Application of the XT3D Multi-Point Flux Approximation to Vertically Staggered Grids

or maybe

Application of the XT3D Multi-Point Flux Approximation and Enhanced Grid Connectivity to Improve Accuracy of Flows in MODFLOW 6 Models With Steeply Sloping Layers

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Conflict of interest: None.

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Abstract

This is the best paper ever...

1 Introduction

Some intro stuff here about MODFLOW (Hughes et al., 2017; Langevin et al., 2017, 2022) and XT3D (Provost et al., 2017)...

2 Theoretical Background

Introduce vertically offset grids and explain the connection angle/length issue.

Summarize XT3D and how it accounts for connection angle/length. Reference Kerry and Jim's demonstration that, in spite of that, XT3D doesn't really improve things for a steeply sloping grid. Must be something else going on.

Explain wormholes and how they induce horizontal flow in a sloping channel regardless of XT3D.

- Grid with "connector cells"
- Role of flows between layers
- Shutting off flows between layers using extreme anisotropy in connector cells
  - Sloping flow in connector cells
  - Horizontal flow in flat-top cells
- Squashing of connector cells VO grid with horizontal flows and "wormholes"

Proposed solution is to introduce cross-connections between layers.

3 Approach

Summarize the overall approach here.

Will use a DISV plan-view model with connector cells and XT3D to demonstrate the "wormhole" effect discussed in the Theoretical Background in the limit as connector cells are squashed out. (Also can look at the other limit, as flat-top cells are squashed and connector cells dominate, so grid follows the channel boundary.)

Will use a DIS cross-sectional model to show results you get on a vertically staggered grid (without cross-connections), with and without XT3D. (Basically what Kerry and Jim showed.)

Will convert the DIS grid to a DISU grid with cross-connections and show improved results, with and without XT3D.

4 Description of Test Problems

Describe the test problem setups here.

4.1 Test problem 1 (DISV plan-view with connector cells)

Test problem 1...

4.2 Test problem 2 (DIS cross-sectional)

Test problem 2...

4.3 Test problem 3 (DISU cross-sectional with cross-connections)

Test problem 3...

5 Results and Discussion

6 Conclusions

7 Acknowledgments

Thank all those reviewers.

8 Software Availability

MODFLOW 6 is open source; software is developed following modern software development principles. FloPy (Bakker et al., 2016) contains full support for all MODFLOW 6 models and packages. We welcome input to the community through our public software repository. MODFLOW 6 is developed in the open, designed to be teachable, runs on multilple

9 Supporting Information

10 Appendix

References

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