**The Challenge**

1. Change the boundary condition heads to make this an unconfined model. You can pick whatever heads you would like but I recommend keeping both of them above zero (*Hint:these are the variables H\_left and H\_right in the starter code*). Run two simulations with the same head gradient across the model (i.e. H\_left minus H\_right being the same between your confined and unconfined cases) but where one is confined and the other is unconfined.
   * Plot the equipotentials and flow lines for both simulations

Chart

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* + Plot the head difference between the two simulations

Chart, bar chart, histogram

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* + Describe how the two head profiles differ and explain why this is the case.
    - The unconfined aquifer model has high head in the middle and lower head on the sides.
    - The confined aquifer model had nearly the same head everywhere and therefore was not included here?
      1. This is actually very confusing to me because I don’t understand how the head difference can be 0 everywhere for the confined aquifer with imposed BC of 26 and 22.
  + Would your answer be different if you changed the overall head gradient (H\_left-H\_right), still keeping it the same between confined and unconfined cases though?
    - I think my answer would remain unchanged because the gradients are still the same (apart from if we made a BC = 0)

1. For the two runs above (1) plot the flux across the left and right boundaries and (2) calculate the total flux.

Table

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* + Compare these calculations and plots and provide an explanation for why you see the behavior you do.
    - There is a higher flux and flow for our confined system.
    - The flux in equals our flux out. This is because our system is still in steady state.
  + The overall gradient is the same, as is the K of the medium. Is the flow the same for both boundary conditions? Why or why not?
    - The flow is not the same for the two boundary conditions. It is higher in the confined system compared to the unconfined system.
    - The confined system is under more pressure (because it is confined), therefore it would have more flow.

1. Now add recharge at a constant rate of 1e-4 m/day over the entire land surface to an unconfined case with the left boundary set 7m and the right boundary set to a 2m.

Chart

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* Explain the head transect and boundary flows.
  + There is flow originating at grid 11 and propagating outward.
  + Head starts at 7 (the imposed BC) and increases because there is recharge occuring and decreased to 2 (the other imposed BC)
* Is flow in this system 2D or 3D? Is it represented as 2D or 3D? Explain what you mean by your answers.
  + Flow is still 2D because there is no flow in the z direction.

1. Update your model from #3 to model a system with zero recharge except for a farm located in [6:10, 6:10]. Recharge beneath the farm is 1e-4 m/day due to excess irrigation.

Chart

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* + Calculate the annual excess irrigation, in meters, that has been applied to the farm.
    - 1E-4 m/d \* 365d = 0.0365 m/yr
  + Assuming that the crop is cotton, it is located in southern Arizona, and cotton is grown all year (for simplicity), calculate the total irrigation rate on the farm that would be associated with this amount of excess irrigation.
    - If we have 80% efficiency, this means that cotton does not use 20% of the irrigation.
    - Excess that cotton doesn’t use/ total irrigation = excess percentage
    - 0.0365 m/yr / total irrigation = 20%
    - 0.0365/20% = 0.1825 m
  + Finally, use the flux diagram to identify the area within the domain that might be subject to contamination if the recharge water was somehow tainted (you can do this by saving the plot to powerpoint and annotating it there).

Chart

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1. Lastly, start the well located at [10,15] pumping at a rate of 8 m3/day. Using one color, identify the capture zone of the well. Using a second color, show the area that might be contaminated by the irrigated farm fields (see not above you can do your annotations in powerpoint if that is easier. ).

Chart

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* + Comment on the impact of the well on the pattern of potential contamination.
    - The well is capturing the contaminated water. Flow directly past the well is reduced, this might lower the contamination right past the well.
  + How will the steady state capture zone of a model with recharge differ from that in the same model without recharge?
    - Without recharge the flow lines left of the capture zone would all move toward the well.

**Glossary questions:**

I am the glossary person for this week, so I did not answer here.