

Parametric Terrain Maps

Introduction

The Bryce terrain editor has remarkable versatility but its limitations make it impossible (or at least very difficult) to reproduce certain effects. Specifically, it is not possible to model a class of pure mathematical functions in Bryce. A simple example would be the ripple effect of waves on water. Material textures can approximate the effect of waves but the effects are frequently diminished or difficult to produce.

The terrain editor is very good at creating and manipulating fractal based terrain models. It also has the ability to import files created with other applications, which can then be used as a basis for new terrain models. Using this ability, a fairly simple program can be created to enhance the terrain editor's capabilities by adding parametric functions. The program should be easier to use than the Bryce DTE making it accessible to non-technical users.

Since this discussion began, two interesting items along these lines have been shared in the Bryce forum.

	PC Users	Mac Users
It is possible to invoke the <i>Deep Texture Editor (DTE)</i> directly from the terrain editor. When the DTE is closed using the checkmark, the image is transferred to the terrain editor.	Alt-Ctrl click on the "Picture" button, on the "Elevation" tab of the terrain editor. Ctrl-Shift click invokes the picture room.	Command-Shift-Option click on the "Picture" button, on the "Elevation" tab of the terrain editor.
Mark Hessenflow has authored a shareware utility called "Waves World" to recreate wave effects in Bryce.	No luck.	http://www.hknot.com/wavesworld

The DTE uses a filtered noise approach. While extremely useful, it is difficult to master and control. It cannot produce terrain maps based on mathematical functions. The concept behind "Waves World" appears to be similar to parametric terrain maps. It adds a spectacular new dimension to Bryce terrains but it is currently only available to Mac users.

Frequency Modulation

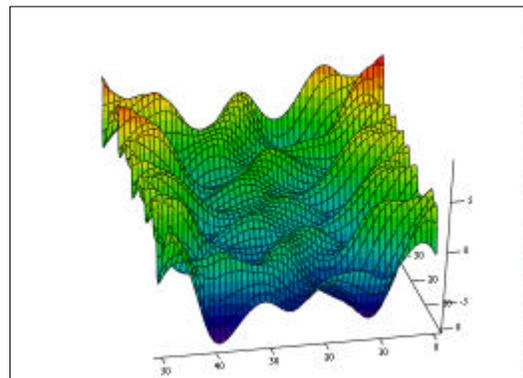
A few years ago the idea of frequency modulation was applied to audio synthesizers. A sine wave oscillator's frequency (pitch) was modulated (changes), either by itself, or by another oscillator. Modulated oscillators were combined in groups called algorithms to generate rich harmonic textures that approximated real instruments. A more detailed explanation of FM synthesis can be found by searching for "FM synthesis" or "DX7". Two such sites are located at:

<http://www.multimania.com/chipple/dx7/english/fm.tone.generation.html>
<http://www.geocities.com/SunsetStrip/Underground/2288/2fmsynth.htm>

Using the concept of FM synthesis and adapting it to three dimensions, it is possible to create a large number of interesting terrain maps.

$$f(x, y) := x \cdot \sin(x + \sin(y))^2 + -y \cdot \sin(y + \cos(3 \cdot x))$$

Frequency Modulated Terrain



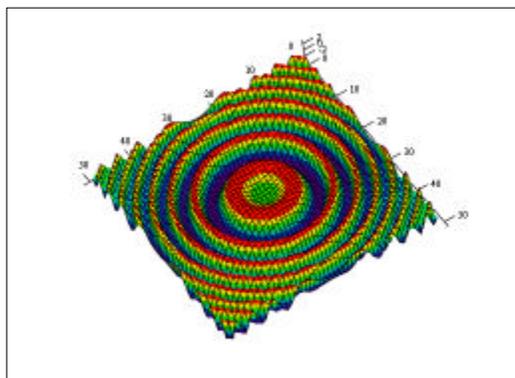
Wave Terrains

Returning to our original wave example; parametric operations easily recreate “real world” interference patterns of waves by simply adding two operators at slightly different spatial coordinates

$$f(x, y) := 3 \cdot \sin(x^2 + y^2)$$

Ripple effect

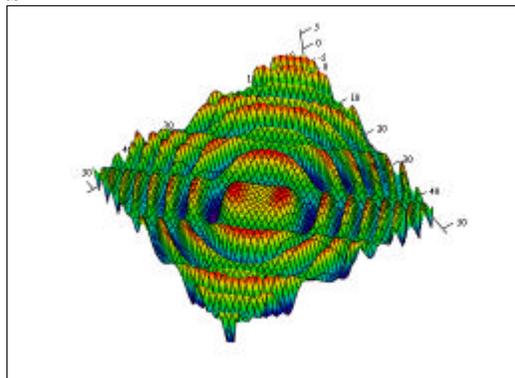
Although these examples are infinite waves (which do not dissipate with distance), variations of these functions can easily include a damping effect.



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$$f(x, y) := 3 \cdot \sin(x^2 + y^2) + 3 \cdot \sin[(x-1)^2 + (y-1)^2]$$

Double ripple effect



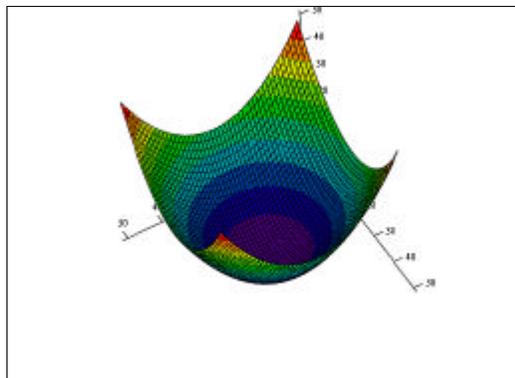
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Other Functions

Applications are not limited to intrinsic functions. Virtually any mathematical function or combination of functions may be used. A properly designed GUI is essential in making these functions easy to use – roughly analogous to using a plug-in filter.

$$f(x, y) := x^2 + y^2$$

Parabolic terrain



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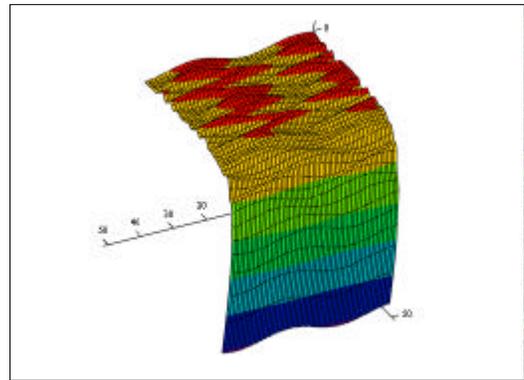
Summary

Some of these effects may be approximated using gradient tools, noise and plug-in filters. However, added to the existing terrain manipulation tools and textures, these new terrain maps can add enormous flexibility for photorealistic and abstract images.

Additional Examples

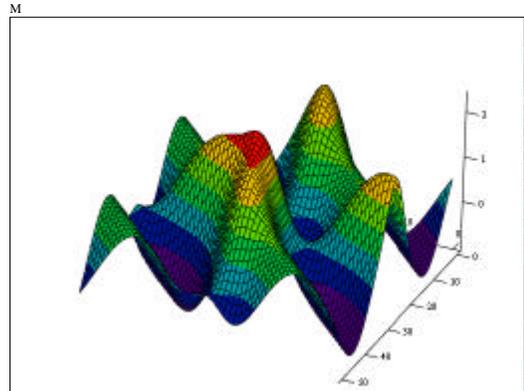
$$f(x, y) := 1.5 \cdot \sin(x + \sin(3 \cdot y)) + \sin(5 \cdot y) - \frac{e^y}{3}$$

Waterfall terrain



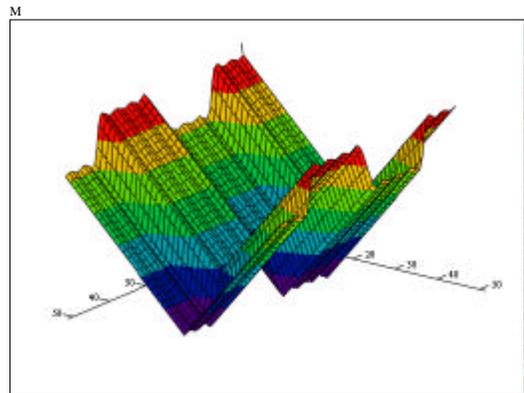
$$f(x, y) := (4 \cdot e^{-\frac{x^2}{2}} + (4 \cdot e^{-\frac{y^2}{2}} + \sin(x+y)))$$

Exponential terrain



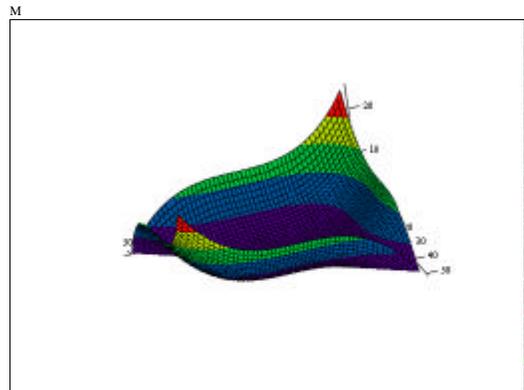
$$f(x, y) := \sin(x) + \frac{\sin(3 \cdot x)}{3} + \frac{\sin(5 \cdot x)}{5} + \frac{\sin(7 \cdot x)}{7} + |y|$$

Absolute square terrain



$$f(x, y) := \frac{|(x)^3 + y^3|}{10}$$

Cubic terrain



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Parametric Terrain Editor

The Parametric Terrain Editor (PTE) generates bitmap files that can be imported into the Terrain Editor (TE) to create effects which are difficult to reproduce with the TE or the Deep Texture Editor (DTE). The operation of the program is similar to many commercial paint programs.

Creating Bitmaps

Select the File/New menu option to create a new bitmap. Create a new bitmap using the File/New command. Enter X and Y resolutions for the new bitmap then click “Ok”. You can create as many bitmap windows as you like.

When you are experimenting with a new bitmap, start with a low resolution like 128 x 128. Small bitmaps generate quickly. After you have refined your settings, switch to a higher resolution and generate the final bitmap.

Bitmaps imported into the TE look jagged in the preview window. Set the terrain height to a low value, relative to the width and depth.

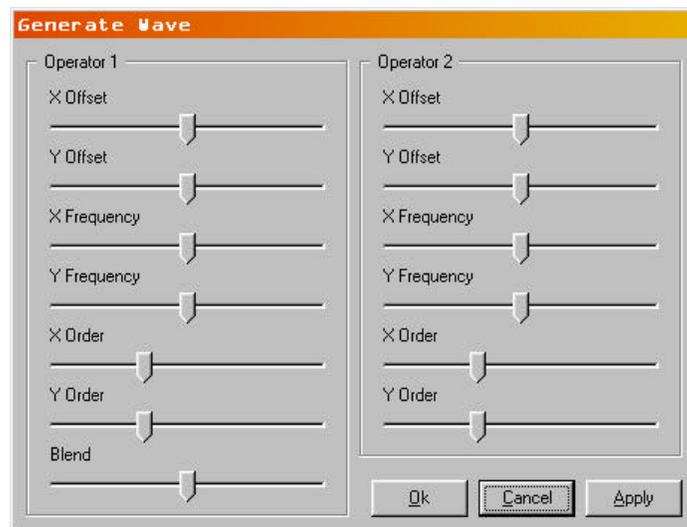
Using the Wave Generator

The wave generator creates a bitmap based on the function:

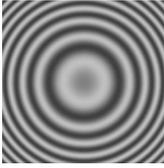
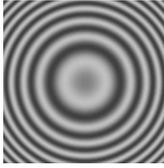
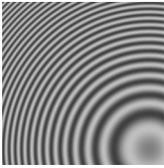
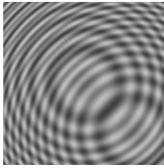
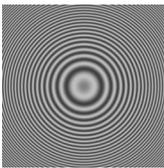
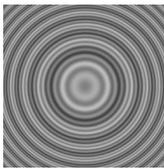
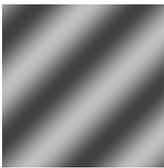
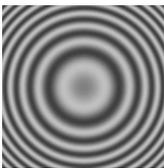
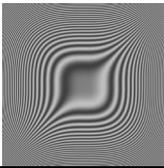
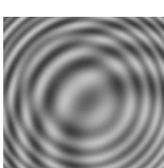
$$f(x, y) := A_1 \cdot \sin \left[\frac{(x - O_{x1})^{P_{x1}}}{M_{x1}} + \frac{(y - O_{y1})^{P_{y1}}}{M_{y1}} \right] + A_2 \cdot \sin \left[\frac{(x - O_{x2})^{P_{x2}}}{M_{x2}} + \frac{(y - O_{y2})^{P_{y2}}}{M_{y2}} \right]$$

The function includes two wave operators and a number of controls to modify the basic shape of the generated wave. It isn't important to understand the function, only the way each slider modifies the basic wave shape.

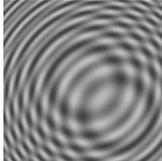
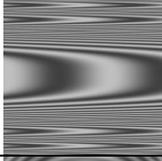
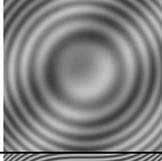
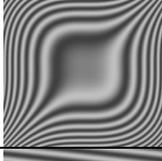
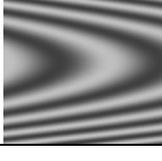
Use the sliders to modify the shape of the wave operators.



Click “Apply” to generate the bitmap in the current window. When you have finished, click “Ok” to close the dialog or “Cancel” to revert to the previous bitmap.

	Single Operator	Description	Both Operators
Default		This is the default wave pattern.	
Offset		Use the X and Y offset sliders to reposition the starting point for the wave. When the offsets for operator 1 and 2 are different, interference patterns are created.	
Frequency		Use the frequency sliders to increase or decrease the number of wave fronts in the view.	
Order	  	Order controls how the frequency of an operator changes with the distance from the offset. These pictures are generated with order 1, order 2 (default) and order 3.	
Blend		Blend controls the how much an operator contributes to the final bitmap. Setting the blend slider to -10 turns off operator 2, +10 turns off operator 1.	

Effects

Waves		Operator 2: X, Y Offset = 2
Corrugated Metal		Operator 1: X Frequency = 0 Y Frequency = 5 Y Order = 1 Blend = -10
Swept Waves		Operator 1: X Order = 1 Y Order = 4 Blend = -10
Swell Waves		Operator 2: X, Y Order = 1 Blend = 0
Crater		Operator 1: X, Y Frequency = -7 X, Y Order = 3 Blend = -10
Sand		Operator 1: X Order = 1 Y Order = 2 Blend = -10

Future Work

Additional functions as well as support for plug-in filters will be added in later releases.

Boring Stuff

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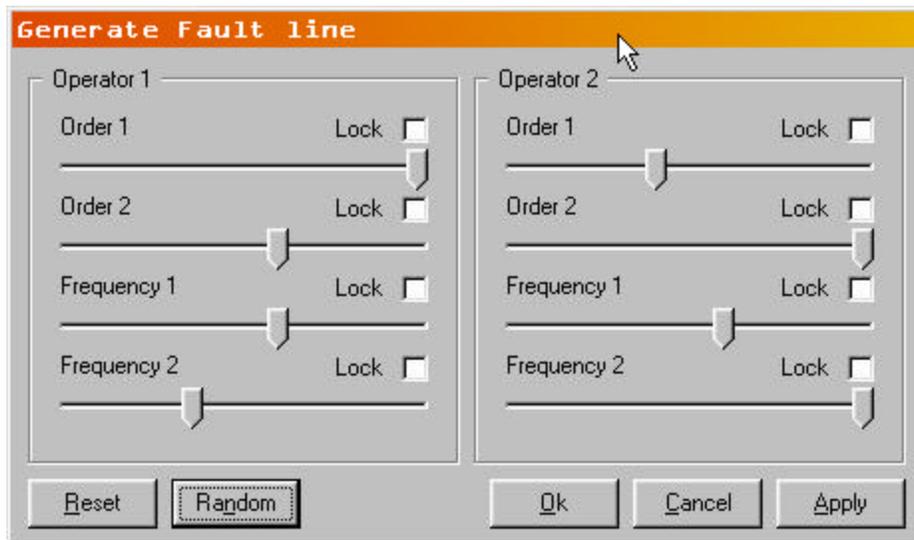
Using the Fault Line Generator

The fault line generator creates a bitmap based on the function:

$$f(x, y) := x^{P_{11}} \cdot \sin(M_{11} \cdot x + \cos(M_{12} \cdot y))^{P_{12}} - y^{P_{21}} \cdot \sin(M_{21} \cdot y + \cos(M_{22} \cdot x))^{P_{22}}$$

The function includes two operators and a number of controls to modify the basic shape of the generated wave.

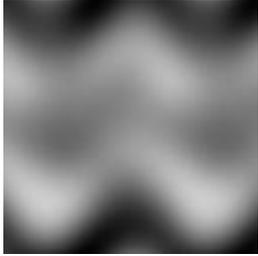
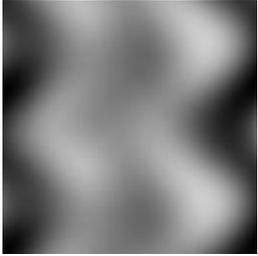
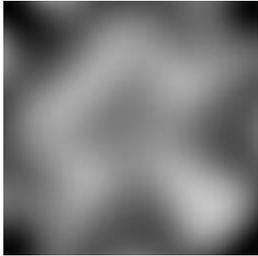
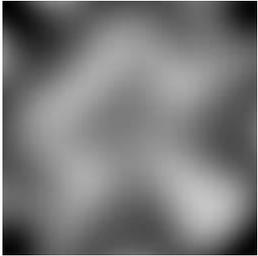
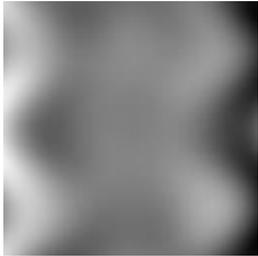
Use the sliders to modify the shape of the operators.

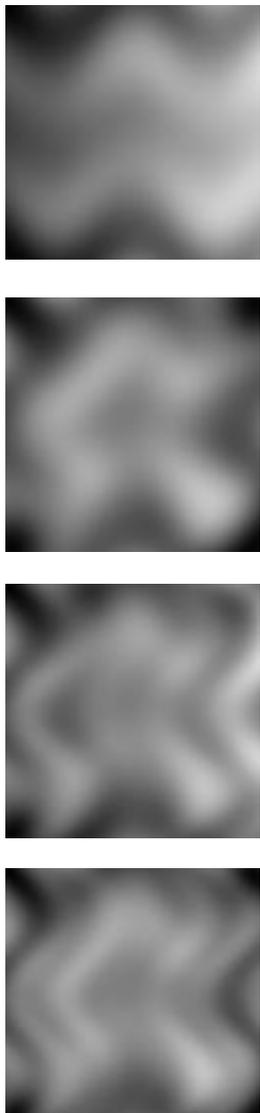
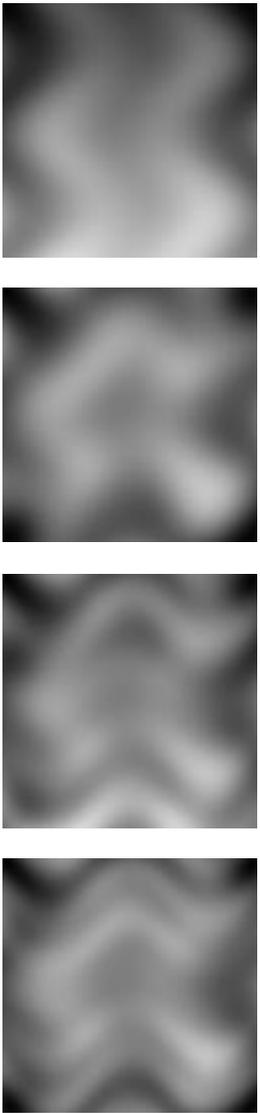


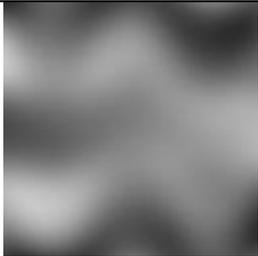
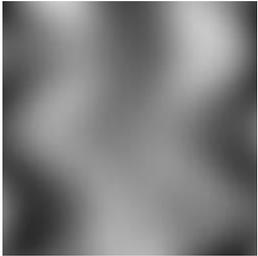
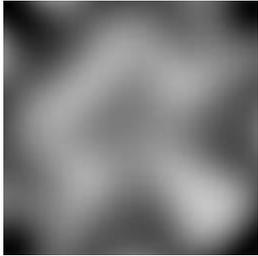
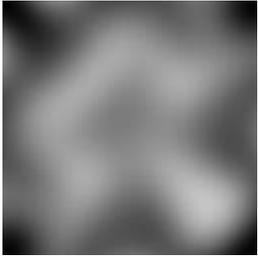
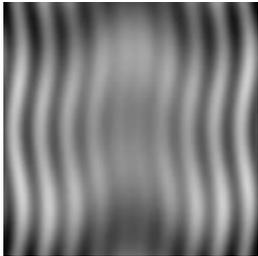
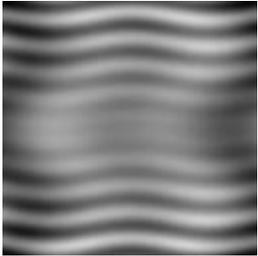
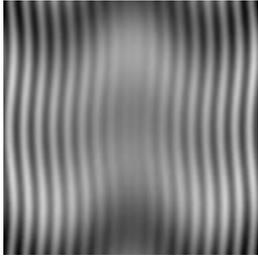
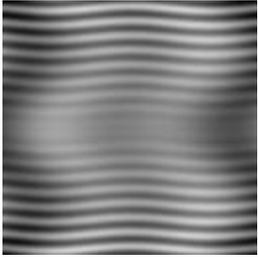
Click “Apply” to generate the bitmap in the current window. When you have finished, click “Ok” to close the dialog or “Cancel” to revert to the previous bitmap.

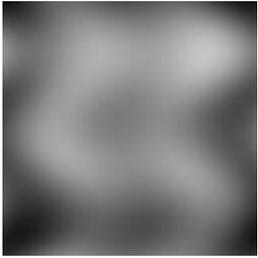
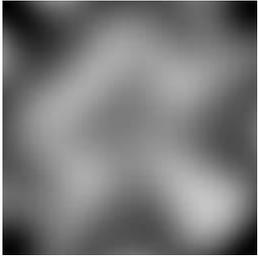
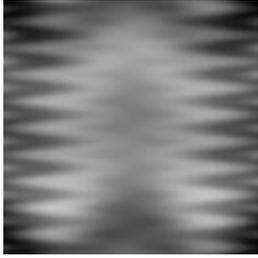
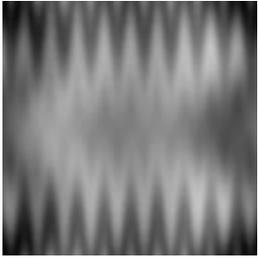
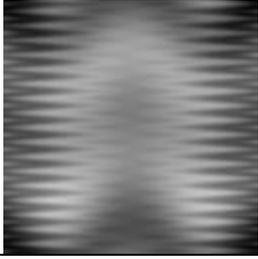
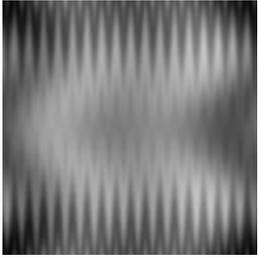
Click “Reset” to return to reload the defaults.

Click “Random” to generate random parameters and apply. Lock specific sliders by clicking on the checkboxes.

	Operator 1	Description	Operator 2
Order 1		<p>Order 1 = 0, 1, 2, and 3</p> <p>Increasing the value of order 1 causes a flattening of the center area in either the X or Y directions.</p>	
			
			
			

	Operator 1	Description	Operator 2
Order 2		<p>Order 2 = 0, 1, 2 and 3</p> <p>Increasing the value of order 2 causes an increase in detail in either the X or Y directions.</p>	

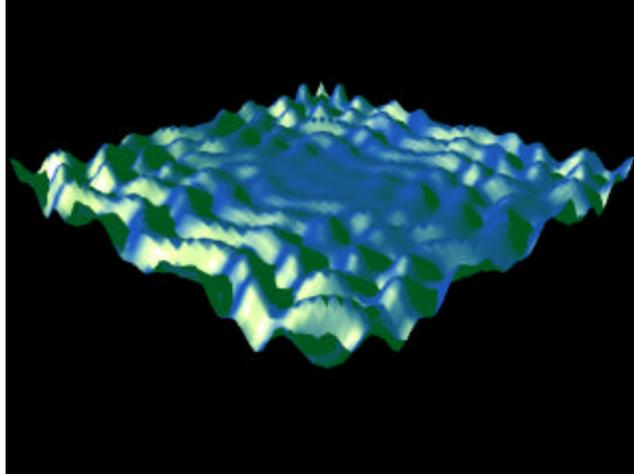
	Operator 1	Description	Operator 2
Frequency 1		<p>Frequency 1 = -10, 0, 5 and 10</p> <p>Frequency 1 controls the number of ridges in the X and Y directions.</p>	
			
			
			

	Operator 1	Description	Operator 2
Frequency 2		<p>Frequency 2 = -10, 0, 5 and 10</p> <p>Frequency 2 controls the number of sub-ridges in the X and Y directions.</p>	
			
			
			

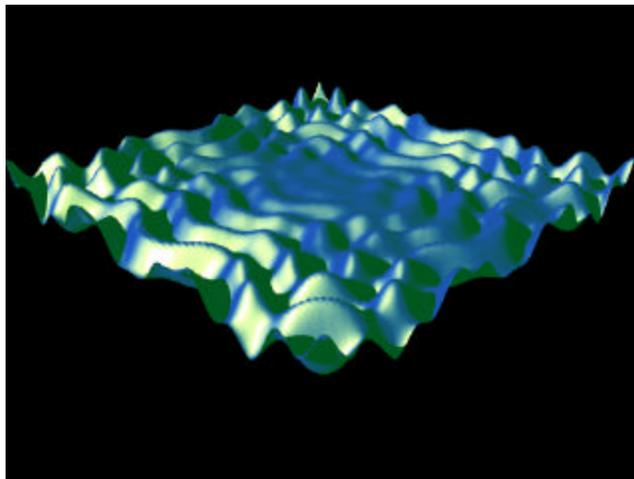
Resolution Tips

Smaller images generate faster. However, be careful to match the image size to the grid size in the terrain editor. Too much grid resolution produces striations while too little leads to loss of resolution. Although sometimes unwanted, these effects can be interesting if properly controlled.

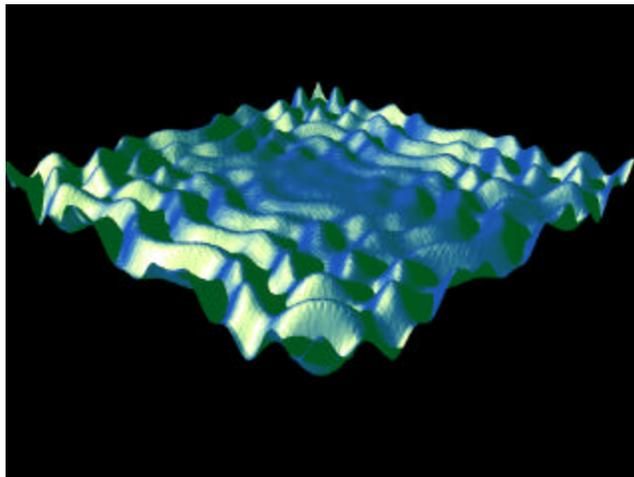
Remember to set the grid size before you import the image.



Grid size less than image size, loss of resolution.



Grid size equals image size, good resolution. Add smoothing to remove jagged edge or increase the image size slightly.



Grid size more than image size, striations appear.