3ds Max CLOUD tutorial

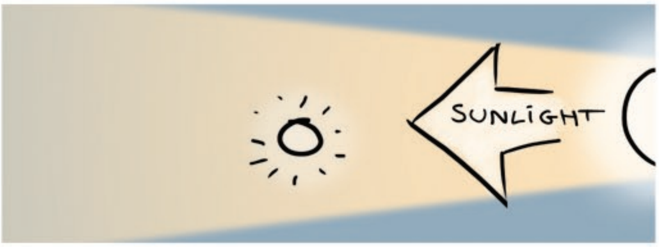
Faking ray-marching using gradients and distance-based lighting

In this tutorial you will learn to create a fly-through of a realistic cloud tunnel that renders relatively fast, using 3D Studio Max with no plugins or 3rd party renderers.

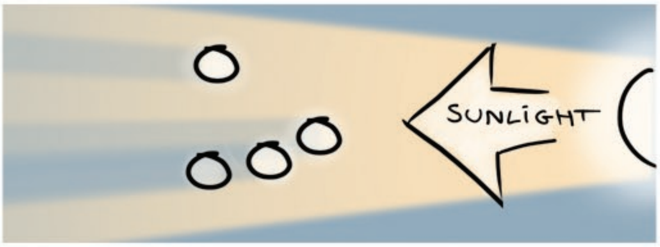
But first, a little theory... the rest of the tut is based on this, so no fair skipping ahead!

The problem of ray-marching and volumetrics

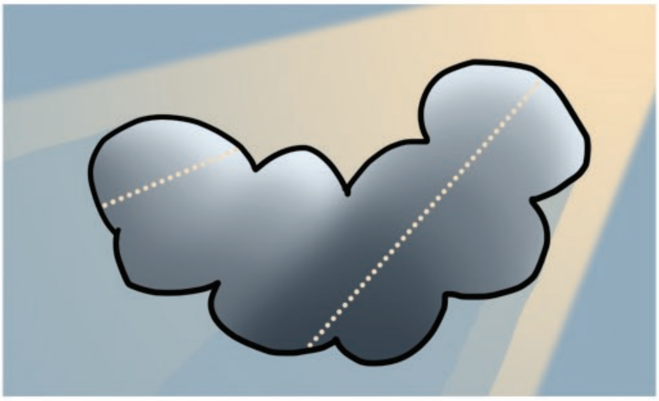
The basic physics of light moving through a gaseous cloud has nothing to do with traditional polygon lighting, and therein lies the main challenge when rendering clouds.



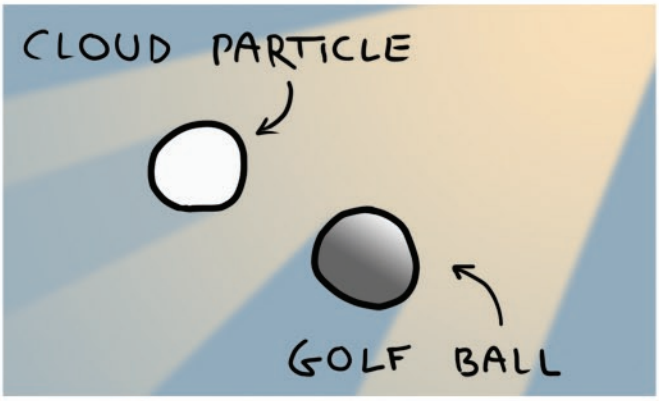
Cloud particles are translucent, and will be visible from all sides when illuminated.



However, light decays in strength as it passes through.



This will make the backside of a cloud illuminated only by how far through the cloud the sunlight has travelled.

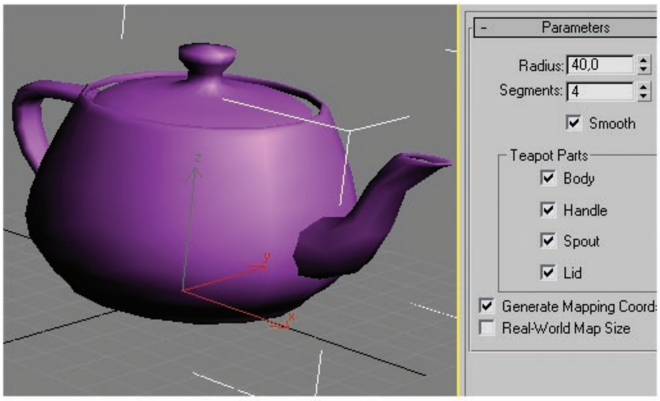


Note that the angle of a cloud particle's surface is completely irrelevant, contrary to "normal" polygon lighting.

We will now move on, knowing that the photorealistic look of a cloud is dependant on decaying, non-polygon lighting.

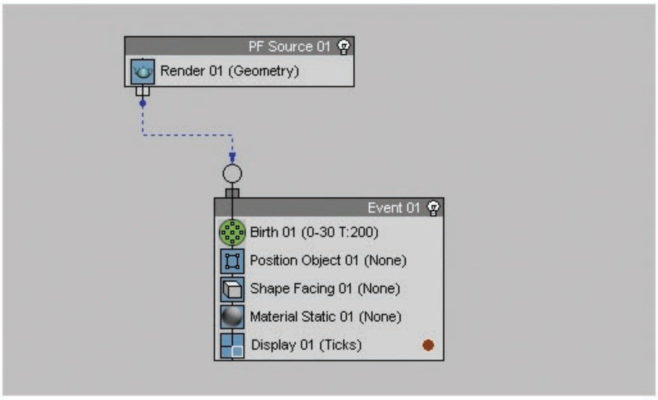
1. The cotton teapot

Before moving onto a larger cloud formation, we'll take the theory from above and apply it to a simple shape.



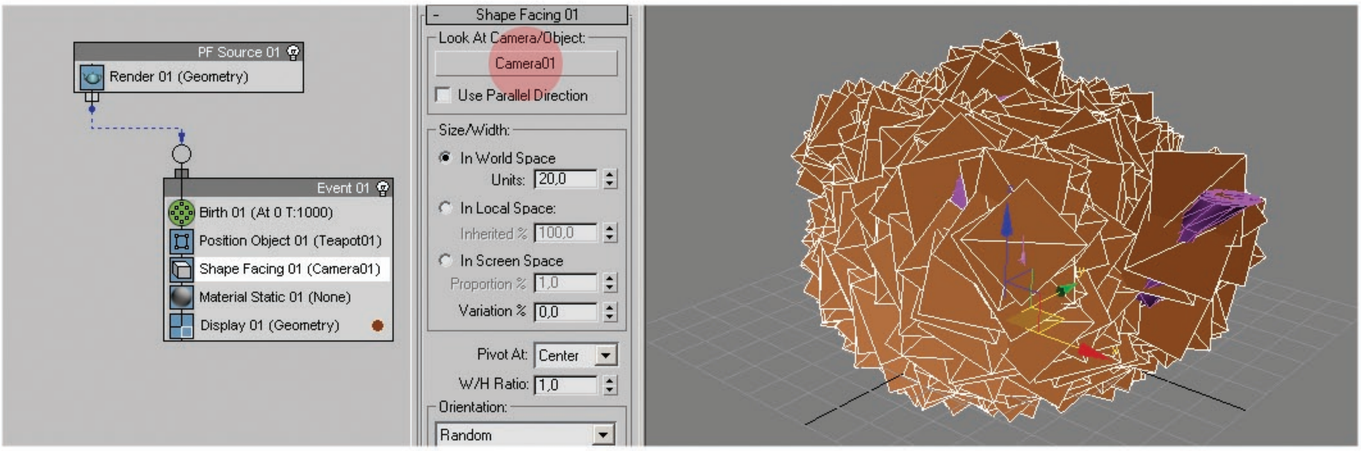
Parameters
Radius: 40,0
Segments: 4
☑ Smooth
Teapot Parts
☑ Body
☑ Handle
☑ Spout
☑ Lid
☑ Generate Mapping Coords
☐ Real-World Map Size

1.1. Create a teapot with a radius of 40 in the Perspective viewport. Right-click, choose **Properties**, and de-select "Renderable". Press CTRL+C to create a camera in the viewport.



PF Source 01
Render 01 (Geometry)
Event 01
Birth 01 (0-30 T:200)
Position Object 01 (None)
Shape Facing 01 (None)
Material Static 01 (None)
Display 01 (Ticks)

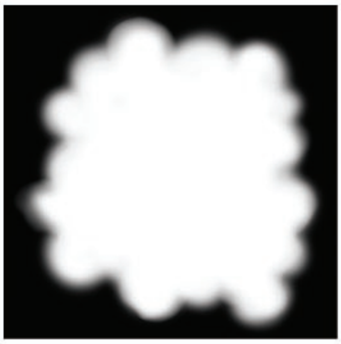
1.2. Press "6" to open Particle View. Create a flow with a Birth event, Position Object, Shape Facing and Material Static.



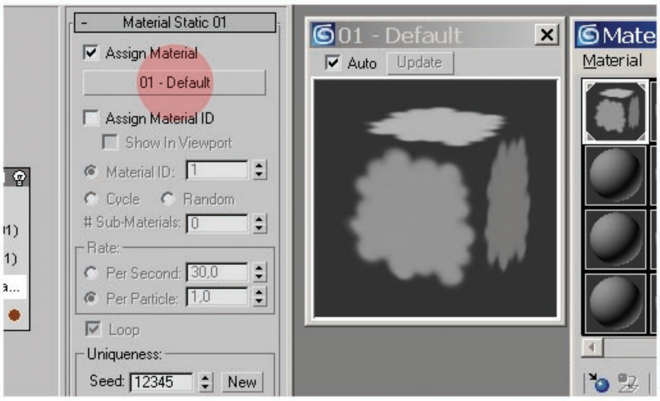
PF Source 01
Render 01 (Geometry)
Event 01
Birth 01 (At 0 T:1000)
Position Object 01 (Teapot01)
Shape Facing 01 (Camera01)
Material Static 01 (None)
Display 01 (Geometry)

Shape Facing 01
Look At Camera/Object: Camera01
☐ Use Parallel Direction
Size/Width:
● In World Space
Units: 20,0
○ In Local Space:
Inherited % 100,0
○ In Screen Space
Proportion % 1,0
Variation % 0,0
Pivot At: Center
W/H Ratio: 1,0
Orientation: Random

1.3. In the **Birth** Event, set **Emit Stop** to 0, and **Amount** to 1000. In **Position Object**, select the teapot as Emitter Object. In **Shape Facing**, select the camera in the scene as Lookat Object, set **Size** to 20 and select **Random orientation**. In the **Display** event, set **Type** to
Geometry.

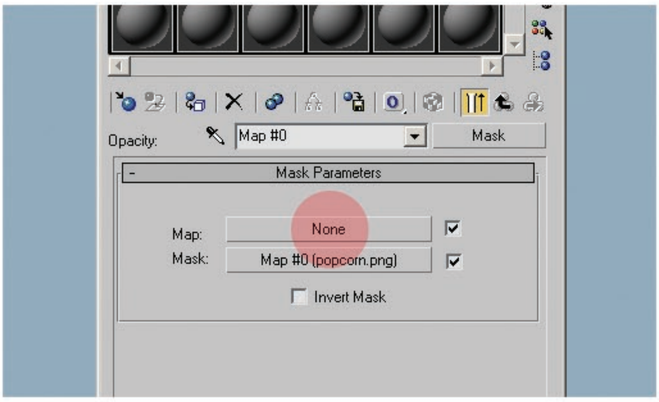


1.4. Now, in your favorite paint program, use a **soft brush** to make a popcorn shaped blob that looks something like this. Make sure it's white on black background.



Material Static 01
☑ Assign Material
01 - Default
☐ Assign Material ID
☐ Show In Viewport
● Material ID: 1
○ Cycle ○ Random
Sub-Materials: 0
Rate:
○ Per Second: 30,0
● Per Particle: 1,0
☑ Loop
Uniqueness:
Seed: 12345 New

1.5. In 3ds Max, create a material with a **solid white color**, that uses your popcorn image as **Opacity Map**. Drag this to the Material Static event in the Particle View.



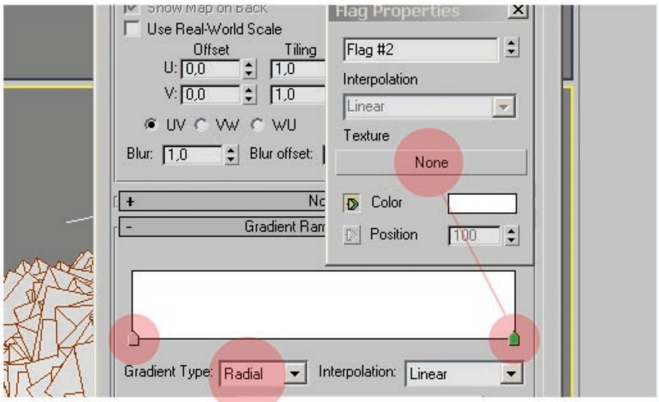
Opacity: Map #0

Map: None ☑

Mask: Map #0 (popcorn.png) ☑

☐ Invert Mask

1.6. In the Material Editor, make sure the popcorn map is open. Click on “Bitmap”, and select **Mask** from the Map Browser. Choose “Keep old map as sub-map” in the “Replace Map” dialog. In the new Mask material, your popcorn map is set as Map, so drag that do the Mask slot, and choose “Swap”.



☐ Use Real-World Scale

	Offset	Tiling
U:	0,0	1,0
V:	0,0	1,0

● UV ○ VW ○ WU

Blur: 1,0 Blur offset:

Flag #2

Interpolation: Linear

Texture: None

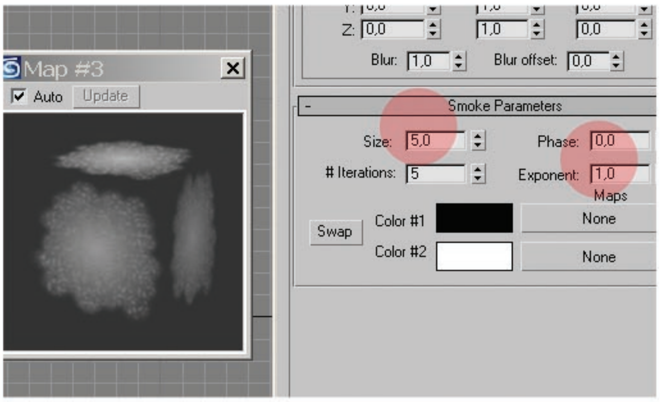
Color

Position: 100

Gradient Type: Radial

Interpolation: Linear

1.7. Click the Map slot, and choose **Gradient Ramp** from the Map Browser. Set Gradient Type to **Radial**. Right-click the left flag, choose “Edit properties” and change the color from black to white, right-click the center flag and choose “Delete”, and right-click the right flag and choose “Edit properties”.



☑ Auto

Z: 0,0 1,0 0,0

Blur: 1,0 Blur offset: 0,0

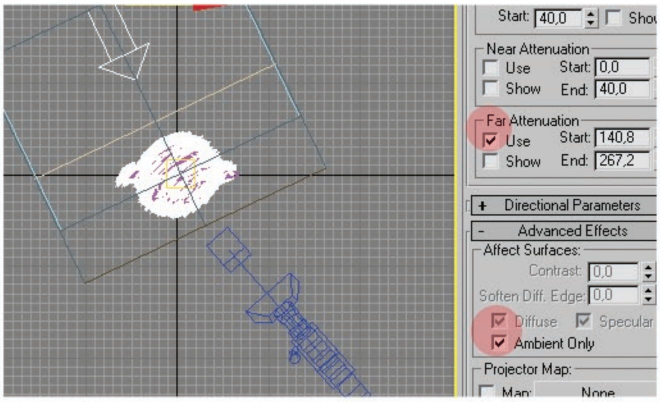
Size: 5,0 Phase: 0,0

Iterations: 5 Exponent: 1,0

Color #1 None

Color #2 None

1.8. Press the None slot to open the Map Browser and choose **Smoke**. In the Smoke Map settings, enter Size 5, and Exponent 1.



Start: 40,0 ☐ Show

Near Attenuation: ☐ Use Start: 0,0 ☐ Show End: 40,0

Far Attenuation: ☑ Use Start: 140,8 ☐ Show End: 267,2

Contrast: 0,0

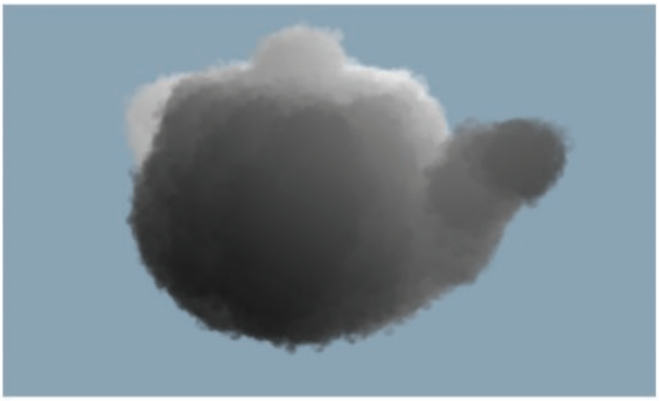
Soften Diff. Edge: 0,0

☑ Diffuse ☑ Specular

☑ Ambient Only

☐ Map: None

1.9. Create a **Target Direct** light in the top viewport, so it lights the teapot from behind, and place the target in the center of the teapot. On the light’s “Intensity...” rollout, activate **Use Far Attenuation**, and adjust the Near and Far values so the range covers the whole teapot ***and*** the particles. Under Directional Parameters, adjust the **Hotspot/Beam** so all the particles are covered. Now for the magic: in the light’s Advanced Settings rollout, click “**Ambient Only**”. This will make the light ignore the polygons’ angles, which is exactly what we want.



1.10. Render that out to see the fluffiest teapot!
(hint: switch to Mental Ray to double render speed)

What we’ve done here is fake ray-marching. The fake part is that we ignore how far the light has travelled inside the cloud, and instead concentrate only on how far the light travels in space. For our purposes, it’s close enough.

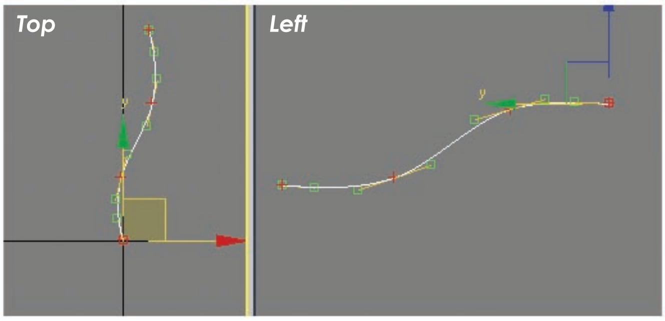
2. Flight path

First, we'll create a camera that chases an airplane through a tunnel. Later, we'll turn that tunnel into clouds. If you think you've already spent too many hours of your life creating tunnel effects, move onto chapter 3, but skim chapter 2 to make a note of the dimensions used.

2.1. Delete the teapot and the light from before, but keep the camera, particle system and the material.

2.2. Create an s-shaped spline like this, using four bezier points. Note the shape in the Top and Left viewports. Be careful with the bezier handles – no sharp corners! And since we don't want any jittering in the camera, increase the interpolation to 20, and de-check Optimize. *(actually, we* ***do*** *want jittering, but not this kind... more on this later!)*

2.3. The first point in my curve is at 0,0,0, and the last is at 50,400,-100. This isn't crucial, but the closer your scale is to this, the easier it will be to match the sizes of particles and procedural maps later in the tutorial.

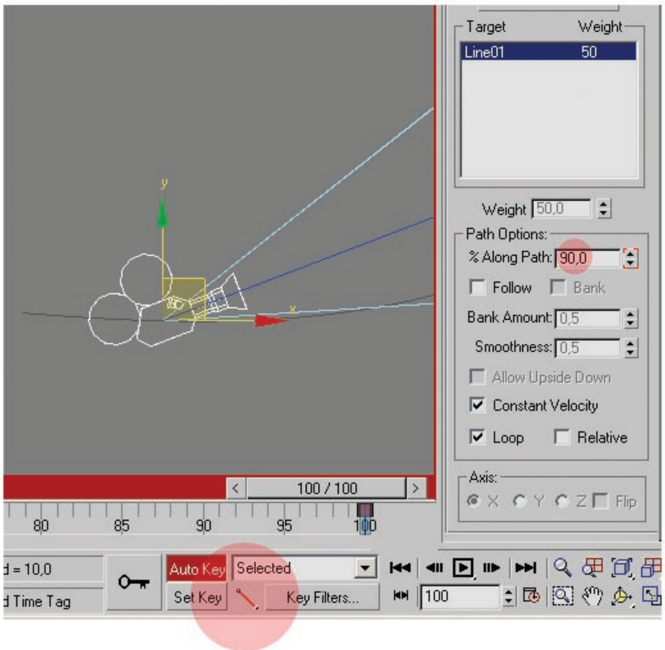


2.4. Select the camera, and add a Path Constraint by going to the Motion rollout, expand the Assign Controller rollout, click Position, click Assign controller and double-click Path Constraint.

2.5. In the Path Parameters rollout, click Add Path and click the spline in a viewport. Now the camera follows the length of the path during the whole length of the animation, but we want it to have a distance to the camera target, so go to the final frame, activate Auto Key, set the Default Tangent to linear, and type in 90% in the %Along Path field.

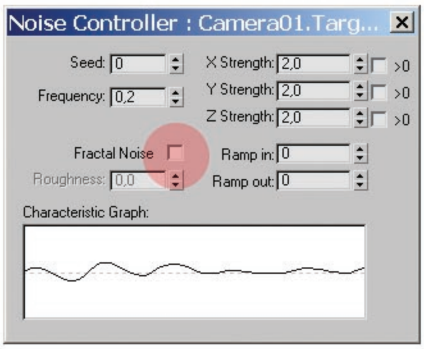
2.6. Create a dummy, and add a Path Constraint to make it follow the same spline, but now (with Auto Key on) go to frame 0 and type in 10% in the %Along Path field. Turn off Auto Key.

2.7. Align the camera target to the dummy, and then link the camera target to the dummy. Play the animation, and double check that you now have a nice animation of a camera following the camera target at a constant distance.

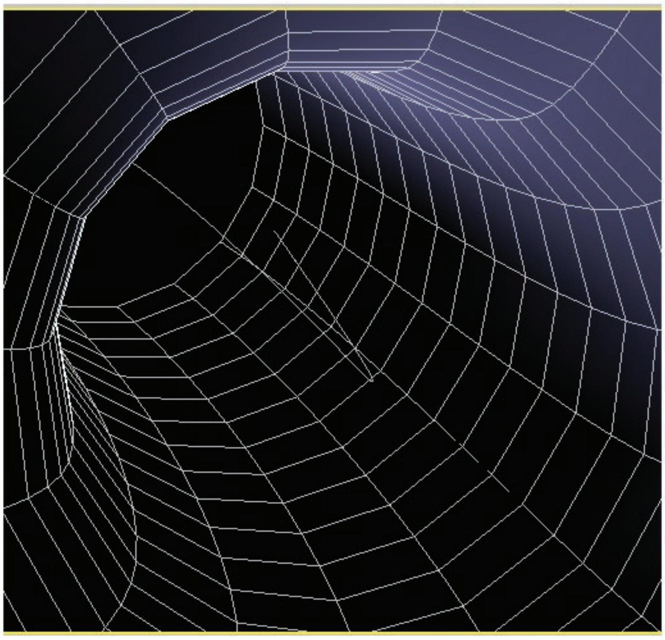


Target Weight
Line01 50
Weight: 50,0
% Along Path: 90,0
☐ Follow ☐ Bank
Bank Amount: 0,5
Smoothness: 0,5
☐ Allow Upside Down
☑ Constant Velocity
☑ Loop ☐ Relative
Axis: ● X ○ Y ○ Z ☐ Flip
Selected
100

2.8. Why use the dummy and not apply the Path Constraint directly to the camera target? Remember that jittering we were talking about? Select the camera target, and assign the Noise Position controller to it, instead of the Path Constraint. In the Noise Controller dialog, de-select Fractal Noise, enter 0,2 as Frequency, and 2,0 as X, Y and Z Strength. This gives a nice turbulent bounce to the camera.



Noise Controller : Camera01.Targ...
Seed: 0
Frequency: 0,2
X Strength: 2,0 ☐ >0
Y Strength: 2,0 ☐ >0
Z Strength: 2,0 ☐ >0
Fractal Noise ☐
Roughness: 0,0
Ramp in: 0
Ramp out: 0



2.9. Create a cylinder with Radius 45, Height 440, Height Segments 40, Sides 15, and align it to the path (position and rotation) using the Align tool. Right-click the cylinder, go to Properties and de-select Renderable. Also, make sure the cylinder's Backface Cull is turned **off**.

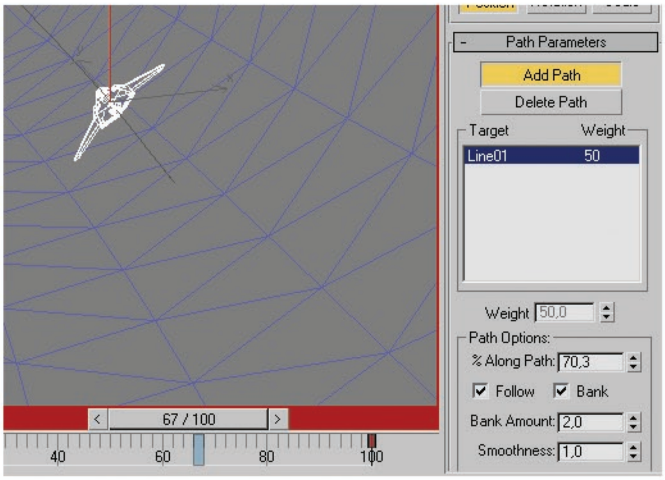
2.10. In the Modify panel, open the Modifier rollout, and select PathDeform (WSM). It's very imortant that you choose the World-Space Modifier version (WSM), and not just the normal PathDeform. Select the path.

2.11. Now you can see the cylinder stretching along the path. If your path coordinates deviated radically from the ones I described earlier, you will need to adjust your cylinder's Length, Radius etc. Play the animation in the camera viewport, and it should look something like a tunnel effect from an Amiga demo, but without the plasma!

2.12. For an extra touch, add a banking effect to the camera: set Default Tangents to auto, activate Auto Key, select the camera, and press F12. Go to frame 25, and set Roll to -25. Go to frame 75 and set Roll to 25. Go to frame 100 and set Roll to 0.

2.13. If you want, now is the time to merge your favourite aircraft model into the scene, and add the same Path Constraint once more. Again, go to frame 0 and set the "%Along Path" to 10. Activate Follow and Bank, set the Bank Amount to 2, and the Smoothness to 1.

2.14. Also, load in a standard environment map, for instance, CHROMBLU.JPG from the Max library *(not that we'll be seing a lot of background, but it's better than black)*



Target	Weight
Line01	50

Weight: 50,0

Path Options:

% Along Path: 70,3

☑ Follow ☑ Bank

Bank Amount: 2,0

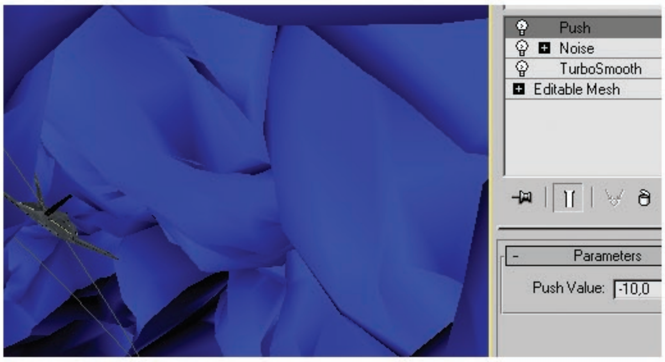
Smoothness: 1,0

Enough with the flying lessons! Let's make clouds!

3. Cloud tunnel

3.1. Collapse the tunnel (Cylinder01), add a TurboSmooth modifier, and set Iterations to 2. Then add a Noise modifier on top. Set the Noise Scale to 40, activate Fractal, set Iterations to 2, and set X, Y and Z Strength to 40.

3.2. Add a Push modifier and set it to -10 to make the walls bulge out in round shapes (if you think the polys are moving in the wrong direction when you use the Push modifier, keep in mind that we are watching the inside of a cylinder, and all the polys are backfacing).



Push Value: -10,0

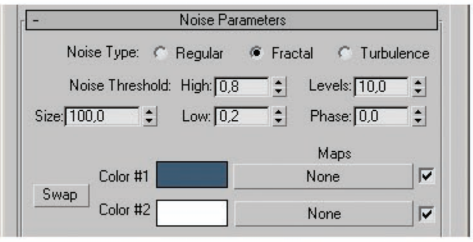
The cylinder is now a representation of where the clouds will be.

3.3. Press “6” to open the Particle View. Change the Amount to 2000, and select Cylinder01 in Position Object. Your tunnel should now be populated with billboard particles. Make a test render of that, to see how you’re doing.

Not bad, but we’re still using traditional lighting, based on polygon angles - that’s the only reason for the grey shades you can see in the render. This isn’t a liable solution, because when the billboards turn to follow the camera, their angle relative to the light source will change, and so will their brightness.

3.4. But before we begin lighting the cloud tunnel, let’s work on the color. We can’t apply any polygon-mapped texture, but we can make large chunks of color variation. In the cloud material, click the Diffuse Color slot, and select Noise from the Map Browser.

3.5. Choose Fractal, High=0,8 Low=0,2 Levels=10 and Size=100. Instead of black, use 60, 90, 115. Turn the cloud material’s Self-illumination up to 100, and render.



Noise Parameters

Noise Type: ○ Regular ● Fractal ○ Turbulence

Noise Threshold: High: 0,8 Levels: 10,0

Size: 100,0 Low: 0,2 Phase: 0,0

Maps

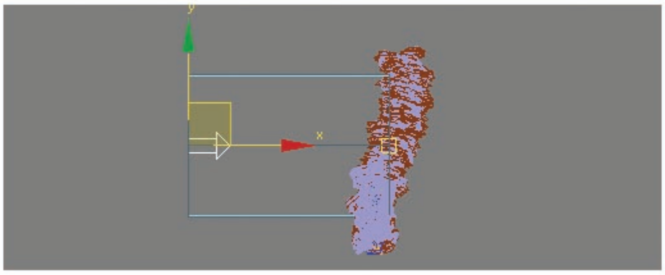
Swap Color #1 None ☑

Color #2 None ☑

What we have created is a large world-space texture variation. The reason we can’t use polygon-mapped bitmap textures with billboard particles is that when they turn to follow the camera, they will intersect in and out of each other, and the textures will “pop” in and out. **But with a world-space texture, two intersecting polygons are guaranteed to have the exact same color information at the intersection point, so the intersection is invisible.**

(Technically, world-space textures aren’t perfect either, because when the billboards turn, their surface will move through the world-space texture information, and the texture will appear to “crawl” over the surface. But with a pattern this large, it’s not a problem)

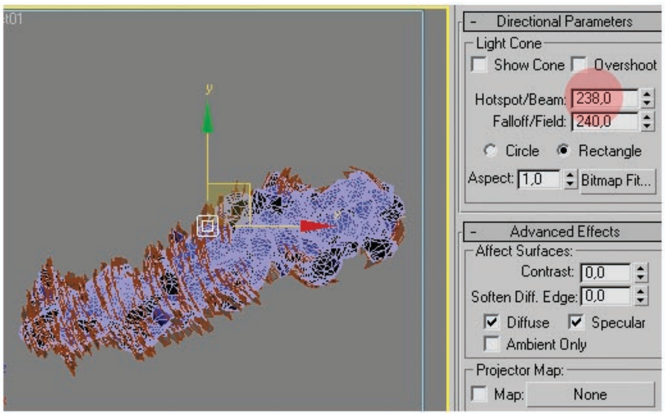
3.6. In the top viewport, create a Target Direct light that lights the cloud tunnel from the side.



3.7. Right-click Top -> Views -> Direct01 to see the scene from the light source's point of view. Under Directional Parameters, adjust the Hotspot/Beam until the particles are totally visible from the light source.

3.8. Render the scene from the light's point of view. Save the image, and load it into your favourite painting program.

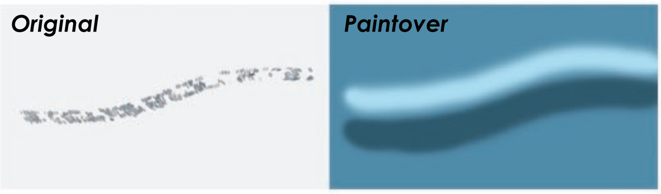
Your particles will propably look all flat and weird because they're pointed at the camera and not the light source, but that's OK.



☐ Show Cone ☐ Overshoot
Hotspot/Beam: 238,0
Falloff/Field: 240,0
○ Circle ● Rectangle
Aspect: 1,0
Affect Surfaces:
Contrast: 0,0
Soften Diff. Edge: 0,0
☑ Diffuse ☑ Specular
☐ Ambient Only
Projector Map:
☐ Map: None

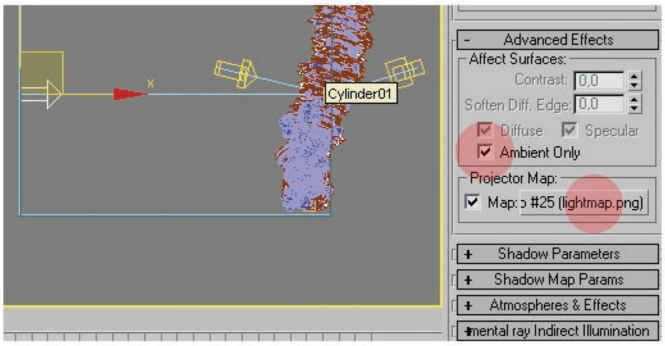
3.9. In the paint program, paint over the particles so they get covered with a gradient like this, and save the image. The idea is that anywhere in the cylinder, the cloud particles will have a gradient from top to bottom. We're faking ray-marching of light coming from the top.

I have used **170, 220, 240** for the bright color, **50, 90,110** for the dark color, and **80, 140, 170** as the background base.



3.10. Back in 3ds Max, click the Map slot in the light's Projector Map rollout, and choose your paintover image. Remember to check "Ambient Only"!

3.11. NOTE: the purpose of this light source is to illuminate this particular cloud and nothing else, so if you have an aircraft in the scene, go to the light's **Include** list and add your cloud Particle Event, which is propably called "PF Source 01->Event 01". Then you're going to have to add new lights to light up your aircraft, so go ahead and add the same Particle Event to those lights' **Exclude** list.

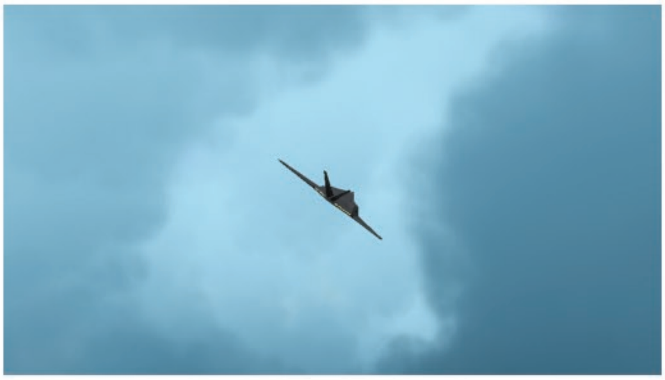


Affect Surfaces:
Contrast: 0,0
Soften Diff. Edge: 0,0
☑ Diffuse ☑ Specular
☑ Ambient Only
Projector Map:
☑ Map: p #25 (lightmap.png)

3.12. Now it's time to test the light. Go to the cloud material and turn the **Self-illumination** to 0, and turn off the Noise Map in the Diffuse Color slot. Render!

(note: the first few frames might have particles right up in the camera because of the capped ends of the emitter cylinder, so delete those faces on the cylinder, or go forwards to a more interesting frame)

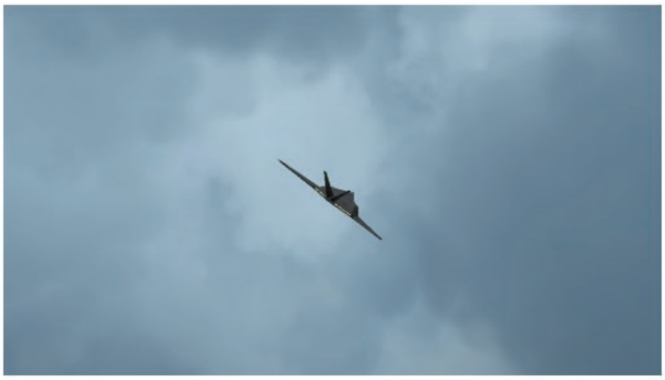
We're almost there! Now all we have to do is combine the world-space noise map with our light gradient.



3.13. Set Self-illumination to 50, and re-activate the Noise Map in the Diffuse Color slot. Render again! You're done!

If you will, adjust the Self-illumination and the Diffuse Map's Amount slider to blend between the Noise Map and the gradient light source.

Now render the whole animation while you make a pot of coffee...

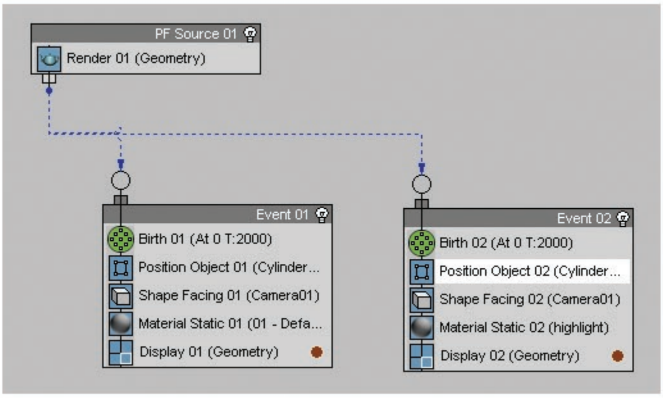


4. Highlights on the sunny side

Remember that rimlight/halo look that clouds get when they're backlit? So far we've seen nothing like that in this tutorial, but there is a cheap and dirty way to fake it. Stay with me.

4.1. Copy the emitter (Cylinder01) in the Top viewport, and move the copy just a few units North.

4.2. Press "6" to open Particle View, and create a copy of Event 01.

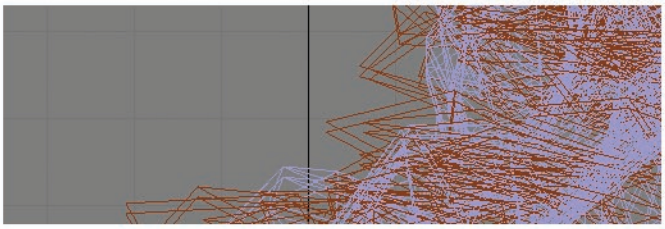


PF Source 01
Render 01 (Geometry)

Event 01
Birth 01 (At 0 T:2000)
Position Object 01 (Cylinder...
Shape Facing 01 (Camera01)
Material Static 01 (01 - Defa...
Display 01 (Geometry)

Event 02
Birth 02 (At 0 T:2000)
Position Object 02 (Cylinder...
Shape Facing 02 (Camera01)
Material Static 02 (highlight)
Display 02 (Geometry)

4.3. In Event 02, change the Position Object to Cylinder02. You should see the double particles in the Top viewport like this. This should also warn you that the particle count has doubled, so prepare for slower renders...

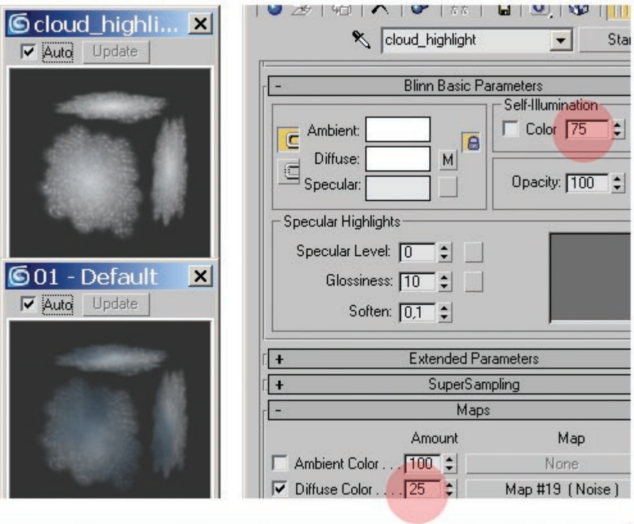


4.4. Press "M" to open the Material Editor, and create a copy of the cloud material. Name this "cloud_highlight".

Change the Self-illumination to 75, and change the Diffuse Map's Amount slider to 25. This will make the highlight material brighter and more self-illuminated than the rest of the clouds, which is exactly what we want.

You can further enhance the effect by lowering the original cloud material's Self-illumination.

4.5. Drag the "cloud_highlight" material to Event 02's Material Static slot.



cloud_highlight

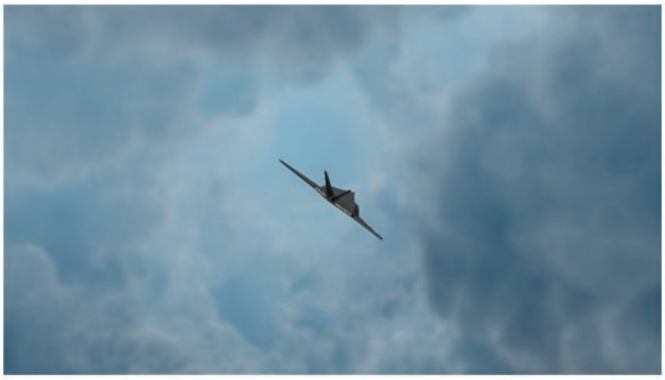
Self-Illumination
☐ Color 75

Opacity: 100

Specular Highlights
Specular Level: 0
Glossiness: 10
Soften: 0,1

☐ Ambient Color . . . 100 None
☑ Diffuse Color . . . 25 Map #19 (Noise)

4.6. Render again to see the new look. At first glance, it may seem much better, but remember the disadvantages about textures and intersecting billboards? They'll start showing, once you render the whole animation.



THE END

That's it, I hope it's been informative. If you found this tutorial useful, please stop by my CGSociety portfolio or website:

http://jussing.cgsociety.org/guestbook/
http://www.duck.dk/

- Jonas