PhD Diary

Nathan Hughes

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1 Just need to remember that this exists:

http://hplgit.github.io/fdm-book/doc/pub/diffu/html/._diffu-solarized001.html

2 TODO Tasks [5/7]

2.1 DONE Fix cell border reflection

- This is one of the reasons that analytical solution would be ideal ... although saying that, it has the same **problem** of no reflection.
- There are a fixed number of 2D/1D states which need to be considered. Considering Y and X interchangeable we would do something like:
  1. Y = i+1, i-1, X = i+1, i-1
  2. Y = i+1, X = i+1, i-1
  3. Y = i-1, X = i+1, i-1
  4. X = i+1, i-1

2.1.1 DONE Solution:

Solved - the reflection happens asymmetrically if the IC isn't centred

Will need this regardless, as when it comes to cells becoming "switched off" we will need to consider intermediate solutions

Use an intermediate 1.5D function:

- 2 points (1D diffusion)
- 3 points (1.5D diffusion)
- 4 points (2D diffusion)

2.1.1.1 Quick clarifications

1. 1D

$$c_i^{t+1} = c_i^t + D\frac{c_{i-1}^t - 2c_i^t + c_{i+1}^t}{\Delta x^2} + b \tag{1}$$

2. 2D

$$c_{i,j}^{t+1} = c_{i,j}^t + D(\frac{c_{i-1,j}^t - 2c_{i,j}^t + c_{i+1,j}^t}{\Delta x^2} + \frac{c_{i,j-1}^t - 2c_{i,j}^t + c_{i,j+1}^t}{\Delta y^2}) + b \tag{2}$$

   Which if $\Delta x^2 \equiv \Delta y^2$ then

$$c_{i,j}^{t+1} = c_{i,j}^t + D\frac{(c_{i-1,j}^t - 2c_{i,j}^t + c_{i+1,j}^t) + (c_{i,j-1}^t - 2c_{i,j}^t + c_{i,j+1}^t)}{\Delta x^2} + b \tag{3}$$

   and simplifies to

$$c_{i,j}^{t+1} = c_{i,j}^t + D\frac{c_{i-1,j}^t - 4c_{i,j}^t + c_{i+1,j}^t + c_{i,j-1}^t + c_{i,j+1}^t}{\Delta x^2} + b \tag{4}$$

3. **IDEA** 1.5D

   if we reduce the area of diffusion by 1/4 then it stands to reason that the loss to ${C^t}_i, j$ is also reduced appropriately, giving:

$$c_{i,j}^{t+1} = c_{i,j}^t + D\frac{(c_{i-1,j}^t - 3c_{i,j}^t + c_{i+1,j}^t + c_{i,j-1}^t - c_{i,j+1}^t)}{\Delta x^2} + b \tag{5}$$

2.2 DONE Finally compare diffeq with numerical solution

2.3 With D of SA

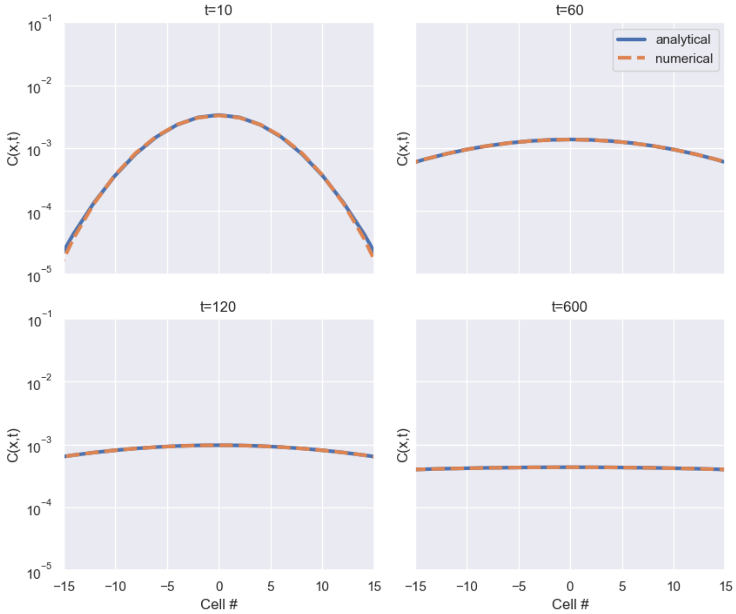

Figure 1: Comarping analytical solution with numerical

2.4 With D_{eff}

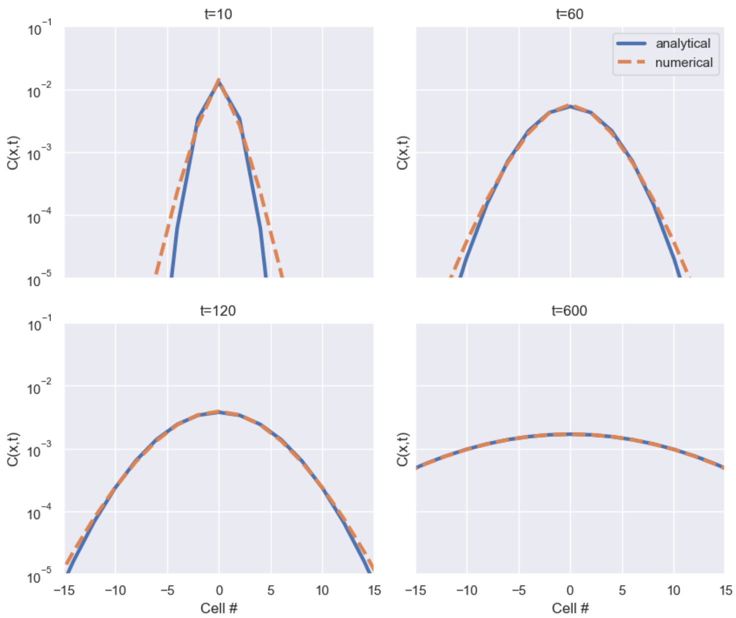

Figure 2: Comarping analytical solution with numerical

2.5 DONE Meet with Jeroen

2.6 DONE Fix D to actually use $D_{eff}$$

- Details can be found in [1]

- Additional details found on pg 23 of [1]

2.6.1 NOTE: As q is described as a flux, then increasing it increases D_{eff}

2.6.2 Equation

2.6.2.1 In number of cells

$$D_{eff} \equiv \lambda^2 \delta = \frac{\delta}{(\log(\Delta\_))^2} \tag{6}$$

2.6.2.2 In μm

$$D'_{eff} \equiv (\lambda')^2 \delta = \frac{\delta l^2}{(\log(\Delta\_))^2} \tag{7}$$

2.6.2.3 Adding in $\lim_{\delta \to 0}$ in number of cells

$$D_{S,eff} = \frac{Dq}{l(D + ql)} \tag{8}$$

2.6.2.4 Adding in $\lim_{\delta \to 0}$ in μm

$$D'_{S,eff} = \frac{Dql}{D + ql} \tag{9}$$

Table 1: Parameters of D_{eff}

Parameter	Default	Comment
δ	$0.001; 1 \times 10^{-5} s^{-1}$	Degradation constant
l	$10; 100\mu m$	Cell length
q	$1; 10\mu m/s$	Effective wall permeability for symplastic transport
λ	Integer	Number of cells
D	$300\mu m^2/s$	Diffusion speed of auxin (needs verification with stokes equation)
$\Delta\_$	?	Not really required for 2nd set of equations

2.6.2.5 Parameters

2.7 **TODO** Use newly updated model to find effective flux of data presented by Kitagawa and Fujita [2]

2.8 **TODO** In Deinum [1] how did they evaluate model parameters

- Pg. 23 starting point?

2.9 **DONE** Go to employer forum (Thursday 12:30)

References

[1] E E Deinum. *Simple Models for Complex Questions on Plant Development.* PhD thesis, s.n., S.l., 2013. 00011.

[2] Munenori Kitagawa and Tomomichi Fujita. Quantitative imaging of directional transport through plasmodesmata in moss protonemata via single-cell photoconversion of Dendra2. *Journal of Plant Research*, 126(4): 577–585, July 2013. ISSN 1618-0860. doi: 10.1007/s10265-013-0547-5. 00014.