Bringing Extinct Sponges to Life: A New Program for Modeling Stromatoporoid Growth

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Abstract

Most geoscience students readily learn how organisms are shaped by their environment. However, few actually have an opportunity to explore the direct relationship between environmental pressures and an organism's response to them. For example, phototropic plants grow towards a bright light in order to have greater access to this vital resource. But under what type and intensity of light does this occur? How far can the plant grow in any given direction? How do other forces, such as wind and gravity, act in opposition to phototropic growth? By exploring the direct relationship between an environmental pressure and an organism's response, answers to these kinds of questions can become evident more easily. *StromaGrow* explores these types of direct relationships between a stromatoporoid and its environment, and therefore functions as both a teaching and a learning tool.

Our goal was to produce a stromatoporoid-generating program for use in the classroom, to help students understand how stromatoporoids grew, and assist them in visualizing their three-dimensional growth when given a two-dimensional cross-section. We wanted the tool to accomplish the following goals: 1) to model stromatoporoid growth in three-dimensions; 2) to make the program easy and intuitive to use; 3) make it fast enough to grow large organisms in a reasonable amount of time; 4) to make a fully interactive organism that could be easily rotated and inspected; and, 5) make it highly configurable to handle a variety of conditions and settings.

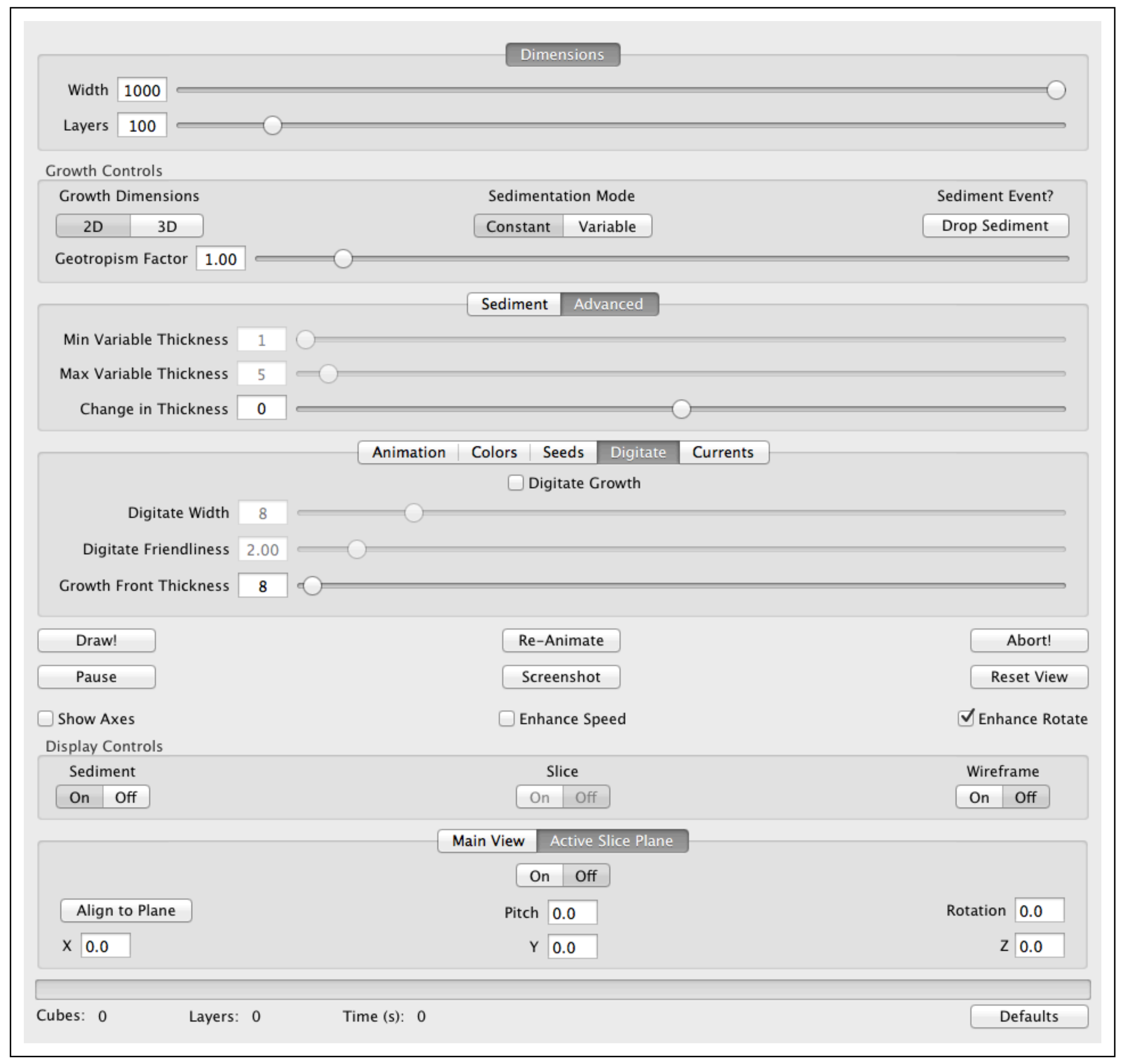
Background

StromaGrow was written in Objective C, a general purpose object-oriented programming language, which is the main language used by Apple for the OS X and iOS operating systems. The program also uses OpenGL (Open Graphic Library) for rendering 2-D and 3-D images. *StromaGrow* runs on OS X 10.7 through 10.9.

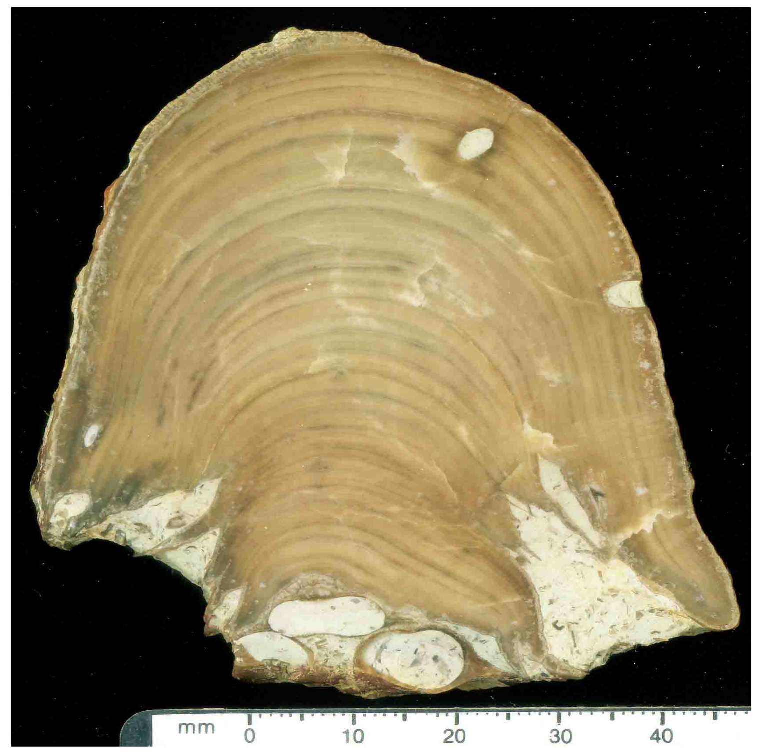
StromaGrow is based on the original 2-D probabilistic accretionary model of stromatoporoid growth developed by Swan and Kershaw (1994). Swan and Kershaw's model was later implemented in Octave for use as an interactive laboratory exercise by Tom Olszewski (Dept. of Geology & Geography, Texas A&M University). Building on the work of both Swan and Kershaw and Olszewski, Goodwin and Havill previously developed an interactive 3-D version of the probabilistic accretionary model in VPython. While the VPython version of the model successfully illustrated stromatoporoid morphology in three dimensions, it was extremely slow, limiting its utility in lab settings. *StromaGrow* retains all of the advantages of 3-D visualization, yet it is fast, highly configurable, and easy to use.

User Interface

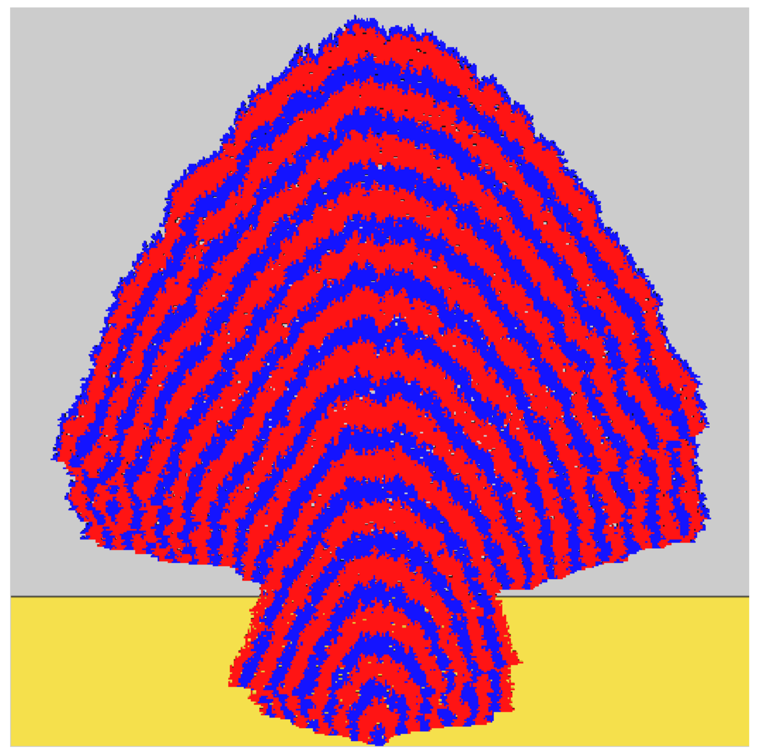
- 2-D and 3-D capabilities
- passive and interactive slice planes
- interactive rotation, translation, and zooming
- scalable growth environment
- constant and probabilistic sedimentation rates
- single and multiple seeds
- variable current strengths
- sediment viewing toggle
- variable animation rates
- save image and parameters
- variable geotropism factor
- massive or digitate growth
- open image and parameters
- integrated PDF manual



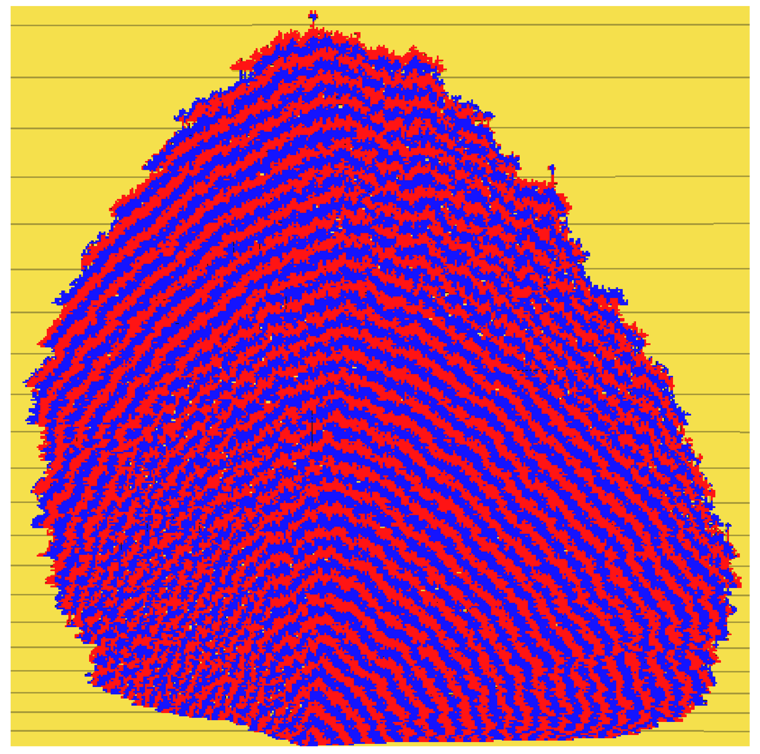
Two-dimensional Capabilities



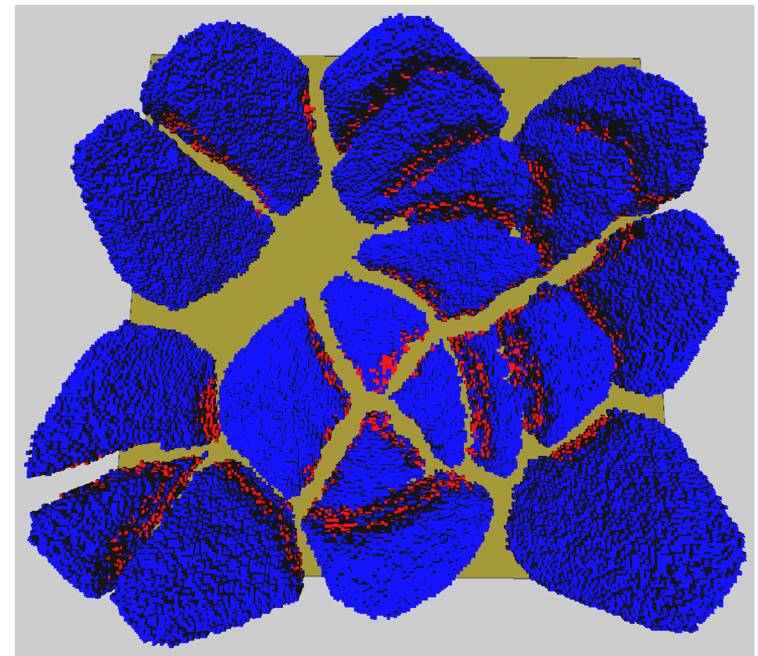
Observed stromatoporoid cross section [1]

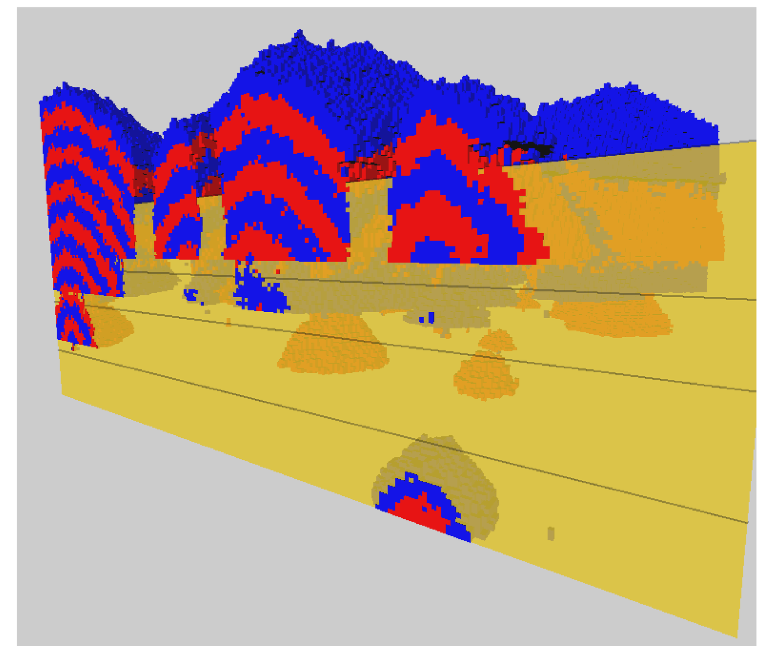

StromaGrow model of cross section

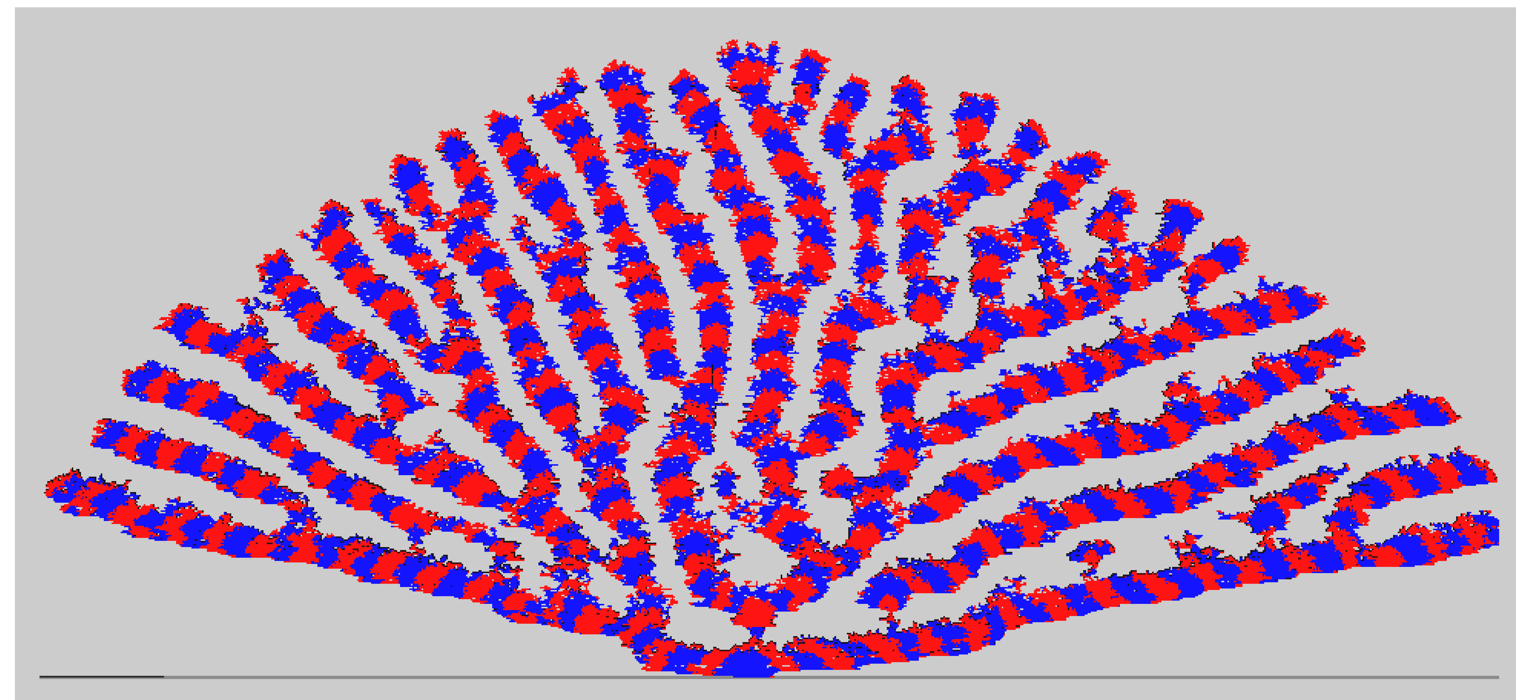

Observed stromatoporoid specimen [2]


StromaGrow model of specimen cross section

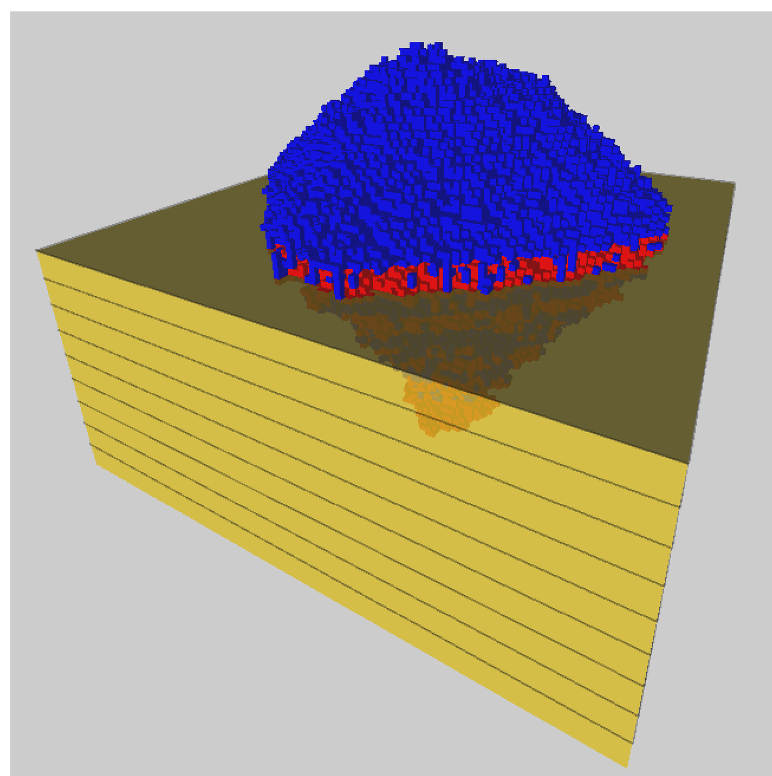
Alternate Growth Modes

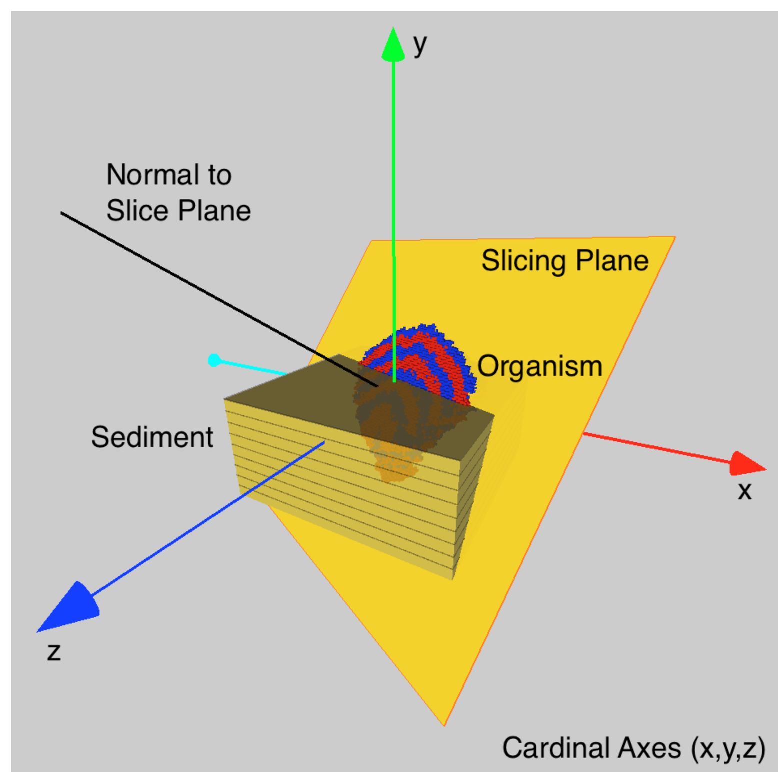

Deformed specimens resulting from competitive seeds grown in a relatively small three-dimensional volume.


Specimens grown from seeds deposited at different times.

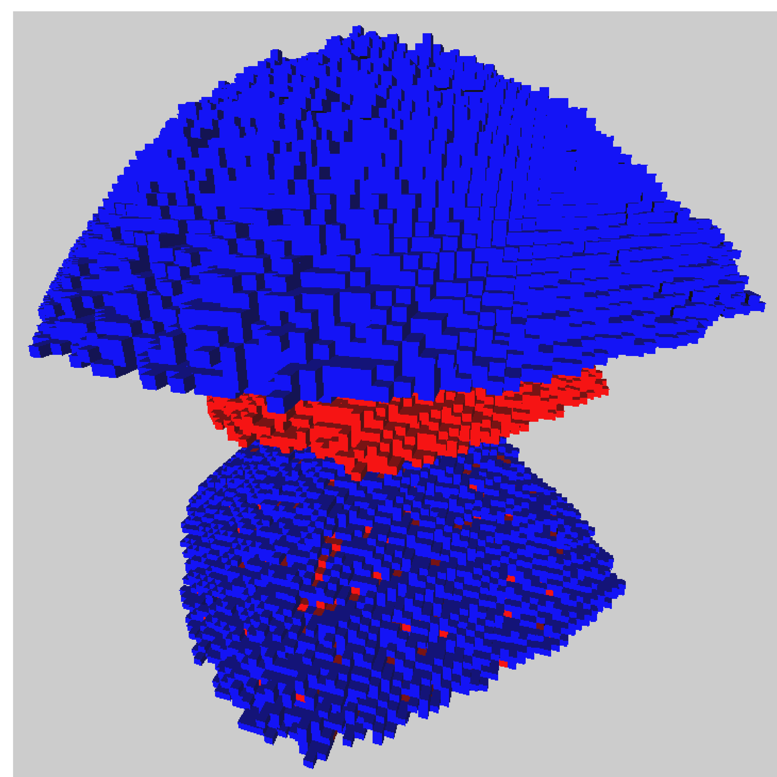

Digitate morphology resulting from a single seed in a relatively large volume.

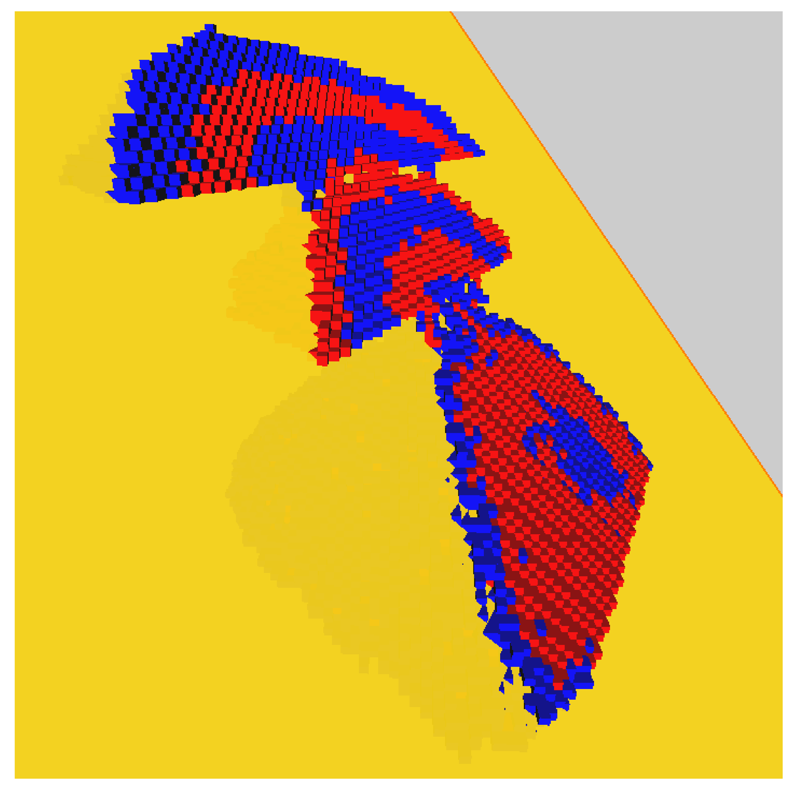
Three-dimensional Capabilities


3-D *StromaGrow* model



Cross section of 3-D *StromaGrow* model showing axes and interactive slice plane.


3-D *StromaGrow* model illustrating multiple sedimentation events (sediment toggled off).


Cross section of previous 3-D *StromaGrow* model. Active slice plane is oblique to growth axis.

[1] http://www.earthsurfaceprocesses.com/5-GeoscientistsHeaderImage-Ha39a-01.jpg.; [2] http://4.bp.blogspot.com/-3HQNYCkQeFc/TlKeOPoKVxI/AAAAAAAADFI/W_ioi3fdT-E/s320/IMG_9519.jpg.