2D Transport Tutorial Part 4b: Zero Dispersion Case with MOC (Refined Grid)

1. Objective

In this final part of the refined-grid simulation, we investigate solute transport under a special case: **zero physical dispersion**. The goal is to simulate a scenario where transport occurs solely due to advection, and observe how the Method of Characteristics (MOC) handles this condition. According to theoretical expectations, the result should be a well-defined solute block propagating through the domain without spreading.

2. Setting Longitudinal Dispersivity to Zero

To simulate pure advective transport:

- Go to `Data > Edit Data Sets > Required`.
- Expand `MT3DMS`, `MT3D-USGS`, or `GWT`.
- Locate `Longitudinal Dispersivity` and set it to `0`.
- Leave all other model settings unchanged.

This modification ensures that no dispersion is introduced and the solute plume is transported strictly by the velocity field.

3. Running the Model

Running MODFLOW

- Click the green triangle below the `Grid` icon.
- Save the model in the directory `Fine/Fine_MOC/` as `Fine.nam`.
- Confirm and execute the simulation.

Running MT3DMS

- Click the dropdown arrow next to the green triangle.
- Select `Export MT3D Input Files`.
- Save the input in `Fine/Fine_MOC/` as `Fine.mtnam`.

4. Analytical Comparison using Streamlit

To validate the model behavior:

- Launch the Streamlit app.
- Set `Longitudinal Dispersivity` to `0`.
- Observe the output: the analytical solution shows a sharp solute block moving through the domain without dispersion.

This serves as the benchmark for interpreting the numerical output.

5. Visualizing the Numerical Results

- Import the `.UCN` file from this run into ModelMuse.
- View the resulting isoconcentration lines.
- If necessary, toggle off the background image to clearly observe the transport behavior.

As expected, the MOC algorithm successfully reproduces the block-like signal with minimal numerical diffusion, validating its performance under zero-dispersion conditions.

6. Breakthrough Curve Analysis

To further confirm the absence of dispersion:

- Load the updated `.MTO` file into the Excel comparison sheet.
- Paste the data into the appropriate section for this run.
- Review the breakthrough curves at various observation points.

The resulting plots show a sharp step increase in concentration, characteristic of pure advection with no physical spreading.

7. Resetting Dispersivity (Optional)

Before proceeding to any future simulations, you may reset the `Longitudinal Dispersivity` value back to `10 m`, as originally configured. Re-running the simulation under standard settings can also help confirm consistency in model behavior.

8. Summary

This exercise demonstrated how the MOC algorithm handles a zero-dispersion scenario with a refined grid. The numerical results align well with theoretical expectations, producing a sharply defined solute block. The breakthrough curves further reinforce the accuracy of MOC under purely advective conditions.