Procedural Ground Dust

This page provides a tutorial on creating a Ground Dust simulation with Voxel Tuner in 3ds Max.

Overview

This is an Intermediate Level tutorial. Even though no previous knowledge of Phoenix is required to follow along, re-purposing the setup shown here to another shot may require a deeper understanding of the host platform's tools, and some modifications of the simulation settings. In this tutorial we explore how to create dust-like simulation

using Chaos Phoenix smoke. We go through setting the right simulation units, appropriate geometry dimensions and scene setup suggestions. Most importantly, we guide you through how to make a realistic sand smoke coming up as the horses step on the ground using Voxel Tuner. We compare how different values of some crucial parameters change the whole simulation's look.

This simulation requires **Phoenix 4.10 Official Release** and **V-Ray Next Official Release** for **3ds Max 2017** at least. You can download official Phoenix and V-Ray from https://downloa d.chaos.com. If you notice a major difference between the results shown here and the behavior of your setup, please reach us using the Support Form.

Download Project Files

Units Setup

Scale is crucial for the behavior of any simulation. The realworld **size of the Simulator** in **units** is important for the simulation dynamics. Large-scale simulations appear to move more slowly, while mid-to-small scale simulations have lots of vigorous movement. When you create your Simulator, you must check the **Grid** rollout where the real-world extents of the Simulator are shown. If the size of the Simulator in the scene cannot be changed, you can cheat the solver into working as if the scale is larger or smaller by changing the **Sc ene Scale** option in the **Grid** rollout.

The Phoenix solver is not affected by how you choose to view the Display Unit Scale - it is just a matter of convenience.

The horse used in the simulation is modeled in centimeters and throughout the fluid simulation we keep using the same unit. If you want to simulate a massive scene, then you might consider using meters.

Go to **Customize Units Setup** and set Display Unit Scale to **Metric Centimeters**.

Also, set the **System Units** such that **1 Unit** equals **1 Centimeter**.



The horse's geometry is modeled with the following dimensions - 196 cm in height, 244 cm in length and width of 60 cm.



Scene Layout

The final scene consists of the following elements:

- 1. An **animated horse** exported to an alembic file provided with the **single_horse_01.ABC** file.
- A dust emitting ground is set by a 3ds Max Standard Plane with Shell modifier applied.
- 3. A V-Ray Infinite Plane is used for easily setting the ground.
- A Phoenix Fire/Smoke Simulator with some tweaks in the Grid, Dynamics, and Rendering rollouts.
- 5. A **Voxel Tuner** is used for a realistic sand smoke coming up as the horse steps on the ground.
- 6. A Standard Physical Camera with minor tweaks for final rendering.
- 7. A V-Ray Sun Light.



Scene Setup

Create a 3ds Max Standard Plane. The exact dimensions of the plane are $6225\ \mbox{cm}$ by $2793\ \mbox{cm}.$

Since Phoenix works best with closed geometry, add a $\ensuremath{\textbf{Shell}}$ modifier to the created plane.

Set the **Outer Amount** to **1.0** cm. The actual value does not have weight in the final render, as the plane will not be visible at all there.

The exact **Position** of the **plane** in the scene is **[X:0cm, Y: -4320cm, Z:-20cm]**.

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Mod	ifier List			
o	Shell			
	Plane			
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• •	Parameters			
	Inner Amount:	0.0cm		
	Outer Amount:	1.0cm		
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	Bevel Edges			
	Bevel Spline:	None		
	Override Inne	er Mat ID		
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	Select Edges			
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Import the single_horse_01.ABC geometry by going to File Import Import...

This tutorial starts off with pre-built geometry to save time setting up the scene. Feel free to use your own personal models. The exact start **Position** of the **alembic mesh** in the scene is **[X:0cm, Y:0cm, Z:0cm]**.

You can control the interaction strength between the horse mesh and the ground plane by adjusting the **Motion Velocity Effect**, located in the **Phoenix Per-Node Properties**. The higher the value is, the stronger the fluid reaction to the body's movement is. For this tutorial, its value is set to **2.0**.



Create a V-Ray Infinite Plane used during rendering.

The exact **Position** of the **V-Ray plane** in the scene is [X: 0cm, Y:0cm, Z:-15cm].

Create a Fire Smoke Simulator.

The exact Position of the simulator in the scene is [X:0cm, Y:-1500cm, Z:-20cm].



Voxel Tuner

We are going to use a Voxel Tuner to emit Smoke where the horse model touches the ground. We will do it in such a way, that we don't even need a Phoenix Source.

In this case, the Voxel Tuner will go through all the voxels of the Simulator, and check if each voxel is close to the ground plane and simultaneously close to the horse mesh. If it passes this condition, then the Tuner will create Smoke in this voxel.

The Voxel Tuner expression is created as follows:

- If a voxel's Distance to Plane001 is Less Than 1.7 voxels and If the Distance to horse mesh is Less Than 1.7 voxels.
- Then the Smoke will be Set to 15.0.

We picked very low values for both distance conditions - if you lower them even more, less voxels will pass the condition and Smoke will be emitted in fewer places. On the contrary, if you increase the distances, Smoke will start getting created in the air around the contact points between the horse and the ground.

We also create very dense Smoke - usually we don't need smoke above 1.0, but in this case we emit 15 units of smoke, which would make the smoke render very dense with the default render settings. Below we will enable **Smoke Dissipation** so the smoke will be thick at first, but then will quickly fade out.

▼ Vo	xel Tuner Enabled When:	Edit Cond	lition		
	([Plane00 ([horse_m	1] < 1.700 lesh] < 1.7) and 700)	<	
	Then:	Smoke			
	Set To		15.0		
	Buildup Tim	e (sec)	0.0		



Phoenix FD Voxel Tuner: Edit Condition		—
Phoenix FD Voxel Tuner: Edit Condition Image: And Image: Islam (Distance to Plane001) Image: Islam (Distance to horse_mesh) Image: Islam (Distance to horse_mesh) Image: Islam (Distance to horse_mesh)	 Edit Value Expression Up ^ Number Random Between Channel Distance To horse_mesh Texture Intensity No Map Create Actions: Replace this item with: (this) + [New Value] 	d 1.0
	Create Actions: Replace this item with: (this) + [New Value] (this) * [New Value] (this) - [New Value] (this) / [New Value] [New Value] - (this)	
	[New Value] / (this)	

Run the simulation for a few frames and render out one frame with the running horse.

Notice how the $\ensuremath{\text{Voxel Tuner}}$ generates smoke around the horse's hoof when it touches the ground.



Simulation

The Simulator Grid parameters are tweaked as follows:

The Scene Scale is set to 5.0.

The Cell Size is set to 2.0cm.

The Size of the Simulator is set to [X:150cm, Y:140cm, Z: 70cm] as a starting point.

The **Adaptive Grid** is set to **Smoke**. The **Adaptive Grid** allows the container to resize on-demand as the simulation progresses, saving you a lot of time. Instead of calculating a giant grid from the start, the specified channel is tracked (Smoke in this case) and the grid is automatically resized around it.

The **Threshold** is set to **0.002**. The grid will expand when the content of a cell near one of the container walls crosses this value. In this case any Smoke value above 0.002 will cause the grid to expand.

The **Extra Margin** is set to **70**. This is important, because if left at 0, the Adaptive Grid will not expand fast enough and the horse will be running without emitting dust.

The Expand and Don't Shrink is enabled.

The Maximum Expansion is enabled. The limitations are set to [-X/+X: 80/155, -Y/+Y: 950/30, -Z/+Z: 0/50].

Grid						
Scene	Scale		5.0			
Cell Si	ze		2.0	cm		
X 1	500.0cm		150			
Y 1	400.0cm		140			
Z 7	00.0cm		70			
Total	Cells		1	470 0(00	
I	ncrease	Res	oluti	on		
C	ecrease	Res	oluti	ion		
Conta	iner Wal	s				
x	Open					
Y	Open					
z	Open					
_	open					
Con	fine Geo	m		None		
Adapt	ive Grid	Sn	noke			
Thres	hold	0.0	0.002			
Extra	Margin	70	70			
🛩 No	Smaller ⁻	Thar	ı Init	ial Gri	d	
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Y (-)	950 :	; (+	-) 3	0	÷	
Z (-)	0 :	÷ (+) 5	0	+	
Max	Cells		517	'44 00	0	
Shr	ink to Vi	ew	N	lone		
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Disab	led					

The three images here compare the differences between \mbox{Sce} ne \mbox{Scale} values [set from top to bottom to 1, 5 and 10].

The higher the value of the **Scene Scale**, the slower the movement of the fluid would be. This will keep the smoke close to the ground.

The goal here is to make the smoke look like sand, so there is no need to be too diffused or raising high from the ground. At this tutorial the **Scene Scale** is set to **5**, but feel free to experiment with other values as well.



In the Dynamics rollout menu, switch the Smoke Dissipation to 0.2 and the Smoke Buoyancy to 0.6.

The Randomize Amount is given a value of 1.0.

The **Conservation Method** is set to **PCG Symmetric**, with a **Quality** of **100**. The PCG Symmetric method, in general, produces the most interesting smoke simulations, preserving both detail and symmetry. The high Conservation Quality will allow the dust to produce swirling motion. For in-depth information, please check the Conservation documentation.

The Material Transfer (Advection) Method is set to Multi-Pass.

The Steps per frame are set to 2.

Dy	namics				:			
	Motion I	nertia	1.0					
	🛩 Gravity		1.0					
	Time Scale		1.0					
	Cooling		0.05					
	Smoke Diss	ipation	0.2	\$				
	Smoke Buo	yancy	0.6	÷				
	Fuel Buoya	ncy	0.0	÷				
	Vorticity							
	Classic Vor	ticity						
	🗸 Massive	Vorticit	y					
	Smoke Sur	face	0.3					
	Temp. Sur	face	0.0					
	Large Scal	e	1.0					
	Randomize							
	Amount		1.0	÷				
	Dynamics		1.0	÷				
	Conservati	on		٦				
	Method	PCG S.	etric	•				
	Quality		100					
		Density						
	Material Tra	ansfer (/	Advectio	n)				
	Method	Multi-P	ass	•				
	Steps Per F	rame	2	÷				
	Active B	odies	None	Ī				
	Texture UV	W						
	Interpolatio	n	0.0					
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	A-tear Iter	ations						

Compare the difference in the $\mbox{Smoke Buoyancy}$ values displayed in these three images.

The values are set as follows from top to bottom to [$0,\,0.6$ and 1].

The **Smoke Buoyancy** could be even set to a negative value so the dust would subside with time.



The **Smoke Dissipation** parameter controls how fast the smoke will disappear. The maximum value of 1 will make the smoke disappear immediately after it was emitted.

The three images here compare the differences between **Sm** oke Dissipation values [set from top to bottom to 0, 0.2 and 0.7].

You might notice that with values of 0.2 and 0.7 there is a lot less detail in the smoke simulation because as it becomes more transparent, sharp edges and sharp shadows are diminished.



The **Randomize** parameter is responsible for the random fluctuations of the fluid's velocity for each grid voxel.

Top image: value of 0 (default value).

Bottom image: value of 1.

The value of 1.0 is chosen for this parameter in order to break the natural fluid mushroom shapes and puffs and make the result look more chaotic.



Open the Output rollout menu, which holds the controls for the simulation result.

The **Storage Quality** is set to ${\bf 20}$ to prevent artifacts in the simulation due to the cache compression.

Since the Temperature is not used in the scene, the **Tempera ture** Output Grid Channel is **disabled**.

The Smoke Output Channel is enabled.

Enable the **Velocity** Channel, if you'd like to render the simulation with **Motion Blur** or start a **Resimulation**.



Open the Rendering rollout menu to prepare the simulation for rendering.

The **Sampler type** parameter determines the blending method between adjacent grid cells. The sampler is set to **Sp** herical.

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			Render Presets										
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In those two images are compared two different **Sampler types - Spherical** (top) and **Linear** (bottom).

With **Linear** Sampler Type the produced dust looks grainy, so for this tutorial the **Spherical** sampling is used instead. That effectively reduces this issue.



Open the Volumetric Render Settings found by pressing the Volumetric Options button in the Rendering rollout menu.

The Volumetric Render Settings are tweaked as follows:

The Fire's Based on is set to Disabled.

The Smoke Color is Based on Constant color. We aim at a sand-looking smoke, so we use RGB [225, 191, 163] for Constant color, but you can tweak it further.

The External Scatter Mult. is set to 0.3.

The Simple Smoke Opacity is set to 0.7.

The Minimum Visible Opacity is set to 0.0.

The Scale Opacity by Scene Units is disabled.

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		Based on	Disable	d		•						
		Texture					Mo	odulate	Res	et to Def	aults	
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Materials

The main focus in this tutorial is on the simulation, so the materials used for the **Infinite Plane** (ground) and the **Horse mesh** are standard **V-Ray Materials**.

The Diffuse color of the "vray_plane_material" is RGB [197, 135, 93].

All other parameters are left with their default values.

vray_plane_material (VRayMtl) ×							
vray_plane_material							
* Basic parameters	5						
Diffuse							
Roughness	0.0						
Reflect			Max depth				
Glossiness	1.0		Reflect on back sid	e			
 Fresnel reflections 			Dim distance				
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r og manpiler	1.0	Ŧ					
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The **Diffuse** color of the "horse_material" is **RGB [128, 128, 128]**.

All other parameters are left with their default values.

horse_material (V	RayMtl)				х
horse_material						
* Basic parameters	5					
Diffuse						
Roughness	0.0	÷				
Reflect			Max depth			
Glossiness	1.0		Reflect on b	ack side		
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Self-illumination			GI	Mult	1.0	
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Lighting and Camera

The source of illumination in the scene is a single V-Ray Sun.

To add one, go to Create Lights VRaySun.

Set the Intensity multiplier to $\boldsymbol{0.02}.$



For this setup a Standard Physical Camera is used.

The Film / Sensor Preset is set to 35mm (Full Frame).

The Film / Sensor Width is set to 36.0 mm.

The Focal Length is set to 40.0.

The Aperture is set to 5.0.

The Film Speed (ISO) is set to 100.

The Shutter Duration is set to 1000.0.

The exact position of the Camera is [-1730cm, -3785cm, 907cm]

and of the Camera Target is [179.267cm, -2317.455cm, 36.06cm].

* Basic							
Targeted							
Target Distance:	2560.767cm \$						
Viewport Display							
Show Cone: \	When Selected 🔹						
Show Horizon Line							
* Physical Camera							
Film / Sensor							
Preset: 35mm (Fi	ull Frame) 🔹 🔻						
Width:	36.0 ‡ mm						
Lens							
Focal Length:	40.0 ‡ mm						
Specify FOV:							
Zoom:	1.0 ‡ X						
Aperture: f/	5.0 \$						
Focus							
Use Target Distar	nce						
Custom							
Focus Distance:							
Lens Breathing:	1.0 \$						
Enable Depth of Field							
Shutter							
Type: 1 / secon	ds 🔻						
Duration: 1/	1000.0 ‡ s						
Offset: 1/							
Enable Motion Blur							

Render Settings

In the previous steps, when setting the dust/smoke simulation we used the shelled plane.

As we don't need this plane to be rendered in the final image - select the plane, right-click it and go to its **Object Properties** menu. Disable the **Renderable** and enable **Display as Box** options.

Object Properties	? ×
General Adv. Lighting User Defined	
Object Information	
Name: Plane001	
Dimensions: X: 2793.0cm Material Nam Y: 6225.0cm Layer: Z: 1.0cm Vertices: 50 Parent: Faces: 96 Num. Childre 0 In Group/Ass	ne: Material #3 0 (default) Scene Root o sembly: None
Interactivity Hide Freeze	Rendering Control Visibility: 1.0 Renderable
Display Properties See-Through By Object V Display as Box Backface Cull Edges Only Vertex Ticks Motion Path Ignore Extents Show Frozen in Gray Never Degrade Vertex Channel Display Vertex Color Shaded Map Channel: 1	 Inherit Visibility Visible to Camera Visible to Reflection/Refraction Receive Shadows Cast Shadows Apply Atmospherics Render Occluded Objects G-Buffer Object ID:
	OK Cancel

In the final render a **Probabilistic Shading is used. The** option is located in Environment Atmosphere PhoenixF D Atmosphere Settings. When Use Probabilistic Shading i s enabled, the volumetrics will select a only few samples (based on the smoke density) along each camera ray, and evaluate the volume lighting at those points. In some situations this will make the render time shorter.

The Use Probabilistic Shading is enabled.

All parameters are left with their default values.

* PhoenixFD Atmosphere settings		
Gamma Correction	1.0	¢
Export and Render in V-Ray GPU as VRayVolumeGrid		
✓ Use Probabilistic Shading		
Samples	20	\$
GI Samples		

In the Render Setup Tab:

The Image Sampler Type is set to Bucket.

The Min Subdivs are set to 1.

The Max Subdivs are set to 6.

The Bucket width is set to 24.0.

The Noise threshold is set to 0.005.

* Image sampler (Antialiasing)							
Туре	Bucket					Default	?
Render m	ask	None					
▶ Image	filter						
* Bucket image sampler							
Min subdiv	/S		¢				
🖌 Max su	bdivs		¢	Bucket width		24.0	¢
Noise thre	shold	0.005		Bucket height	L		

A V-Ray Denoiser Render Element is added to the final image. The Denoiser takes an existing render and applies a denoising operation to it after the image is completely rendered in order to remove the noise in the image.

For this tutorial the **Custom** preset is used.

The strength is set to 0.5.

The radius is set to 10.0.



Final Results



