HWRS 505: Vadose Zone Hydrology

Lecture 12

9/28/2023

Today: 1D steady-state flow with excel spreadsheet model

Review of Lecture 11

1. Steady-state unsaturated flow in 1D:
   - The key idea of numerical solution: Divide the domain into many boxes or layers and convert the **differential equation** to a system of nonlinear **algebraic equations**.
   - Boundary conditions.
2. Solving nonlinear systems of equations: Newton-Raphson method
   - Fundamental idea
     - ✓ Linearize the nonlinear equation using truncated Taylor series
     - ✓ Use iterations to converge to the solution
3. Steady-state spreadsheet model
   - Using the tool to build intuition on unsaturated flow

1D Steady-state Flow: Excel Spreadsheet Model

HWRS 505
Bo Guo
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1. Vertical column p top

- Set p top = 50 cm, and change p base from 100 cm to -100 cm with an interval of 20 cm. Record the flux for each change and plot the flux as a function of the base pressure. Try to make sense of the flux-base pressure plot.

- Set p top = 200 cm, repeat the above but change p base from 200 cm to -100 cm. Compare the flux vs. base pressure plot with the plot made from above.

2. Vertical column q top

Set q top = 100 cm/day, and change p base to 40, 20, 0, -20 cm. Try to make sense of the plots for the heads and volumetric content for each base p value. How do they change with the base p value?

3. Horizontal column p right

Set p right = -50 cm, and change p left to -50, -25, 0, 25 cm. Try to make sense of the plots for the heads and volumetric content for each p left value. How do they change with the p left value?

4. Horizontal column q right

Set q right = 1E-6 cm/s, and change p left to 1, -1, -2, -10 cm. Try to make sense of the plots for the heads and volumetric content for each p left value. How do they change with the p left value?

Note: Copy the plots to a PowerPoint file so that you can save the results to do comparisons and analyses.

Q: For #3 and #4, can the domain be unsaturated if p at the boundaries are non-negative?