Updates: Parameter Estimation

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Work done

- I spent some time last week computationally approximating bounds under which the nonlinear solver for hyperelasticity would converge (later, with more time, I can try to do this numerically) which led me to try parameter estimation with the following:

$$k \in [0, 10]$$
$$D \in [0, 5]$$
$$\gamma_D \in [.01, 5]$$
$$\gamma_k \in [.01, 5]$$
$$\beta \in [0.1, 5]$$

- The bounds were not necessary for linear elasticity or reaction diffusion, but I kept them the same for the LE inverse problem for uniformity

Work done

- I then worked on estimating parameters with these bounds in place. I was experimenting with different cost functions, and I only have results for minimizing difference in cellularity for now:

$$\min_{D,k,\gamma_D,\gamma_k,\beta} ||p_{true} - p||^2$$

- I currently have optimized for rat 5 at day 2, then run the forward problem until the last day of data, day 9.

Results: Optimization for day 2

LE

- Time = 14.5 minutes
- J-opt = 0.9
- $\gamma_D = .56$
- $\gamma_k = 4.67$
- $\beta = .96$

HE

- Time = 28 minutes
- J-opt = 0.108
- $\gamma_D = .05$
- $\gamma_k = 2.35$
- $\beta = 4.0$

Results: Optimization for day 2

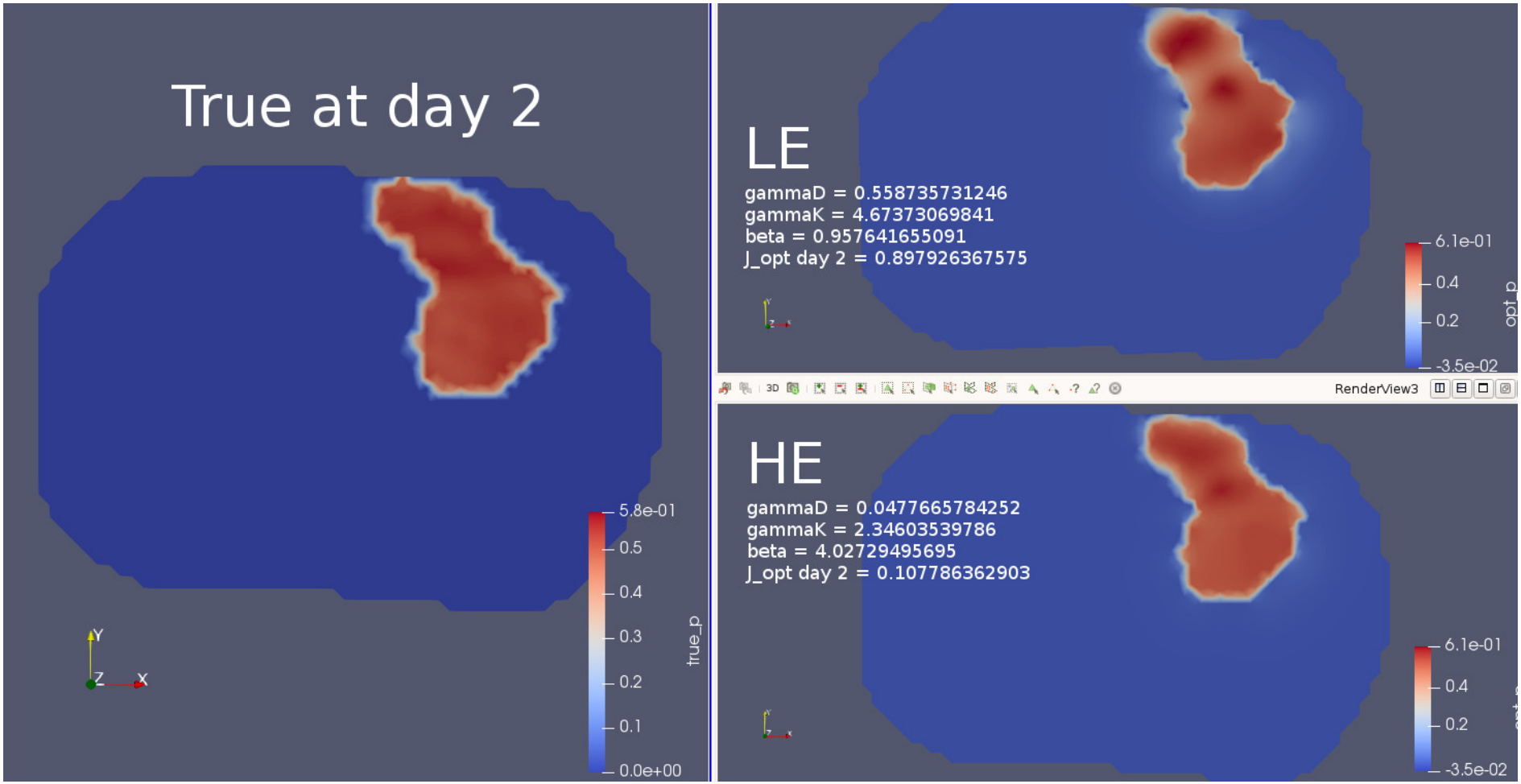

Figure : Running the forward models to day 2 using parameter estimation results from forward model with day 2. Results for HE are better.

Results: Forward to day 6

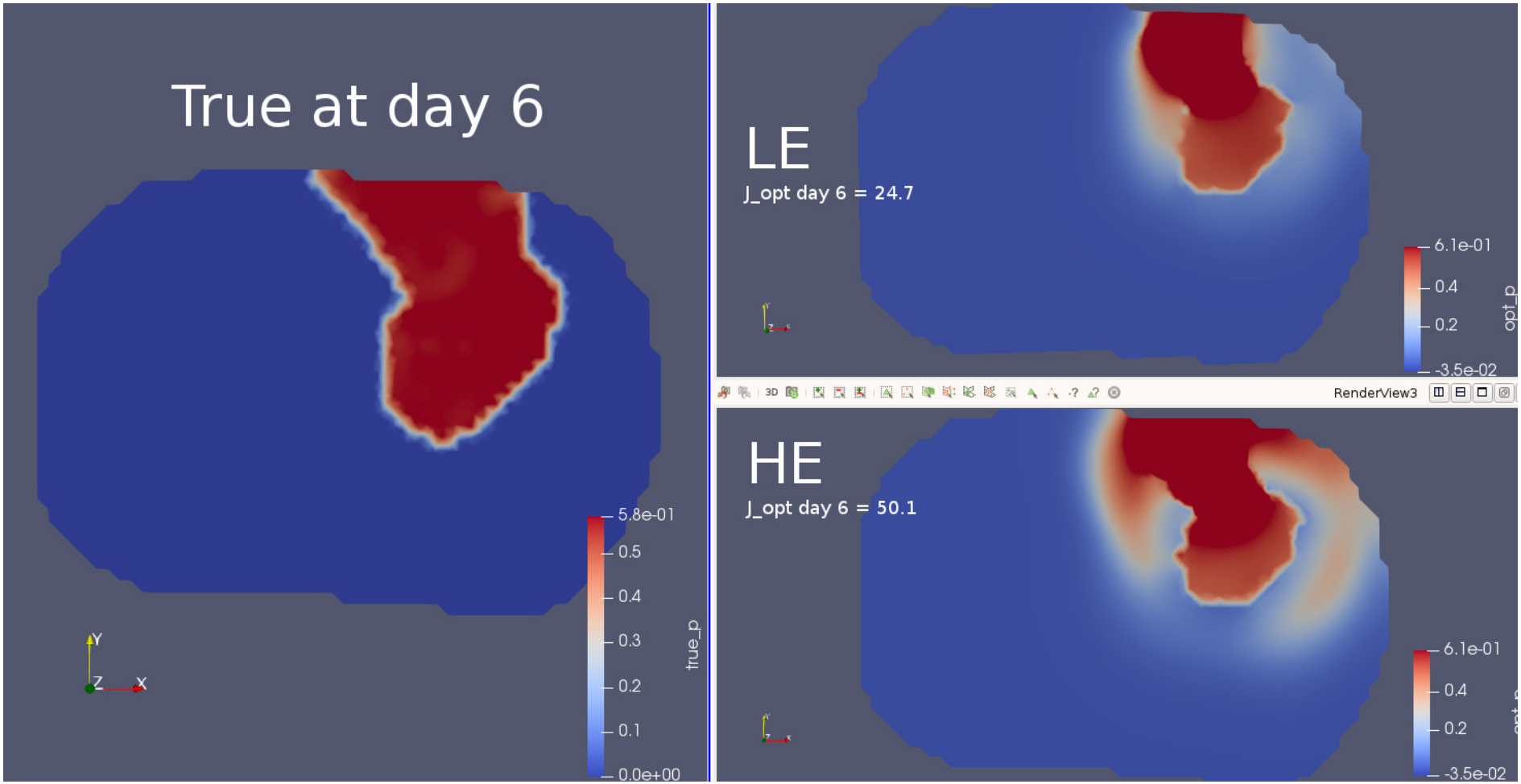

Figure : Running the forward models to day 6 using parameter estimation results from forward model with day 2. LE performs better now and HE begins to show significant diffusion.

Results: Forward to day 9

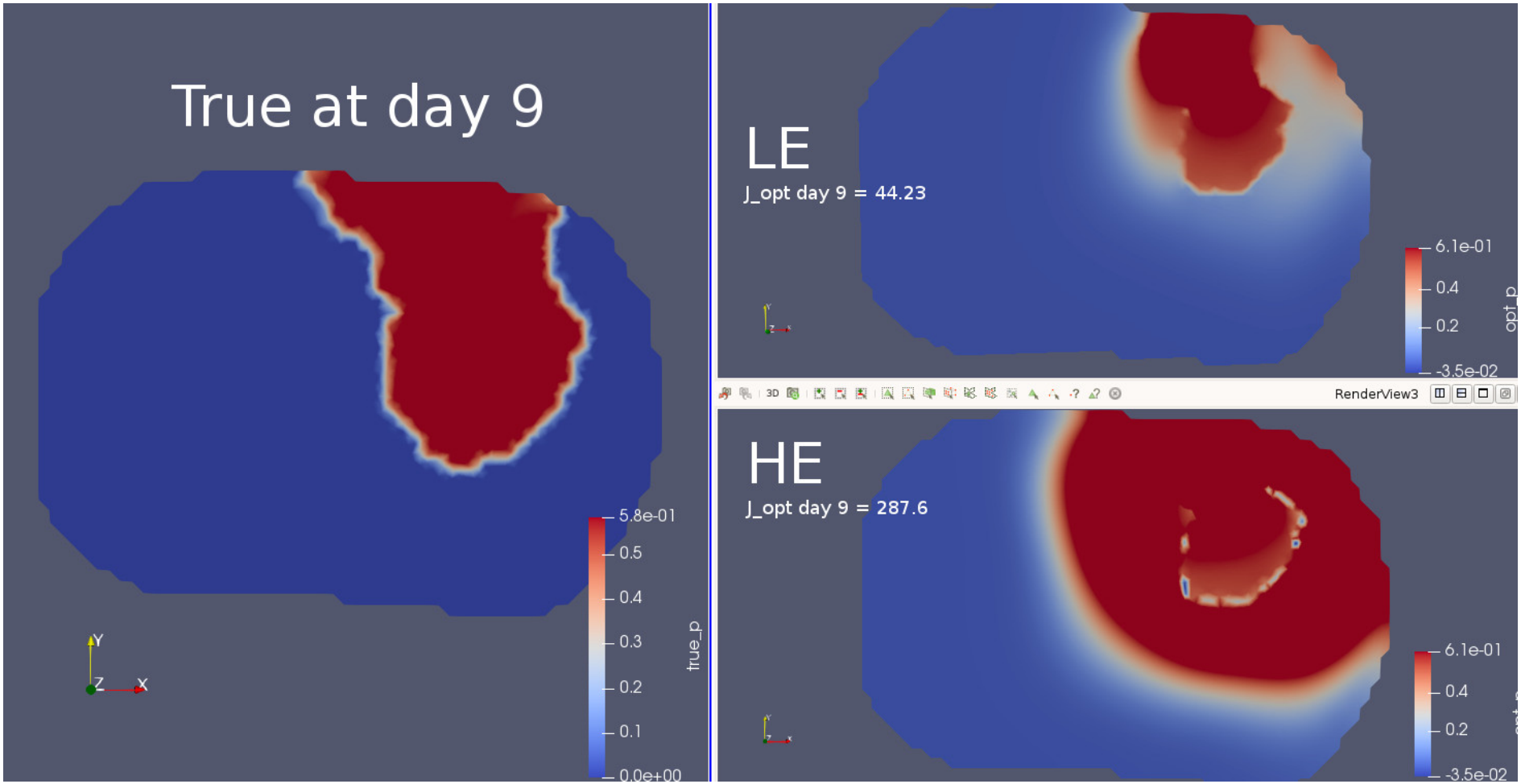

Figure : Running the forward models to day 9 using parameter estimation results from forward model with day 2. LE is still not too different in general shape, while HE shows extreme growth.

Conclusions/thoughts going forward

- LE has larger values for γ_D and γ_k, which would mean higher effect from stress causing a reduction in diffusion/growth. Need to save $D-$ and $k-$fields to observe whether there's a large difference causing the significant diffusion for HE, or if large von Mises stresses are responsible and the γs
- I believe David used $\beta = 1$ so I will try this or varying values but set the same for both. The large difference is interesting - more "body forces" in HE will cause larger stresses, which should have a reduction in D/k.
- I am looking to add regularization to k next,

$$r_1||k||^2 + r_2||\nabla k||^2$$

- Optimizing using day 4, 5, or 6 could prove helpful, but in reality optimizing as early as possible is best so using day 2 makes sense for applications. Maybe days 2 and 4 could be used though?