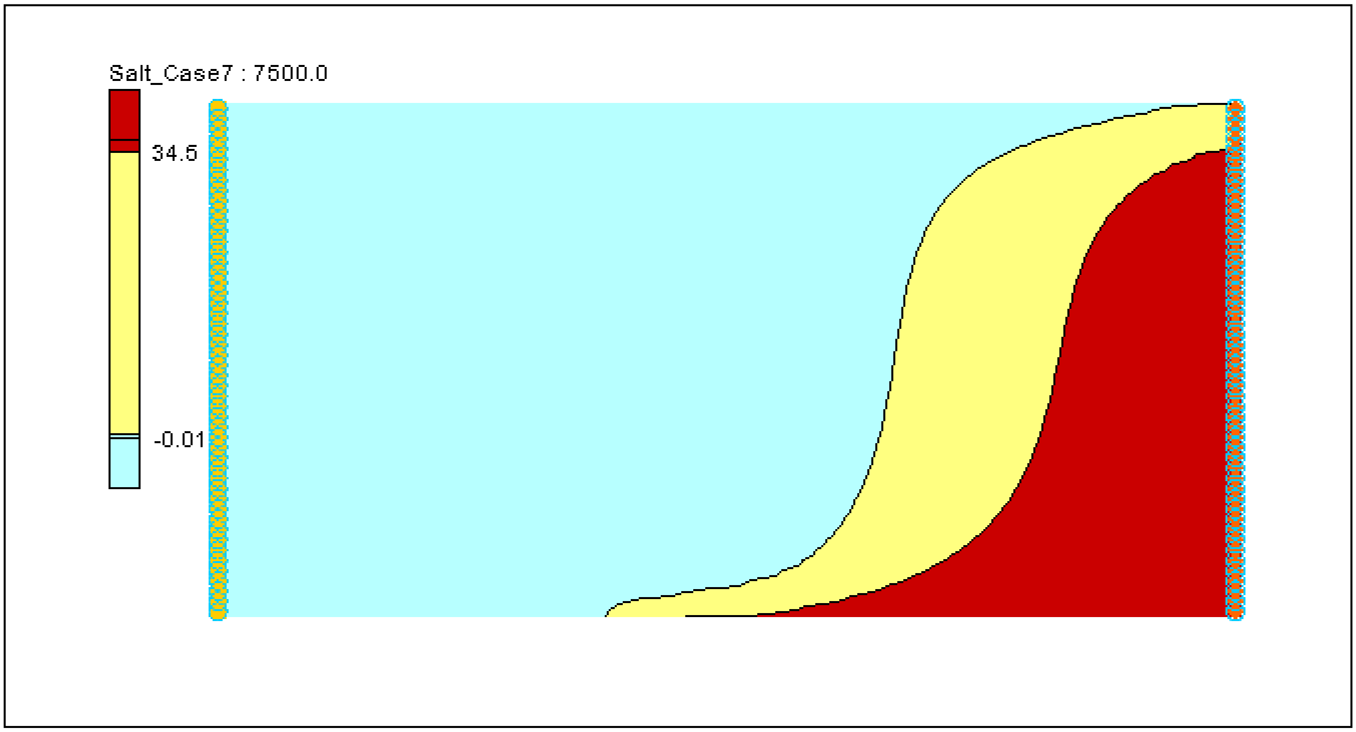
GMS

v. 9.2

GMS 9.2 Tutorial

SEAWAT – Viscosity and Pressure Effects

Examine the Effects of Pressure on Fluid Density with SEAWAT



Objectives

Learn how to simulate the effects of viscosity and how pressure impacts on the fluid density in SEAWAT.

Prerequisite Tutorials

- SEAWAT – Thermal Effects

Required Components

- Grid
- MODFLOW
- MT3D
- SEAWAT

Time

- 30-60 minutes

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1 Contents

2 Introduction

This tutorial describes how to simulate the impact of concentration and/or temperature on fluid viscosity using SEAWAT. Then we will examine the effects of pressure on fluid density.

2.1 Outline

This is what you will do:

1. Importing an existing SEAWAT simulation
2. Run SEAWAT with different scenarios.
3. Examine the results.

3 Description of Problem

Our problem is shown in Figure 1; this is a confined aquifer with an initial temperature of $5^{o}C$. Warm freshwater is injected from the west side of the model at a 1 m^3/day. The initial concentration of salt in the model is 35 kg/m^3.

We'll look at the effects of salinity and temperature on viscosity and the effects of pressure on fluid density in this example. This example problem is very similar to the problem described in the SEAWAT documentation[1].

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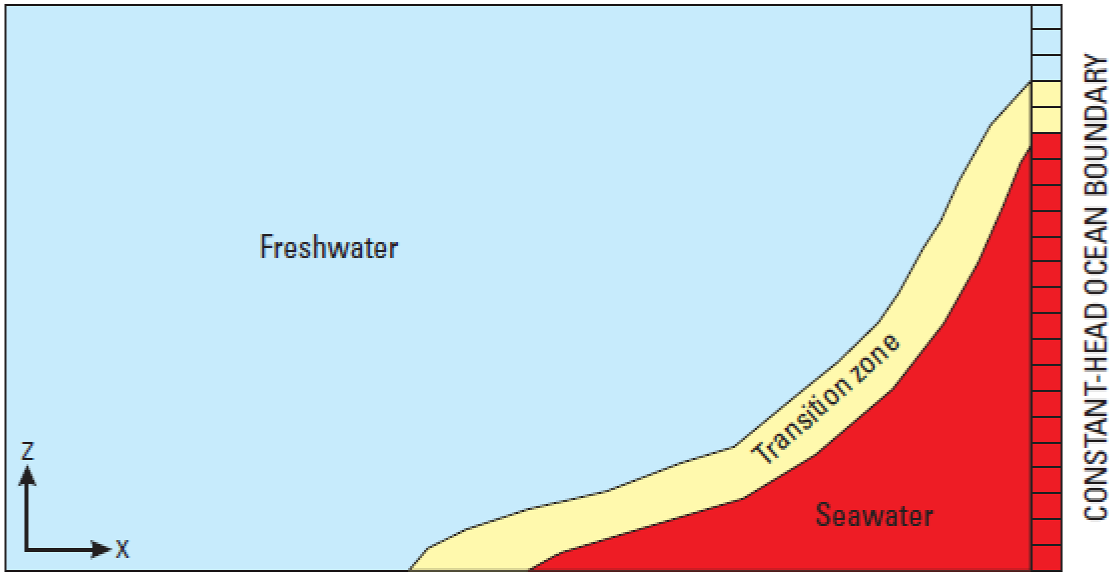

Figure 1. Site to be modeled with SEAWAT.

4 Getting Started

If you have not yet done so, launch GMS. If you have already been using GMS, you may wish to select the *File* | *New* command to ensure the program settings are restored to the default state.

5 Importing the Existing Model

We will start with a model that has already been created.

1. Select the *Open* button (or the *File* | *Open* menu command).
2. Browse to the **\Tutorials\SEAWAT\Case_Studies\Sample\Case5** folder.
3. Select the **case5.gpr** file and click *Open*.

This imports the model.

6 Adding the Effects on Fluid Viscosity

We'll use the VSC package to simulate changes to the fluid viscosity.

1. Select the *SEAWAT* | *Global Options* command
2. Turn on *Viscosity (VSC)*.
3. Select the *OK* button to exit the dialog.

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6.1 Modifying the VSC Package

For the first scenario, we'll simulate the effect of salinity on fluid viscosity in the simulation.

1. Select the *SEAWAT | VSC Package* command
2. Enter a value of -1 for MT3DMUFLG.

This value means that the fluid viscosity will be calculated using one or more MT3DMS species. In this case, they are **Salt** and **Temperature**.

3. Enter **0.0008904** for *VISCREF.*

The reference viscosity (*VISCREF*) is viscosity of the reference fluid (warm freshwater).

4. Select *eq. 18* for *MUTEMPOPT.*

MUTEMPOPT indicates which method/equation is used to solve the fluid viscosity.

5. Enter **2** for *MTMUTEMPSPEC.*

MTMUTEMPSPEC indicates the temperature species. In this project, the *temperature* species ID is 2

6. Turn on *Use default values for A1-A5*.

The default coefficients for this equation are specified according to SUTRA (Voss, 1984). These default values are only valid for temperature in Celsius. Notice that GMS automatically fills in the values for you.

7. Click on to insert a species in the spreadsheet.
8. In Species ID column, enter **1**.

Notice that the species name has changed to *Salt*.

9. Enter **1.923e-6** for *DMUDC* and **0** for *CMUREF*.

DMUDC indicates the slope of the linear equation which relates fluid viscosity to solute concentration. *CMUREF* indicates the reference concentration for species.

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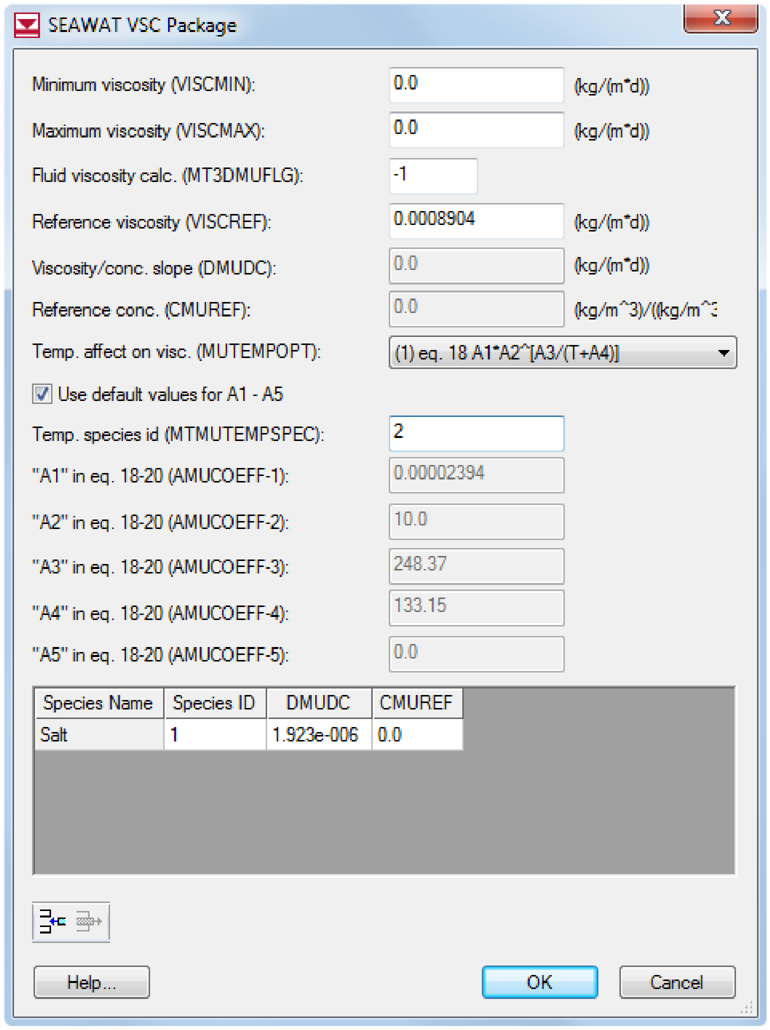

Figure 2 VSC Inputs.

10. Select OK to exit the dialog.

7 Saving the Model with a New Name and Running SEAWAT

We are ready to save our changes and run SEAWAT.

1. Select the *File* | *Save As* menu command.
2. Browse to the **\Tutorials\SEAWAT\Case_Studies** folder.
3. Change the project name to **case6**.
4. Save the project by clicking the *Save* button.
5. Select the *SEAWAT* | *Run SEAWAT* command.
6. When SEAWAT finishes select the *Close* button.

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8 Viewing the Solution

We will now view the results of the SEAWAT model run.

1. Select the **Salt** data set below the **case6 (MT3DMS)** solution in the *Project Explorer*.
2. Select different time step in the time step window.

The results from **case6** and **case5** are very similar. This suggests that viscosity variation has minimal effect on the simulated salinity and temperature in this case. The figure below shows Salt concentration at 5000.0 days for **case5** and **case6**.

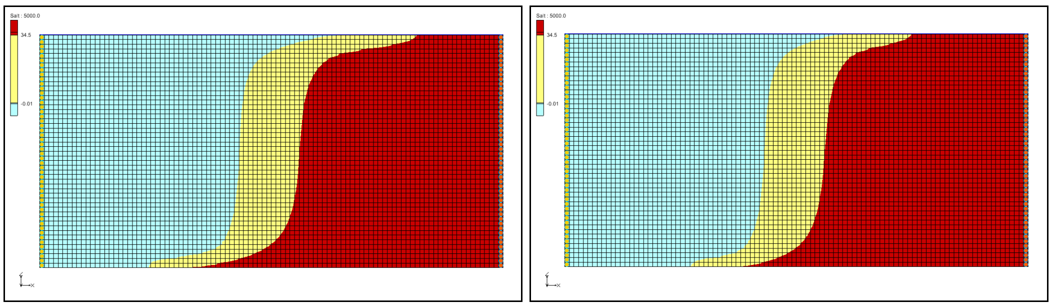

*Figure 2 Comparison of Salt Species for **case5** (left) and **case6** (right)*

9 Saving the model with a new name

We're ready to start making changes for another scenario. Let's save the model with a new name.

1. Select the *File* | *Save As* menu command.
2. Change the project name to **case7**.
3. Save the project by clicking the *Save* button.

10 Adding the Effects of Pressure on Fluid Density

For the next scenario, we will look at how pressure affects the fluid density.

10.1 Modifying the VDF Package

The pressure effects can be activated using the *DRHODPRHD* parameter.

1. Select the *SEAWAT* | *VDF Package* command
2. Enter a value of **0.00446** for the change in density with the change in pressure head (*DRHODPRHD*).
3. The reference pressure head (*PRHDREF*) should be **0**.
4. Your VDF inputs should be the same as the following figure:

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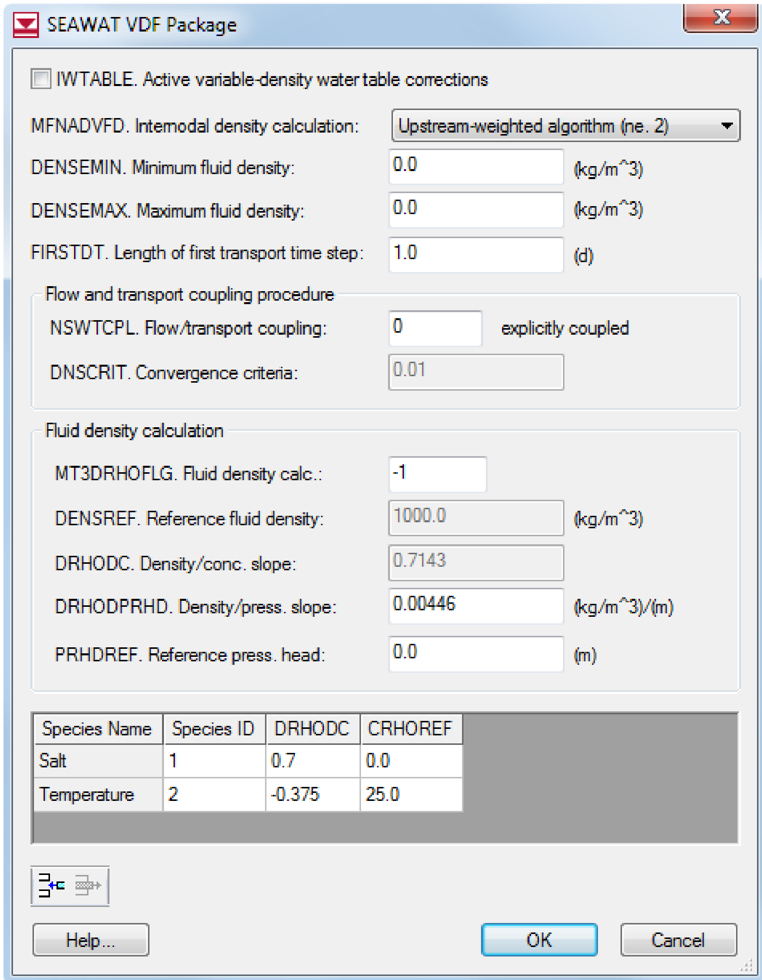

Figure 3 VDF Inputs simulating pressure effect on density.

5. Select *OK* to exit the dialog.

11 Saving and running SEAWAT

We are ready to save our changes and run SEAWAT.

1. Select the *Save* button to save the project
2. Select the *SEAWAT* | *Run SEAWAT* command.
3. When SEAWAT finishes select the *Close* button.

12 Viewing the Solution

We will now view the results of the SEAWAT model run.

1. Select the **Salt** data set below the **case7 (MT3DMS)** solution in the *Project Explorer*.
2. Select different time step in the time step window.

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The compressibility of water due to pressure almost has no effect on the salinity and temperature. This minor effect is due to the shallow depth (500m) of the aquifer in this example. The effect of pressure on fluid density is negligible for shallow aquifers.

13 Conclusion

This concludes the tutorial. Here are the things that you should have learned in this tutorial:

- SEAWAT combines MODFLOW and MT3DMS to solve variable density groundwater flow and solute transport problems.
- SEAWAT can simulate the effect of concentration and temperature on fluid viscosity.
- SEAWAT can simulate the effect of pressure on fluid density.

14 Notes

1. Langevin, C.D., Thorne, D.T., Jr., Dausman, A.M., Sukop, M.C., and Guo, Weixing, 2007, SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport: U.S. Geological Survey Techniques and Methods Book 6, Chapter A22, 39 p.

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