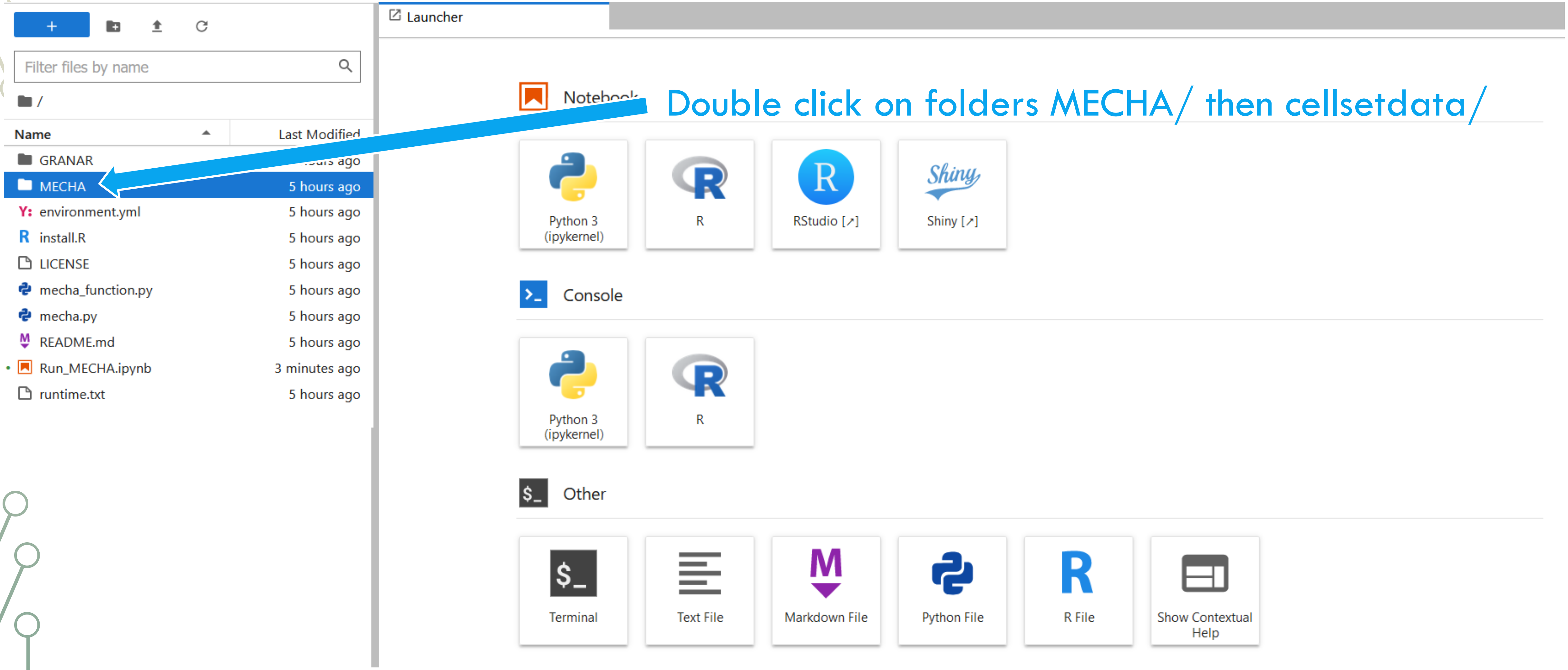
2. k_r for suberised root

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let's update the root anatomy!

Double click on folders MECHA/ then cellsetdata/

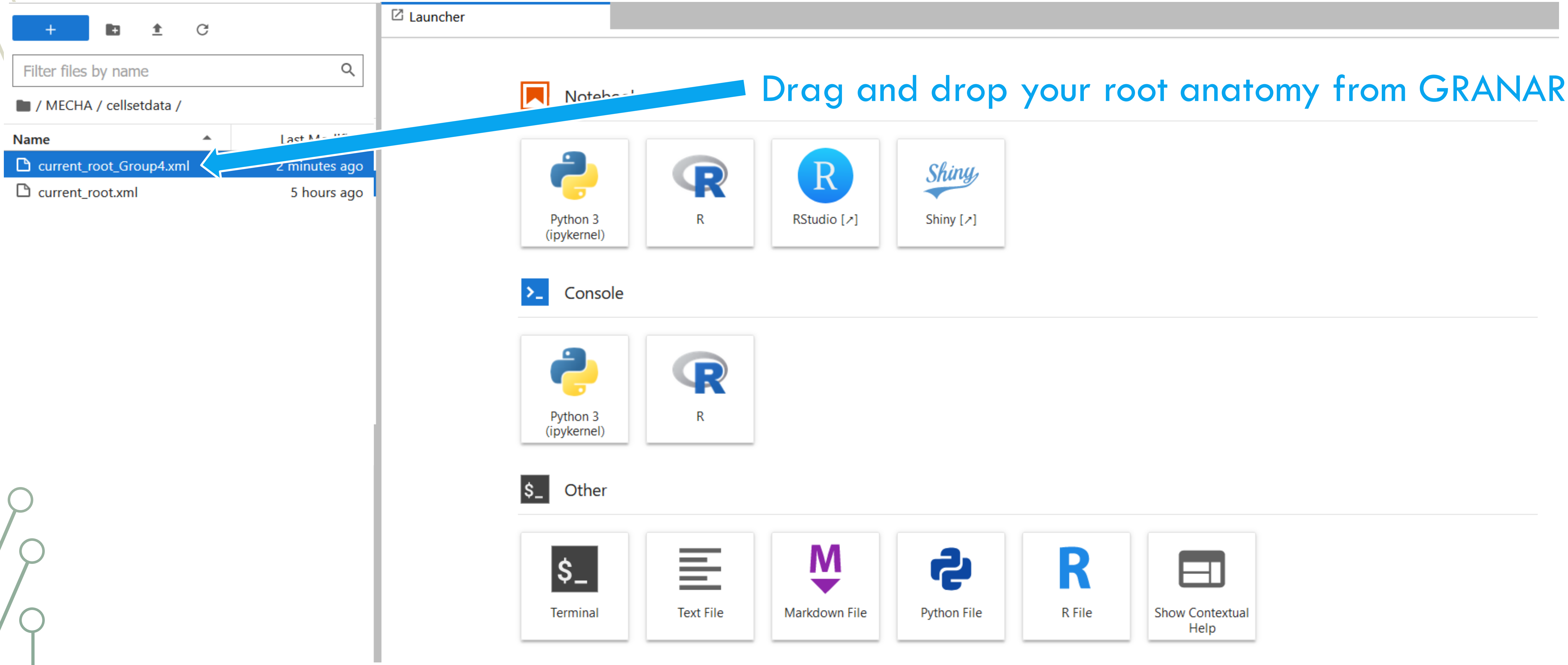


MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let's update the root anatomy!

Drag and drop your root anatomy from GRANAR

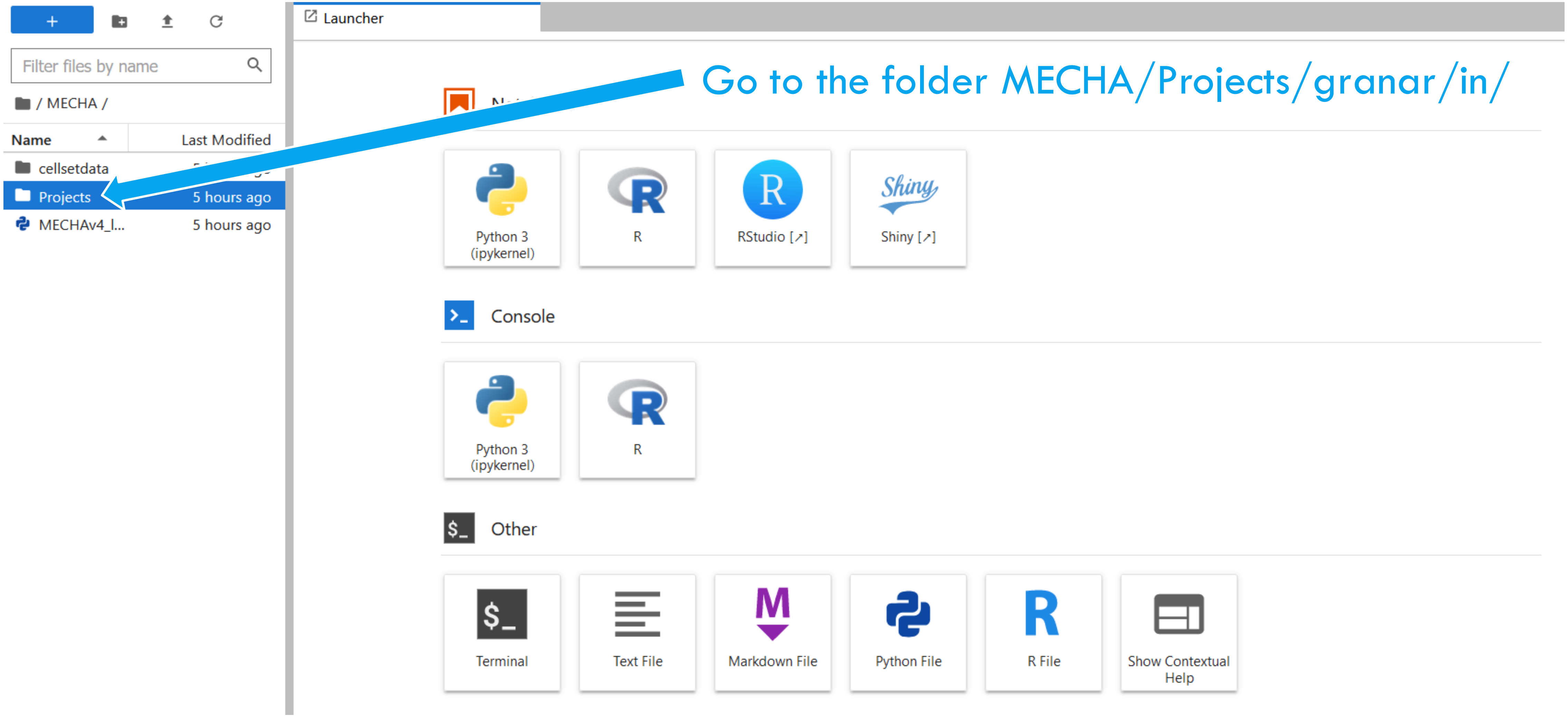


MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let's update the root anatomy!

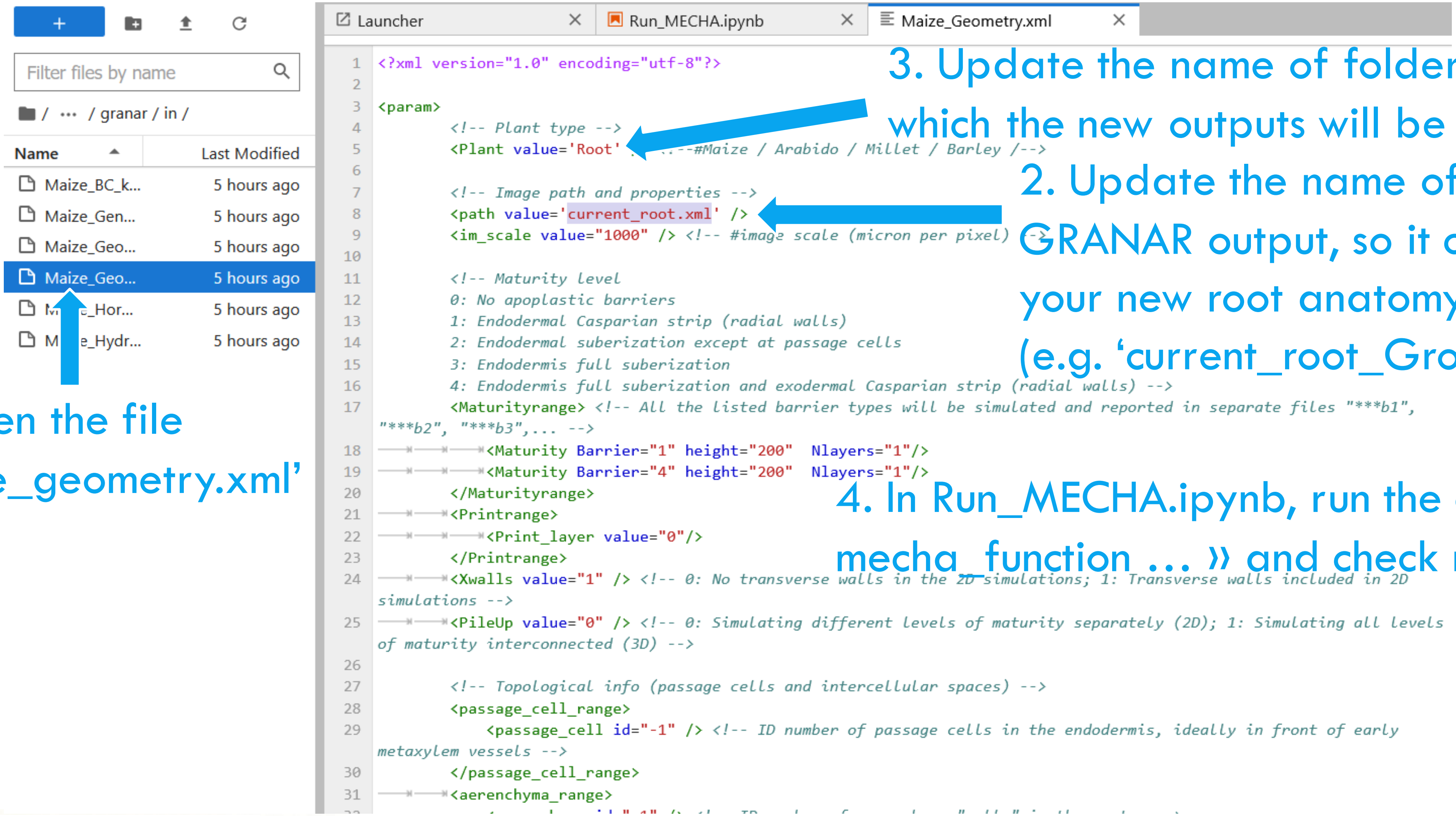
Go to the folder MECHA/Projects/granar/in/



MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let's update the root anatomy!



1. Open the file 'Maize_geometry.xml'

2. Update the name of the dragged GRANAR output, so it corresponds to your new root anatomy file name (e.g. 'current_root_Group4.xml')

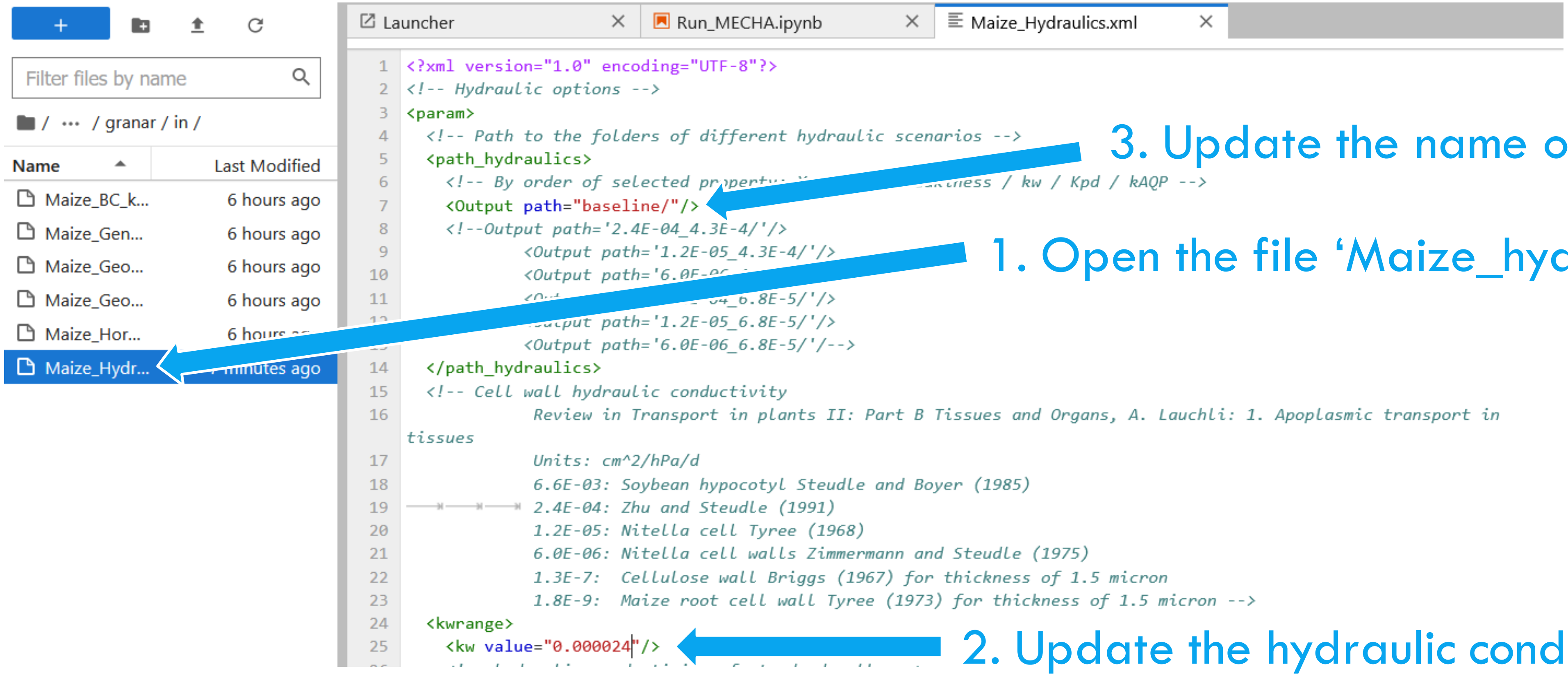
3. Update the name of folder in which the new outputs will be stored

4. In Run_MECHA.ipynb, run the cell « from mecha_function … » and check new kr values

MODELLING WATER FLOW AT THE ORGAN SCALE

- MECHA -

Once on Binder… let's update the cell hydraulic properties!



3. Update the name of the scenario

1. Open the file 'Maize_hydraulics.xml'

2. Update the hydraulic conductivity of cell walls (kw) or membranes aquaporins (kAQP), lower in the file

4. In Run_MECHA.ipynb, run the cell « from mecha_function … » and check new kr values

EXERCISE

https://github.com/water-fluxes/day-2-organ-MECHA

- Please send your GRANAR inputs / outputs and MECHA kr values for default cell hydraulic properties to guillaume.lobet@uclouvain.be so we could discuss and compare anatomies and conductivities ☺