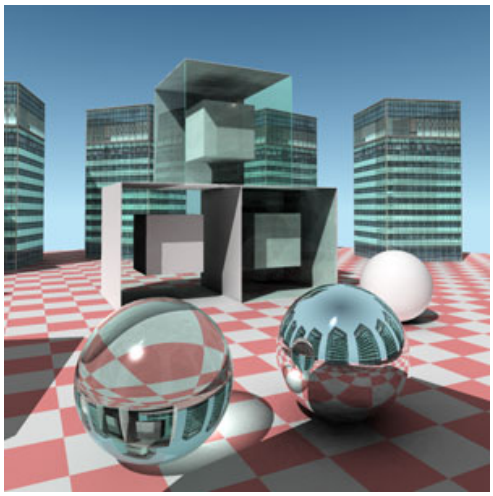
IBL/GI & GLASS

Getting Realistic Results

By Yon Resch

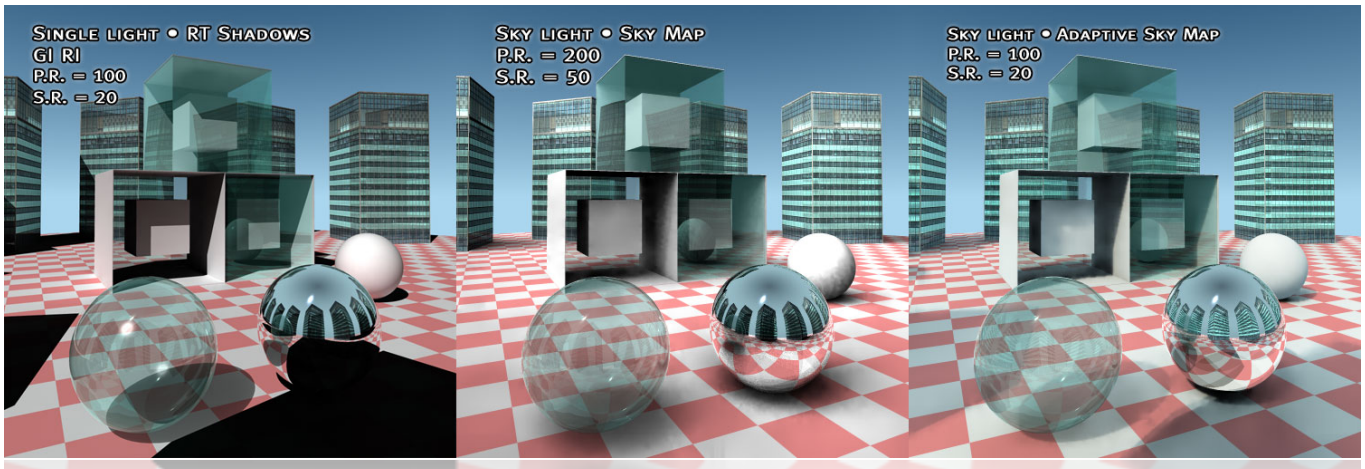


Glass and other transparent materials are some of the hardest materials to render realistically. This has mainly to do with the number of additional attributes that glass has. Transparency, reflection, refraction and caustics can be very touchy variables. They sometimes mix in unexpected ways. Add ***Image Based Lighting*** (IBL) or ***Global Illumination*** (GI) and there are a lot of variables that may or may not give you what you are after.

In order to show you what's at your disposal I'm going to break each piece apart and show you what these variables might do. Skip through the headings below to see what interests you.

The Three Types of GI lighting and Glass

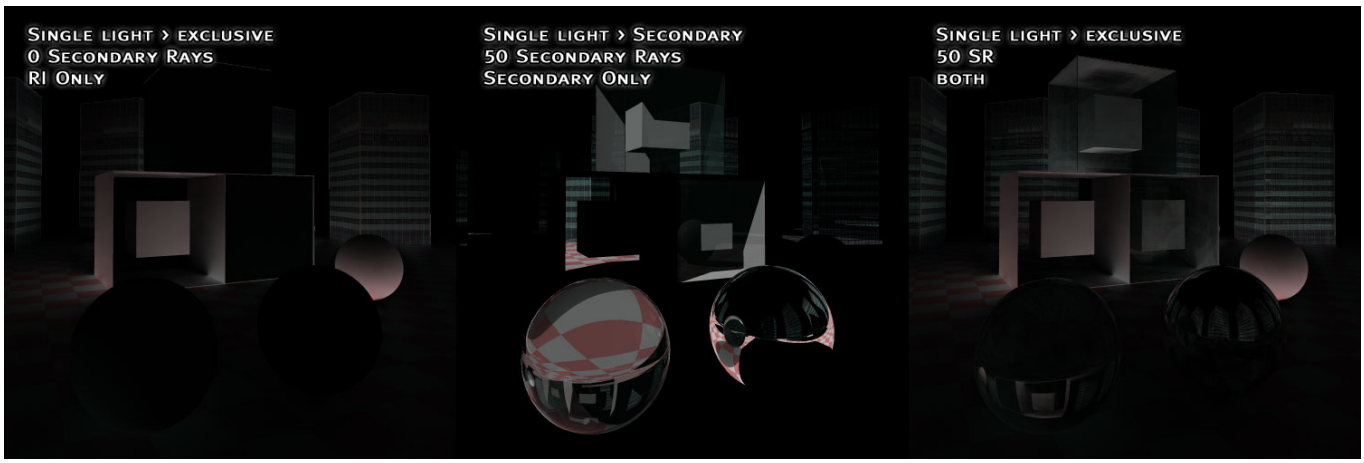
Three main ways to implement GI: Standard ***lights with Reverse Illumination*** (RI), GI ***Sky Lights*** (GISL) with either ***Color Maps*** (Color) or ***Sky Maps*** (SM), and ***GI Sky Lights with Adaptive Sky Maps*** (ASM).



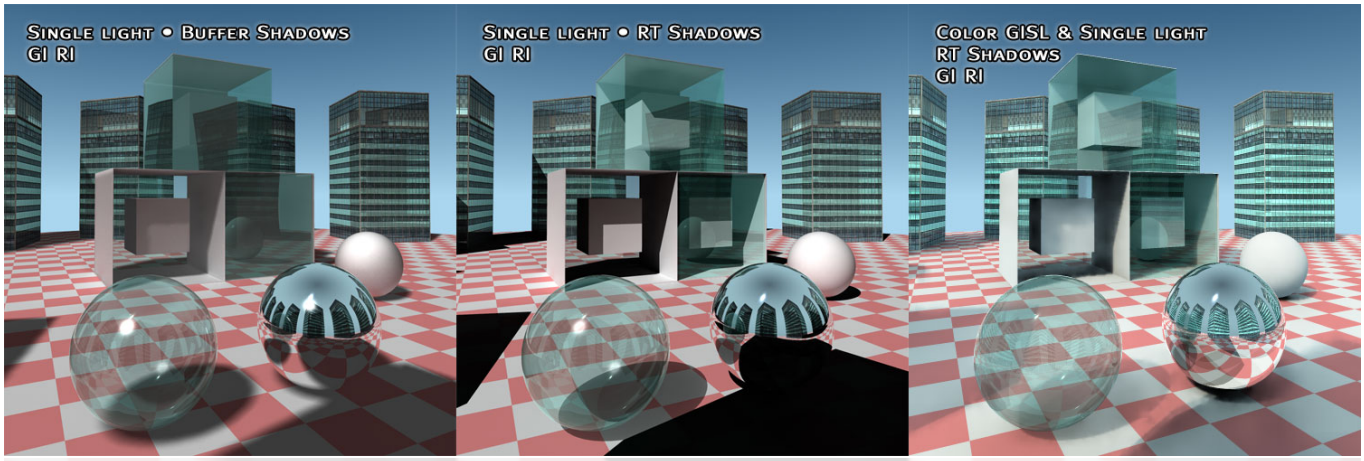
Above, notice how crisp the shadow in the first are, the ASM could approach this if the ray count is made high enough.

Standard Lights with RI

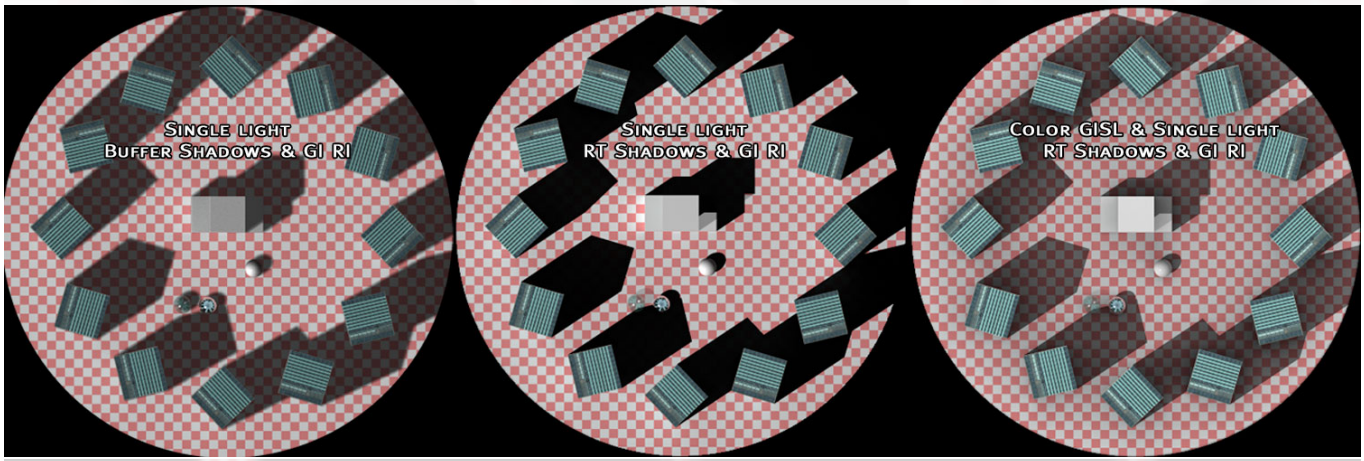
The Standard light (e.g. spot, parallel, radial, etc) can produce GI light in two ways. The first is through ***Reverse Illumination***, which is bounced light. The second method is to switch your light to GI Secondary only (you'll need to have secondary rays enabled in the GI Info Window). Secondary Rays are only apparent in reflections and refractions.



Above, the effect of RI and Secondary GI. The Secondary only looks brighter due to the special way those lights render. See below.

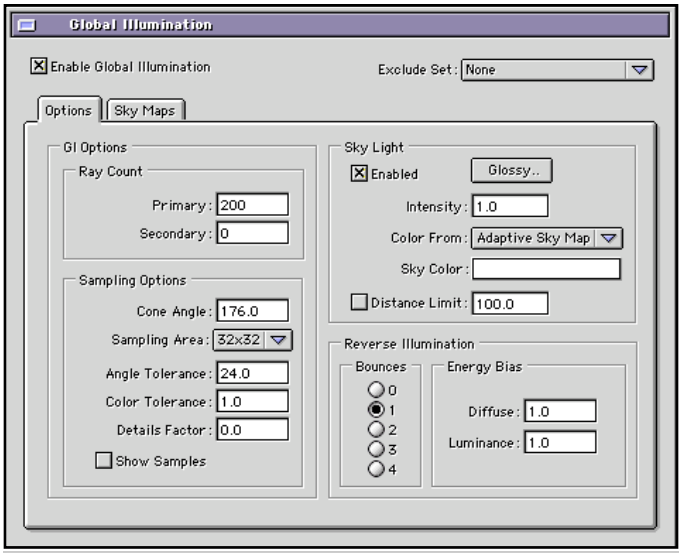


Above and below, the results of GI enabled Standard lights. Sky Light is required to soften RT shadows. RI doesn't get you there.



Primary Vs Secondary Rays

This can be confusing, especially with lights and rays sharing names. So let's look at it more closely, starting with the rays, which the lights cast. ***Primary Rays are Reverse Illumination***, also know as bounced light. I know what you're thinking, 'if it bounced wouldn't it be a secondary ray?' Nope, Primary is the bounce. You can set the number of bounces in the *GI Info tab › Reverse Illumination*. You set the number of rays that are calculated for under *Ray Count › Primary*. The more rays the less noise, and the longer it takes to calculate the scene.

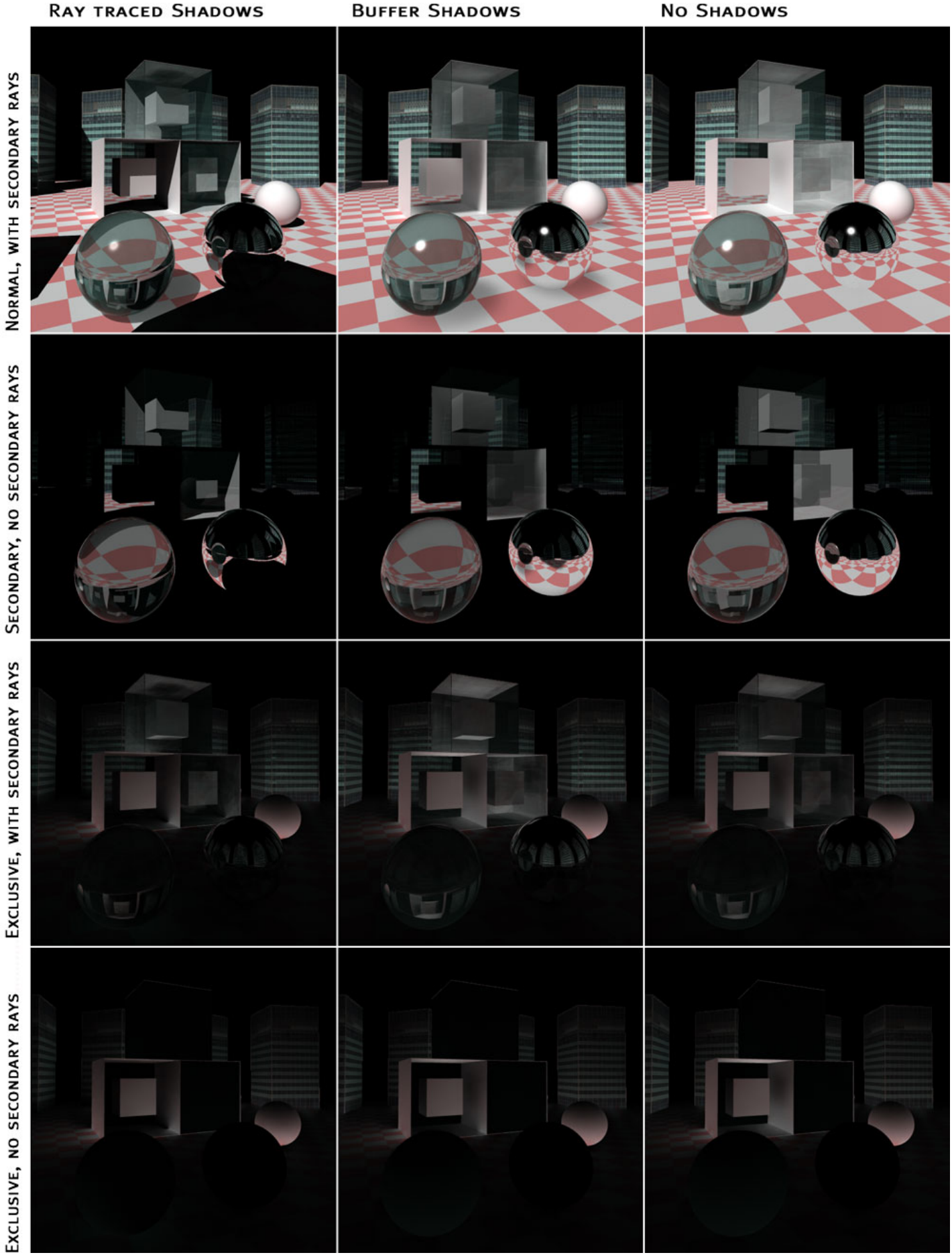


Secondary Rays are the returning rays, as seen in reflections and refractions. They have no effect on a scene without reflections or refraction enabled, except to slow the rendering down. Increasing secondary rays *GI Info › Ray Count › Secondary* will reduce the noise you see in reflections and refractions, not make them brighter (Lights set to secondary can make them brighter, see below). Brightness is a factor of the lights which illuminate your seen, and the reflective/refractive qualities of your materials.

Normal vs Exclusive vs Secondary Lights

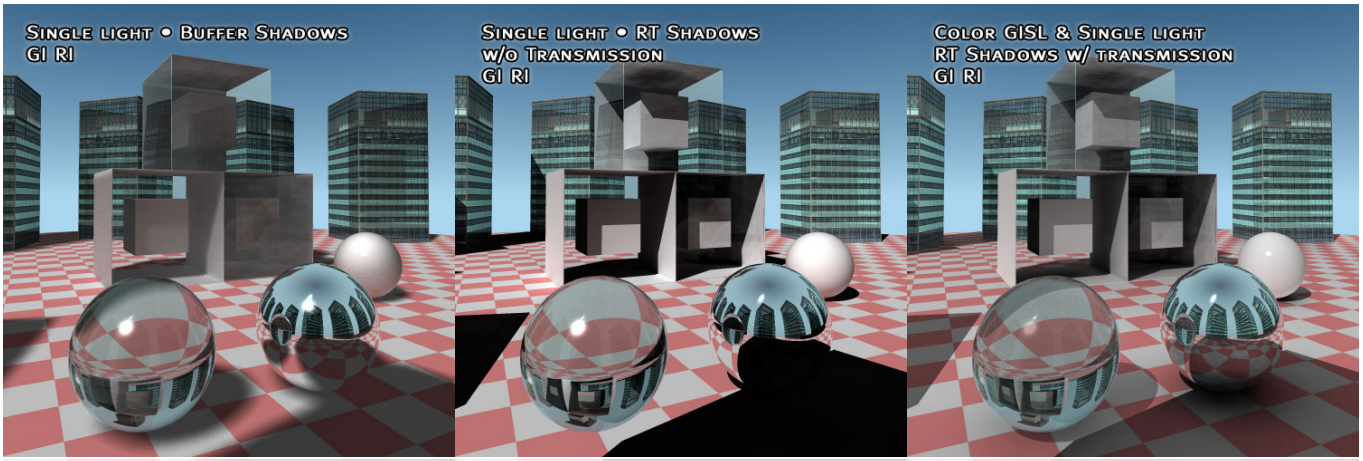
When setting up standard lights, you can chose how they react when GI is on. ***Normal*** is the default, and in this mode your light illuminates as without GI **and** it also follows all of the GI settings for Ray Count and RI. ***Ignore*** *mode*, ignores all GI settings and illuminates without GI. ***Exclusive*** only takes the GI settings into account and ignores standard illumination . Finally ***Secondary***, works through Reverse Illumination and the standard light settings, in order to create what GI Secondary Rays would, without GI Secondary Ray Count being considered, e.g. it GI SRC can = 0. A light in Secondary mode is cast with a phong model, and the shadows are cast as the light has them set. Pretty cool.

Remember, the standard light settings (shadow, caustics, and light type, etc) take effect in all of the GI light settings. They do not always react as you might expect. For example the glass appears opaque in the ***Exclusive, no Secondary*** row below, because it has Ray Traced Transparency. Without the secondary rays enabled, the light doesn't come **back** through the glass, and therefore appears black. If you turn off the RT Transparency the light comes back. Notice that is not a problem in the ***Secondary, no Secondary Rays*** row.


Ray traced Shadows
Buffer Shadows
No Shadows
Normal, with secondary rays
Secondary, no secondary rays
Exclusive, with secondary rays
Exclusive, no secondary rays

Raytraced Transparency

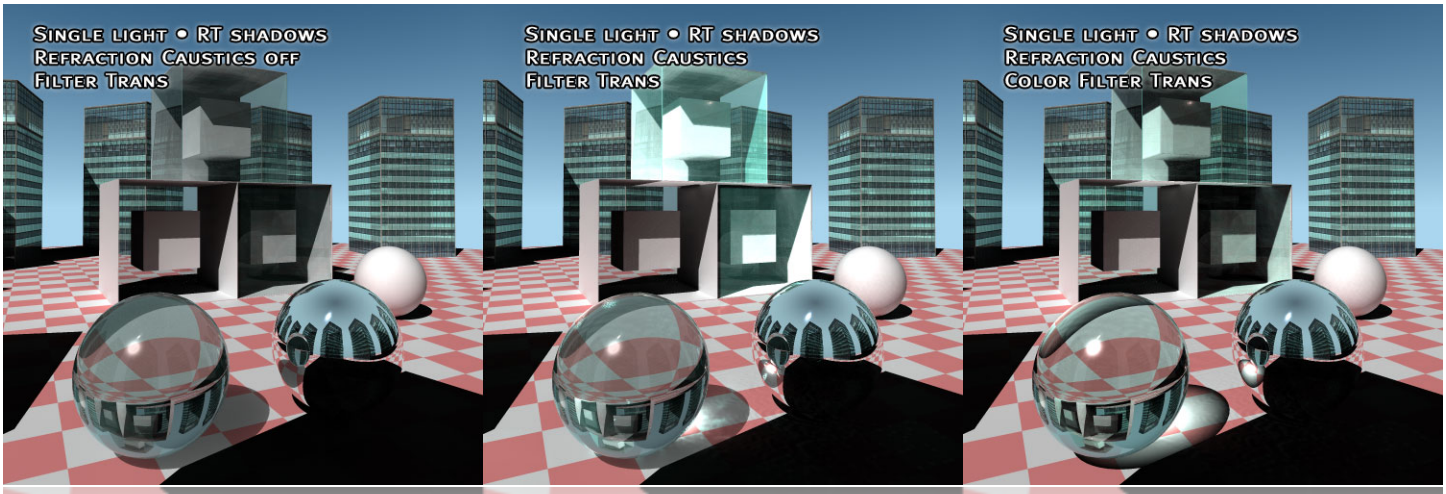
Many of the example renderings above were rendered with Phong Transparency. This makes the glass ball look like a bubble, but has little effect on the window glass. Below the images are rendered with RT Transparency. Notice the differences between Buffer and RT Shadows. The buffer shadows become solid beyond the glass. The solid shadow issue and Buffer shadows is side stepped by using Phong Transparency. The last image I cheated on and added a Color Sky Light to brighten the shadows.



Above, The buffer shadows become solid beyond the glass. No RT Shadow appears with out transmission enabled.

Caustics and GI

Caustics can only be produced by Standard Lights. These lights can however be set to GI Normal, Exclusive, or Secondary and still produce Caustics. With ***RT › Filter Mode Transparency*** you can burn out what is behind the glass if you have caustics enabled with RT shadows. This can be fixed by using ***Color Filter Transparency*** instead. With Color Filter Transparency the color brightness controls transparency, so black glass will always appear solid. To get it to work, set transparency to 0, and use a custom color which is almost white.

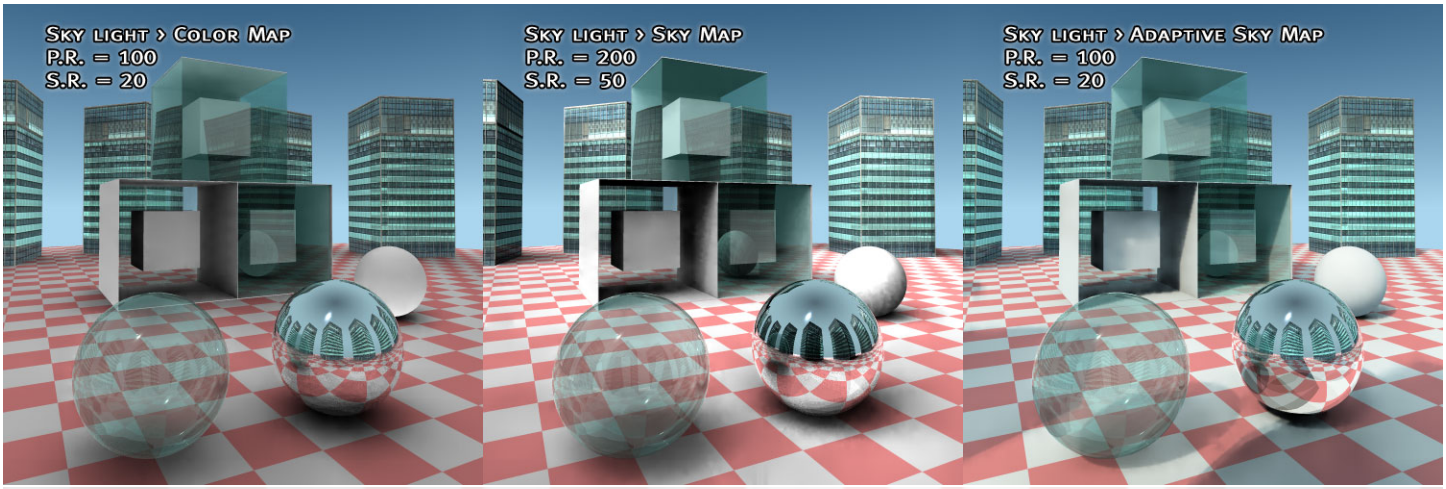


Above, The burnt out look of the center image is Due to the use of RT transparency in filter mode.

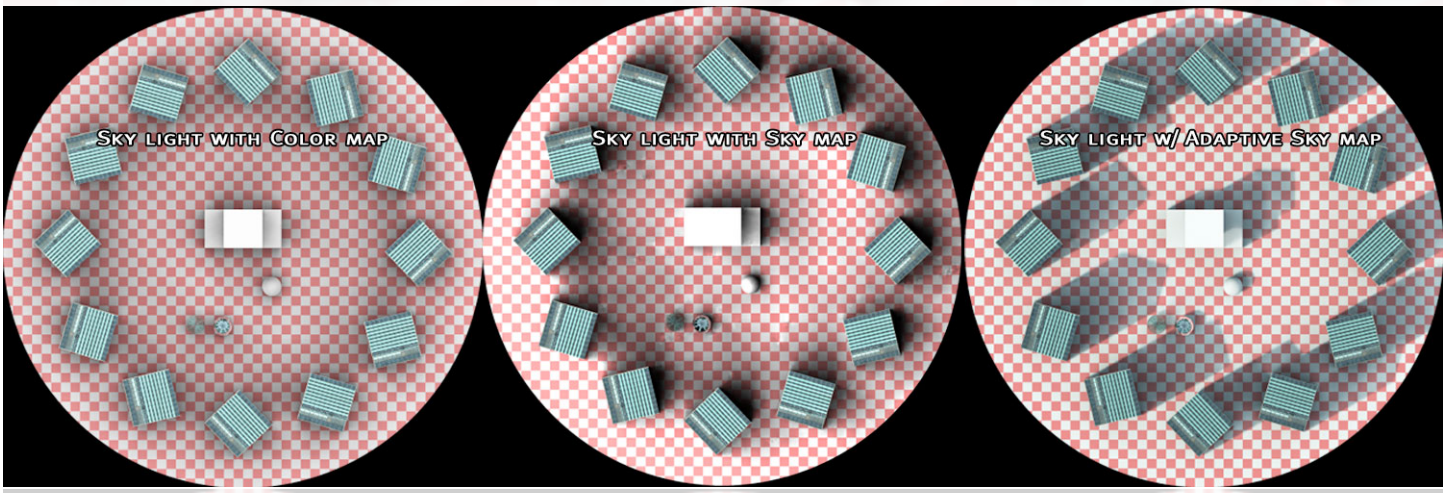
GI Sky Lights

With ***GI Sky Lights***, no other form of lighting is required to illuminate your scene. ***Sky Maps*** and ***Color Maps***, or 'color from below,' both provide an overcast look, with ***Sky Maps*** allowing you to use an image for more directional lighting. ***Sky Maps*** can be very noisy and slow to render. ***Adaptive Sky Maps(ASM)*** give very accurate directional lighting and are relatively fast. With ***ASM*** you want to use HDR imagery, while with ***Sky Maps*** you do not, as it just adds to the noise.

Notice how similar the ***ASM*** image below is to the RT and Color Sky Map image from the Standard Light an GI section. The ***ASM*** image was much faster to render, and with more rays could look the same.

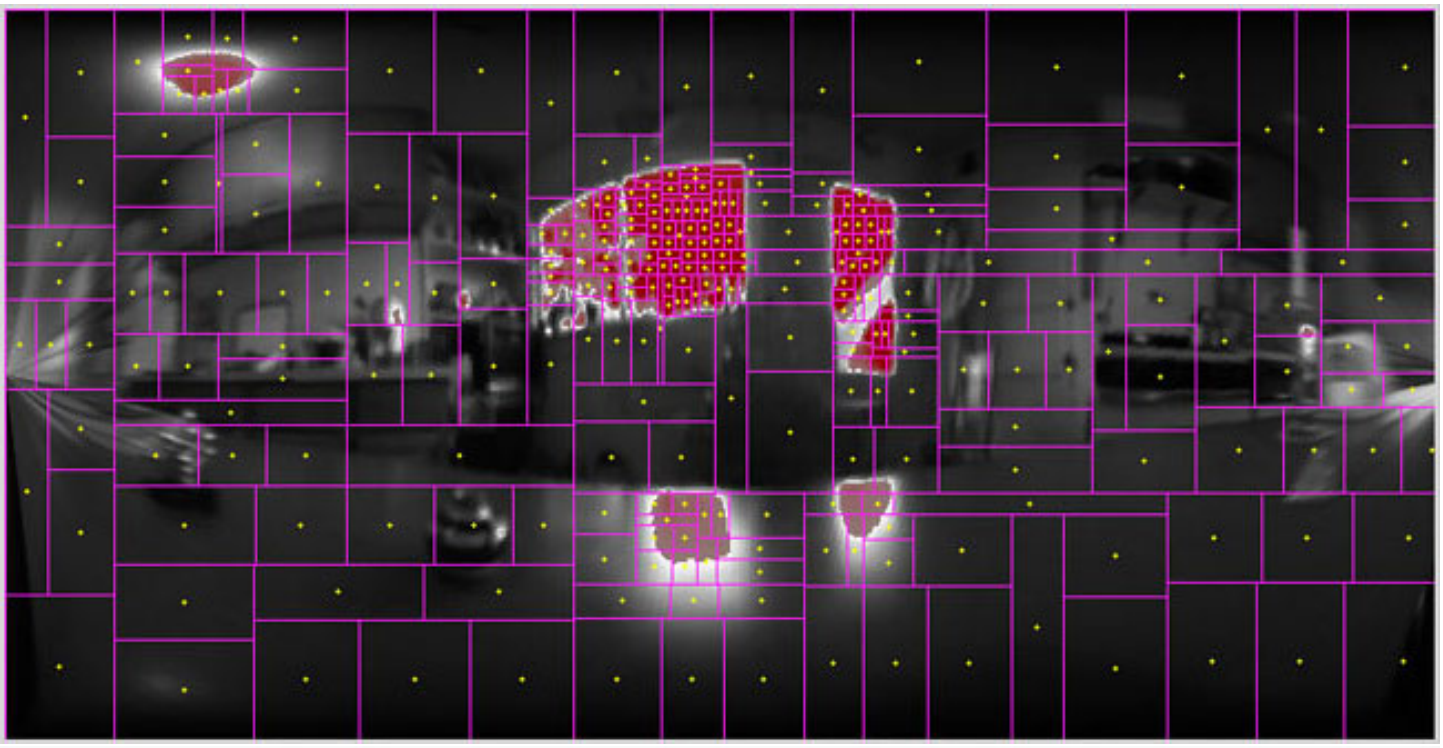


Above and below, with the sky map I had to double both PR and SR to get the noise level down. This tripled the rendering time.

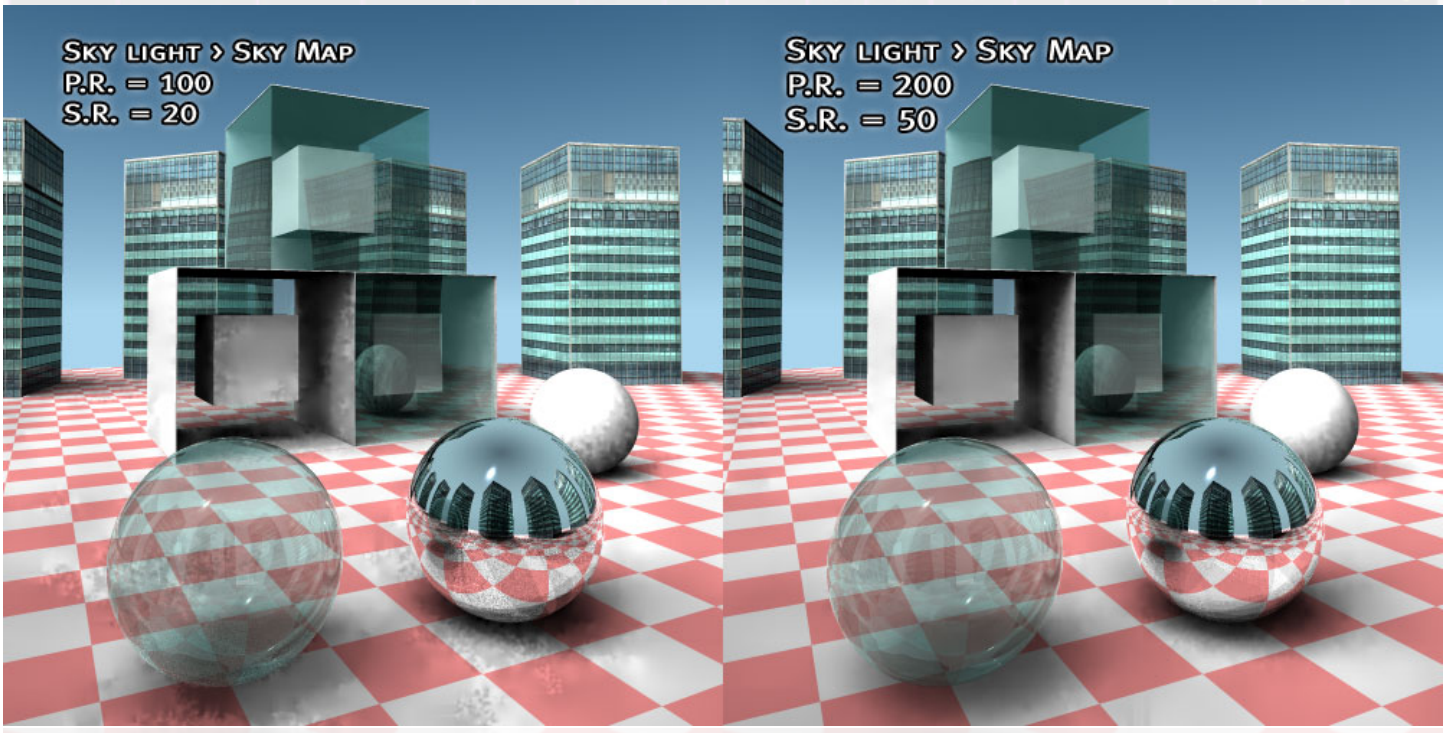


Noise and GI Sky Maps

GI Sky Light Sky Maps can be very noisy, and For the most part have been replaced by ASM. ASM maps concentrate rays around points of higher light values. This means they render faster, and are much more effective in lighting.



Above, the ray concentration of an ASM. IF the same image were used for SM each area would be evenly sampled.



Above, notice the level of noise created by a SM, and then how many more rays need to be added to bring down a bit.

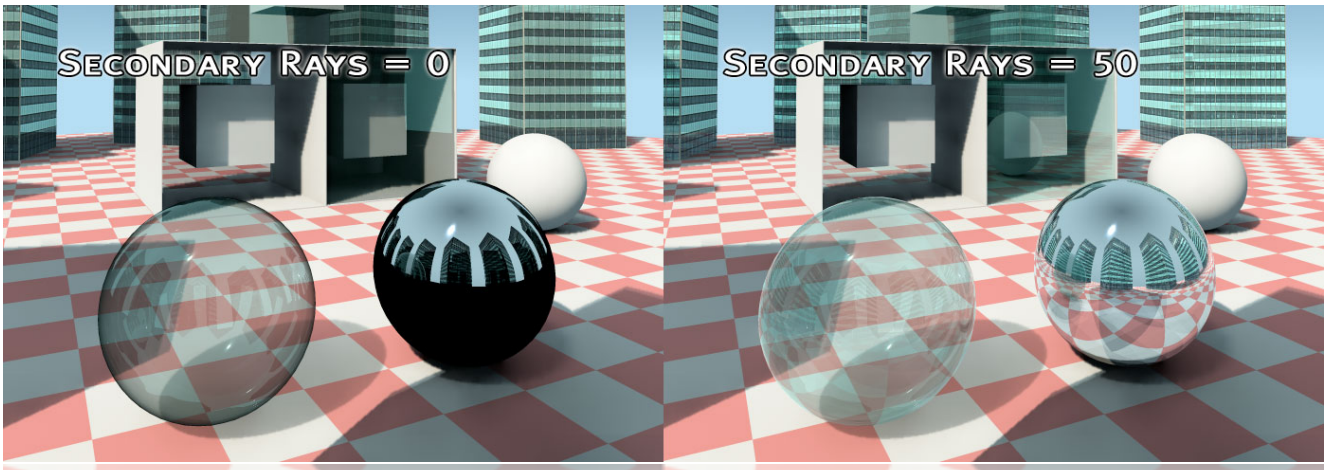
Rules of GI

The GI system requires Raytraced Shadows be enabled to work.

You will se no GI effect with out Raytraced Shadows enabled in the *Render Info Tab*. This does not mean you need to cast RT shadows with your lights.

The GI Primary Light is not calculated for Reflections

You need ***Secondary Rays*** to illuminate what reflects. If ***Secondary Rays = 0*** your reflections will be black (or dark if you're using additional fill lights). The number of *Secondary Rays* determines the degree of noise in the reflection or refraction. The larger the number the less noise. If you don't see the difference in your scene, kill the secondary rays to speed up the rendering.



These images were only illuminated by ASM GI, notice the effects in the various reflections and refractions.

The GI Light is calculated based on image pixel density

The larger you render an image in pixel size (e.g. 2000X600 pixels), the smoother your GI lighting will be with out changing the ***GI Ray Count*** settings. This means small test rendering will not give the exact same results as the full size rendering.

The GI System will ignore a Transparent Object's refraction if...

- Volume transparency is not enabled.
- "Shadow Mode Only" is on.
- The ray-trace transparency is set to 100%.

GI Sky Lights have no Bounce Light; i.e. no Reverse Illumination.

This means that scenes lighted entirely by ***GI Sky Lights*** will have the occlusion look, and not the extra bounce of light off of surfaces onto neighboring surfaces.

ASMs hold to this as well. However a ***ASM*** which casts rays from all directions can very closely approximate the 'bounced look'. A sphere with dim light imitating from the lower hemisphere works well. Also standard lights set up in the Normal mode, mixed with ***GI Sky Lights***, can give you a very natural effect. Setting standard lights to .6 brightness and a ***GI Color Sky Light*** to .5 gives a pretty good mix.

And.....finally...

Set Up An Environment for Reflections

Glass reads as glass from what it reflects and the degree to which it is transparent. If you are rendering a drinking glass, you may get away with only specular highlights. Windows on a building may need an environment. You'll know it when you see it. You'll also know it if you don't see reflections.

I would like to thank 'the' Igors, Ian, and Dave for contributing glass samples and wisdom that helped get this tome out the door.

You are also welcome to contribute. Find any errors, omissions, errata... or if you would like to contribute your own materials or ideas, then email me here **EIAS@BLACKBOXDESIGN•COM**