How to Train Your Cloud

Domin Lee

Who am I?

Domin Lee

FX Supervisor
@DreamWorks
13 years

SA '20 Courses, December 01-09, 2020, Virtual Event, Republic of Korea
ACM 978-1-4503-8112-3/20/11.
10.1145/3415263.3419137

Overview

1. History (Cloudpipe)
2. Modeling
3. Volume Generation
4. Set-Dressing and Framing (Design)
5. Data Management
6. Simulation
7. Lighting and Compositing

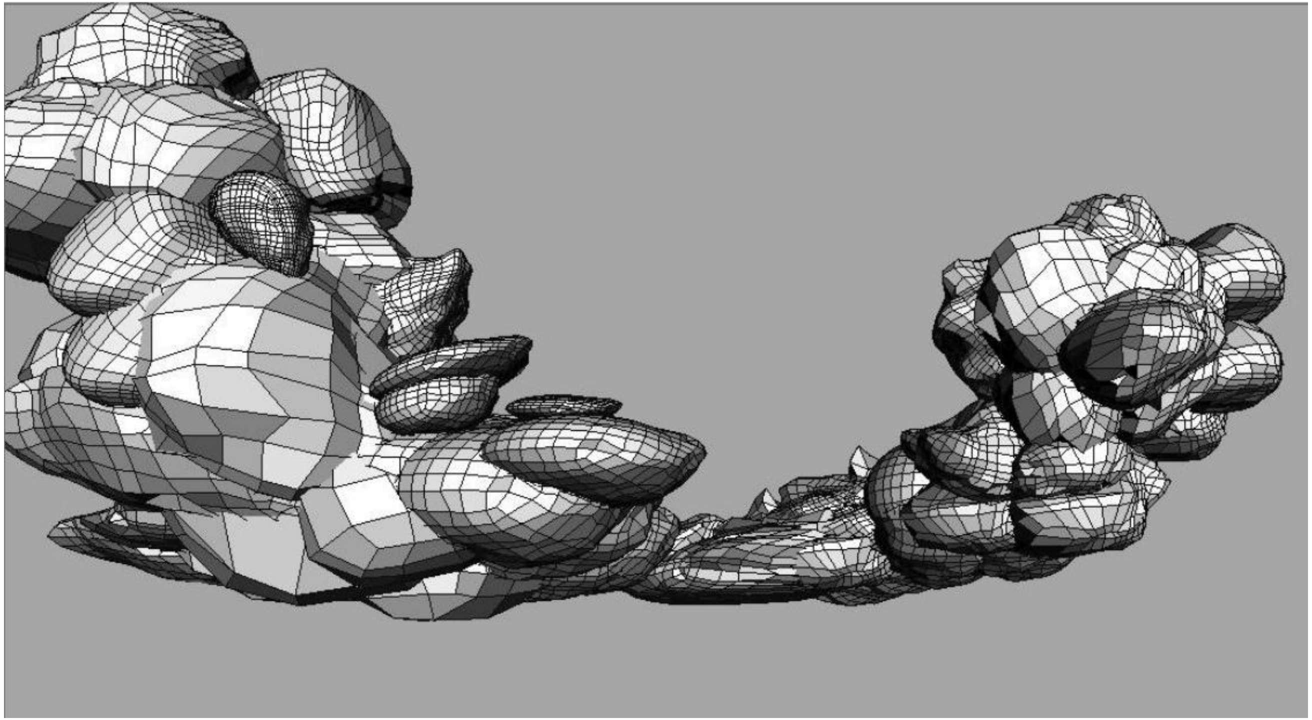
Cloud @ DreamWorks


Property of DreamWorks Animation / Pearl Studio

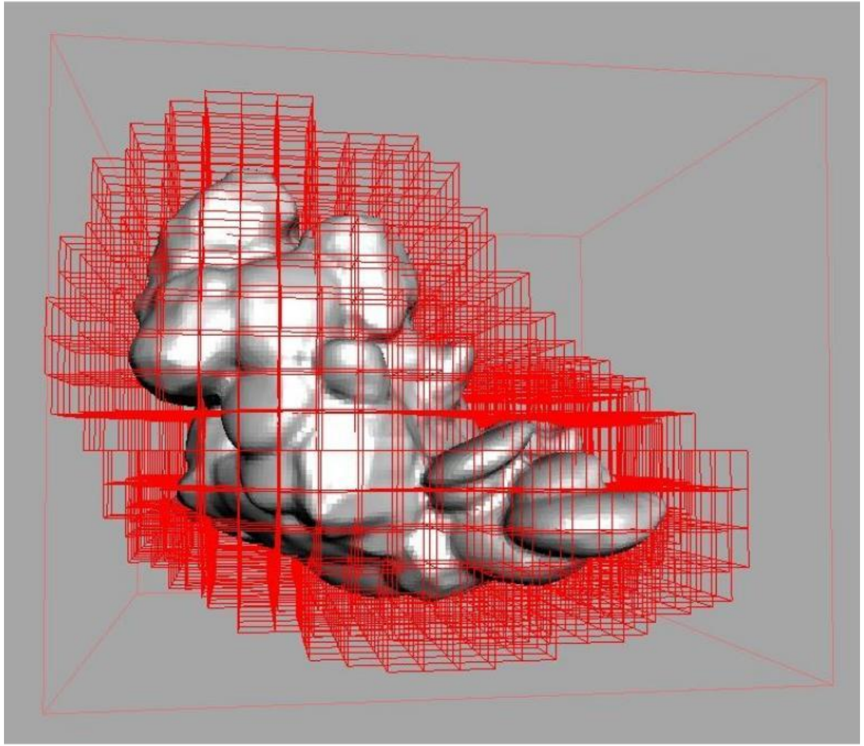
00:00:13:23

Cloudpipe 2.0
(Previous)

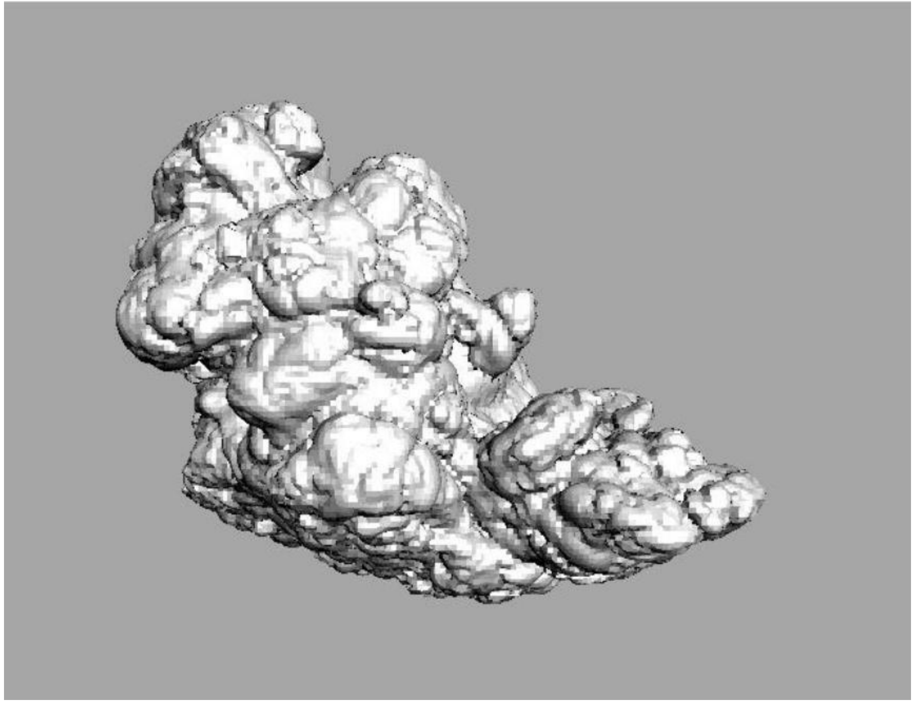
Model Cloud Shapes



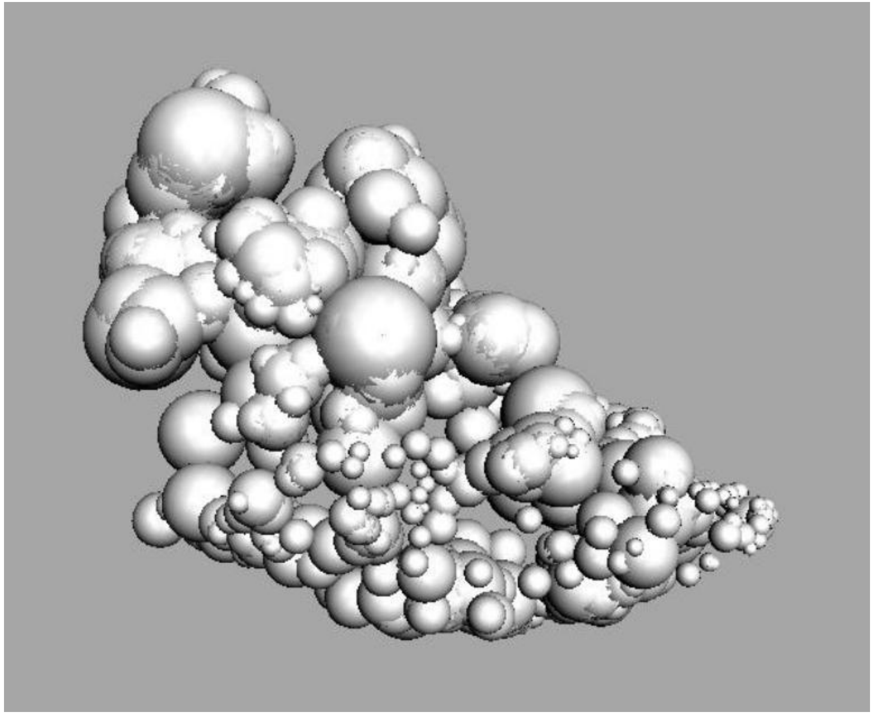
Convert to LevelSet



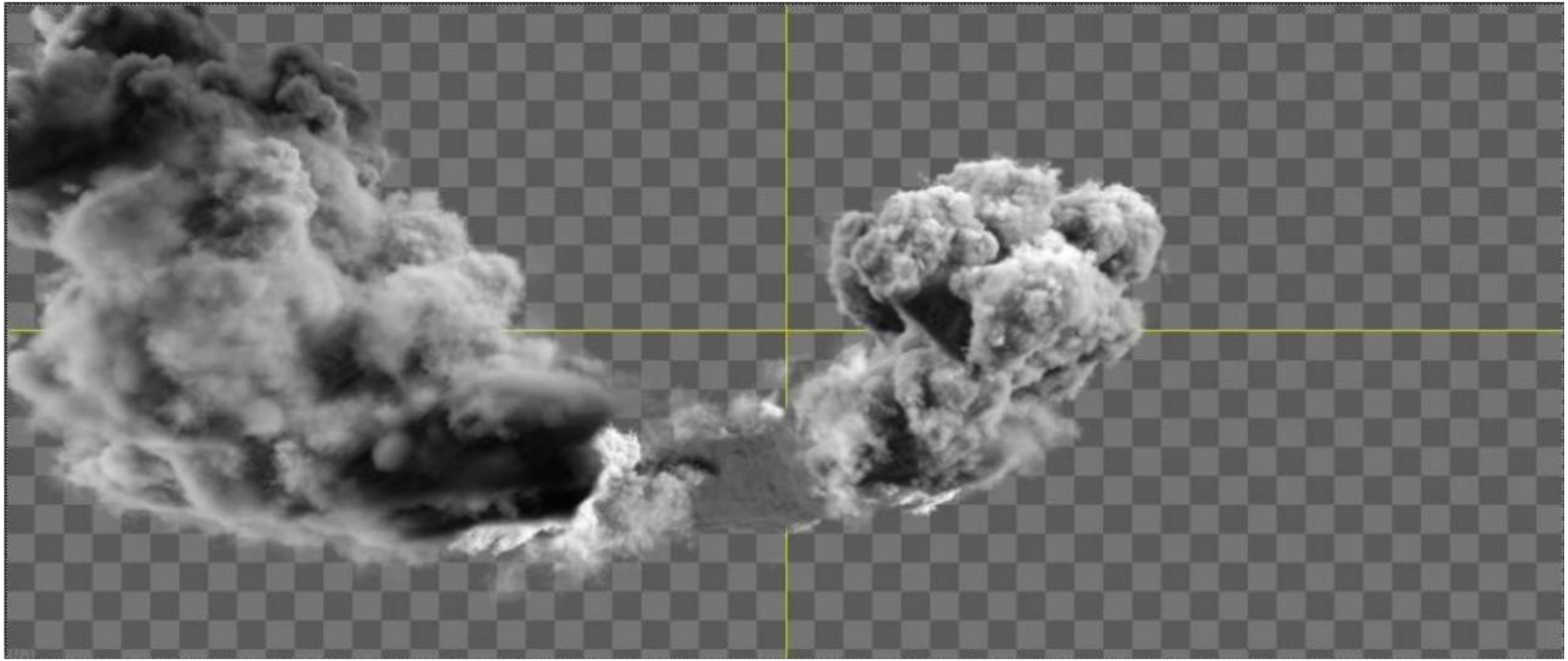
Displace and Deform



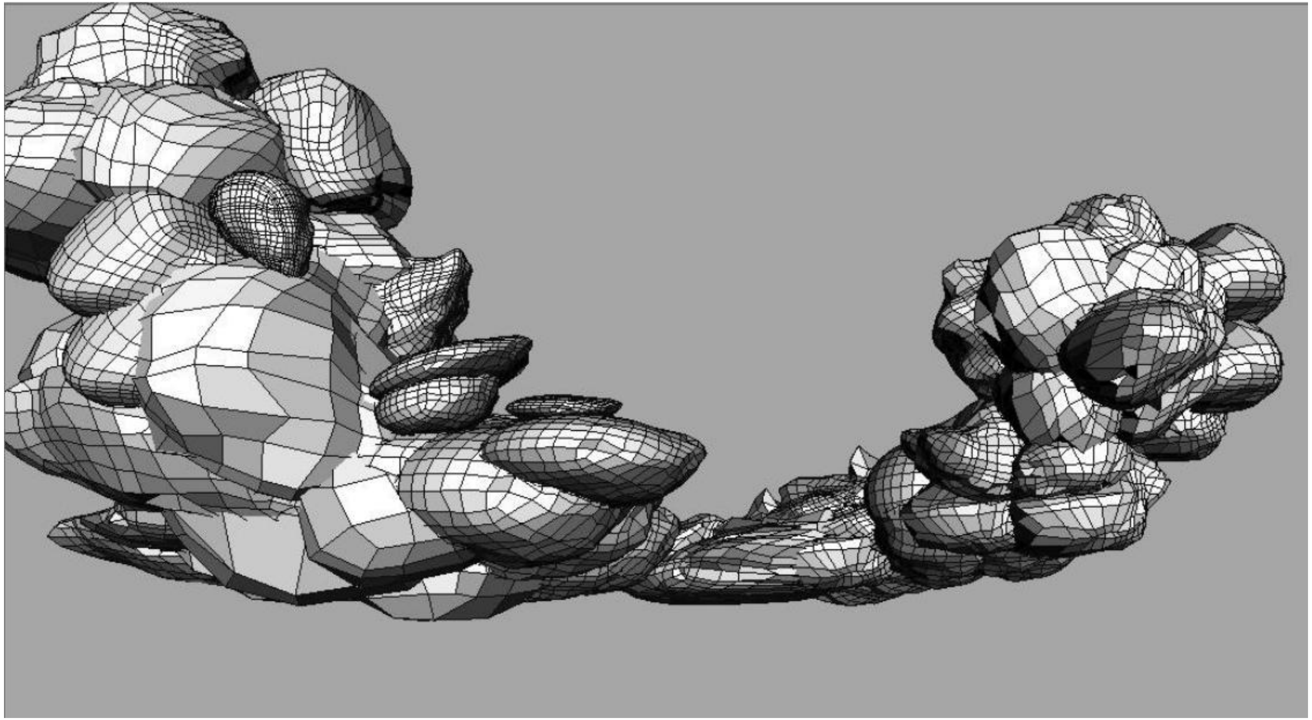
Wispy Detail



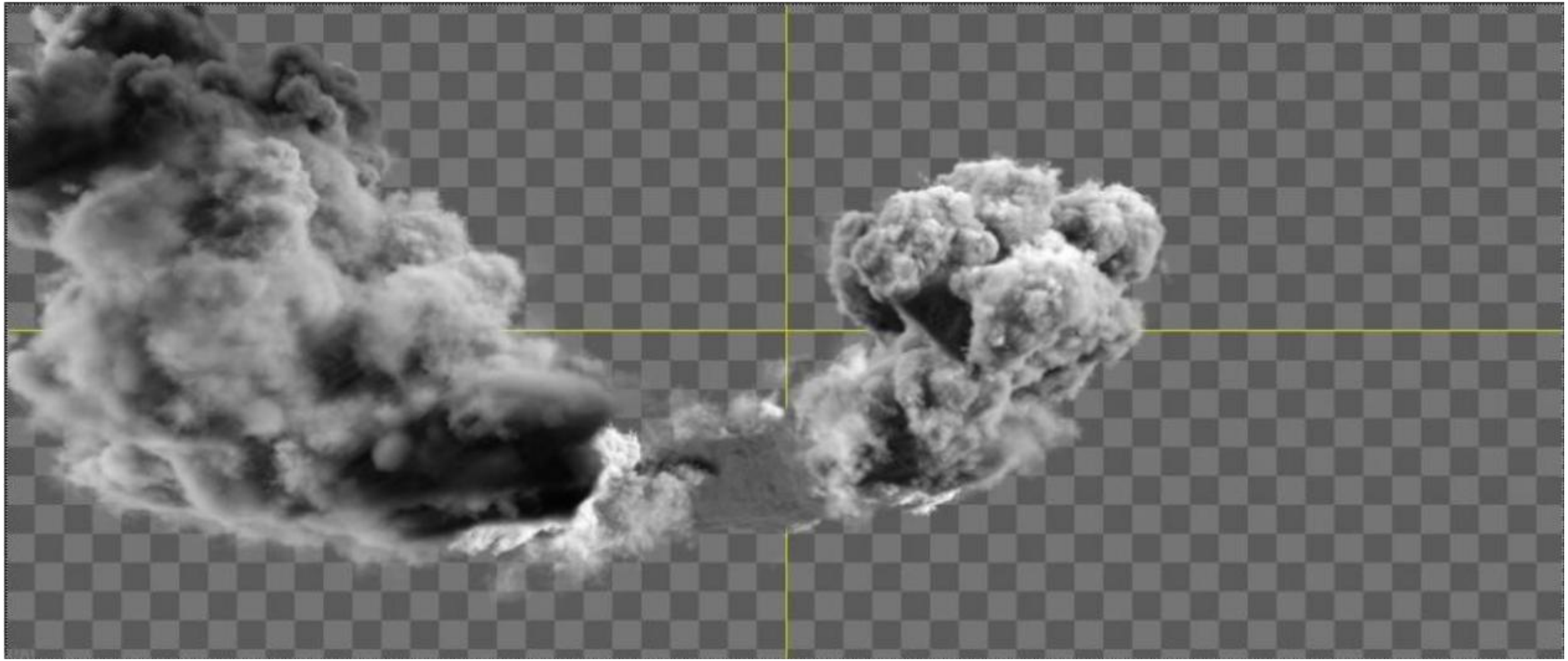
Rasterize into a Volume



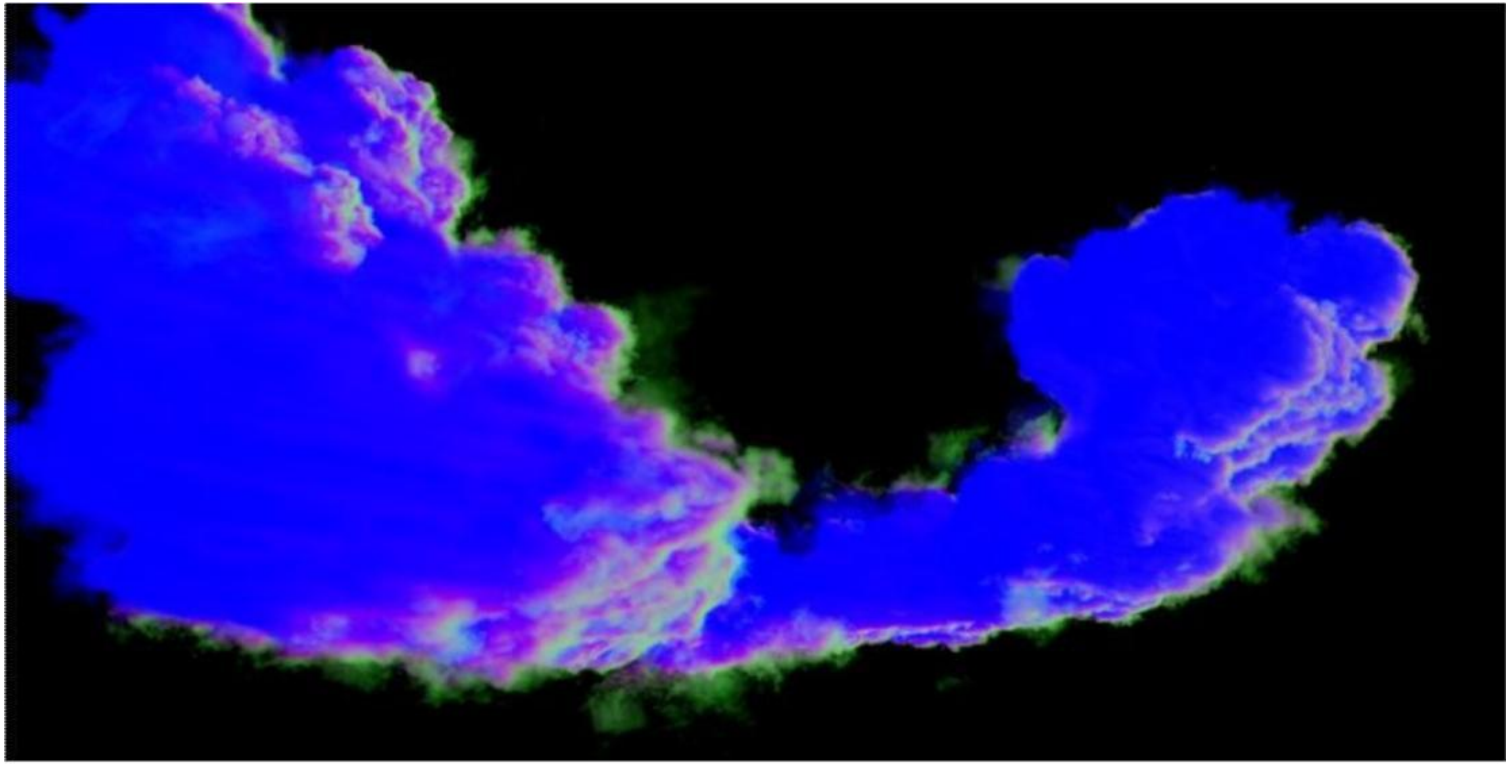
Before



After

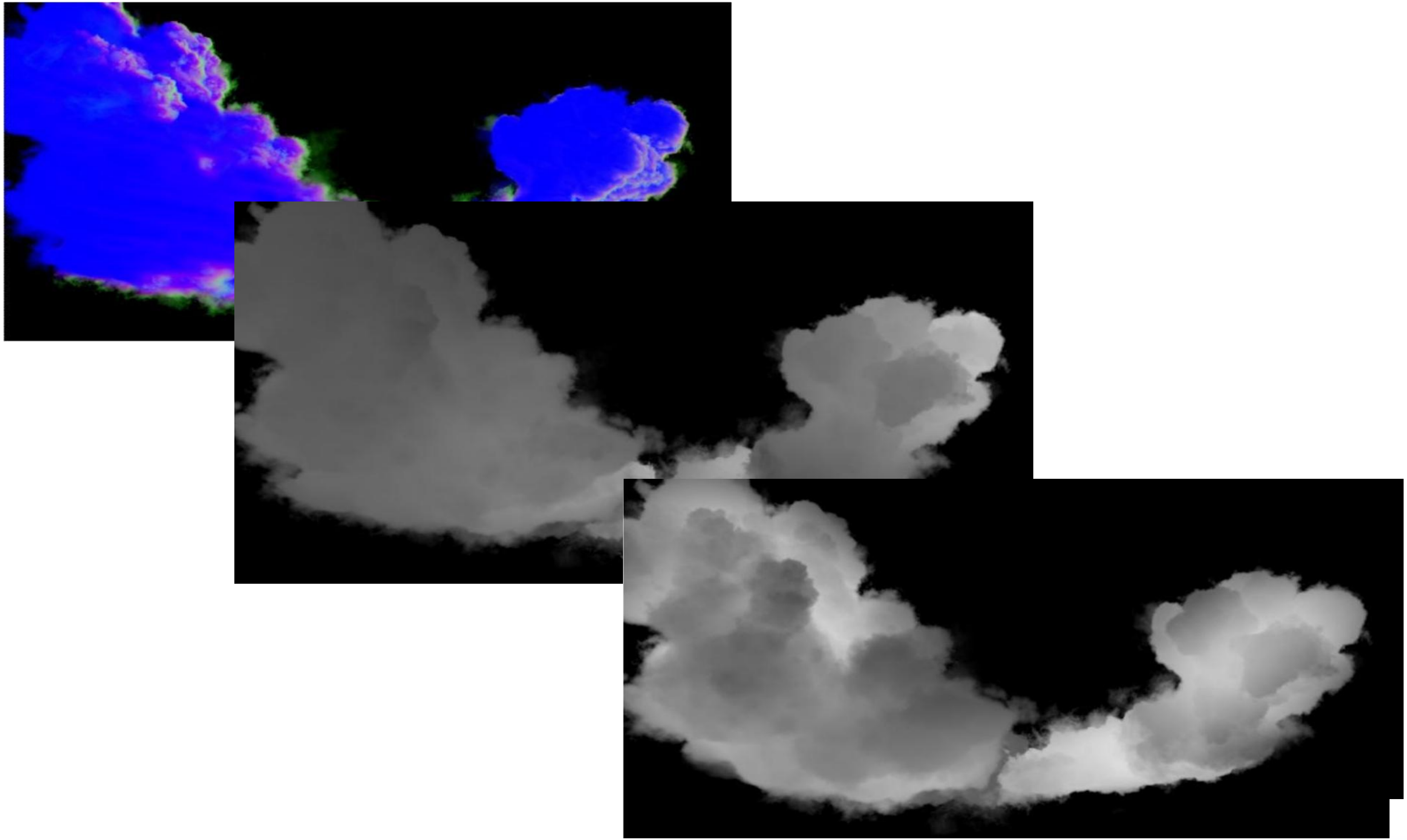


Single Order Scattering



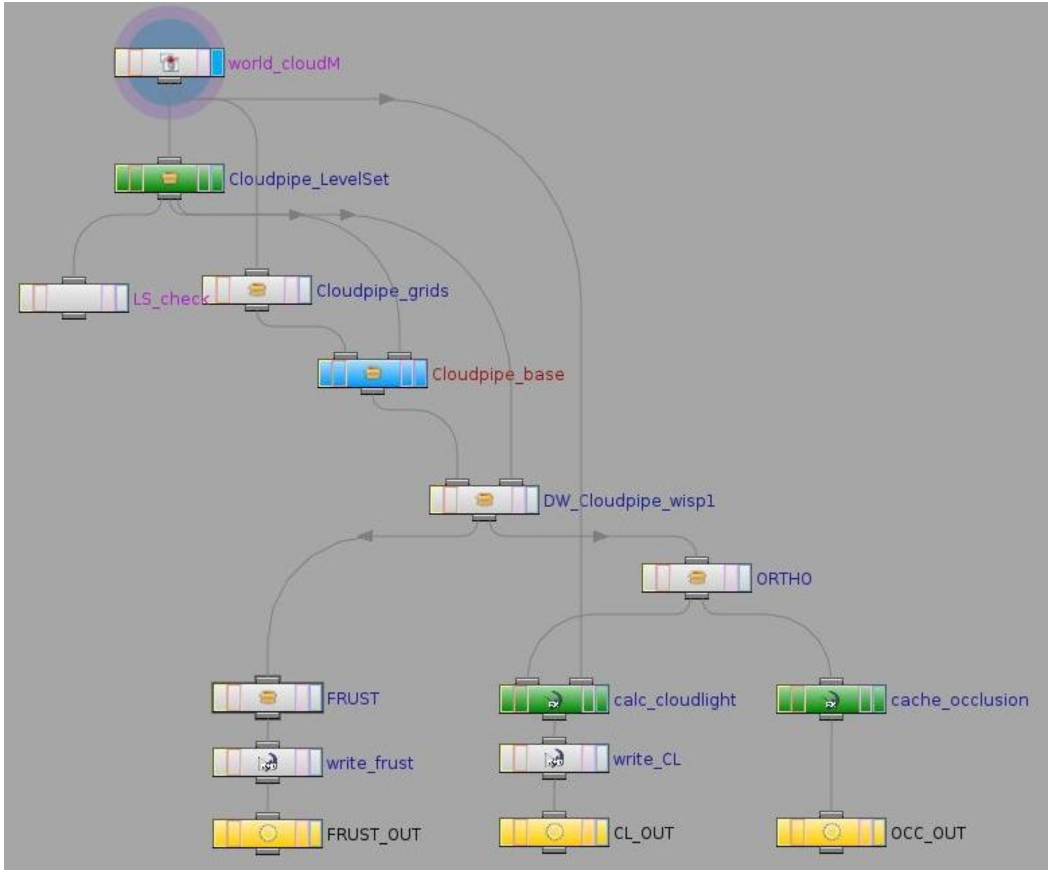
Cloudlight

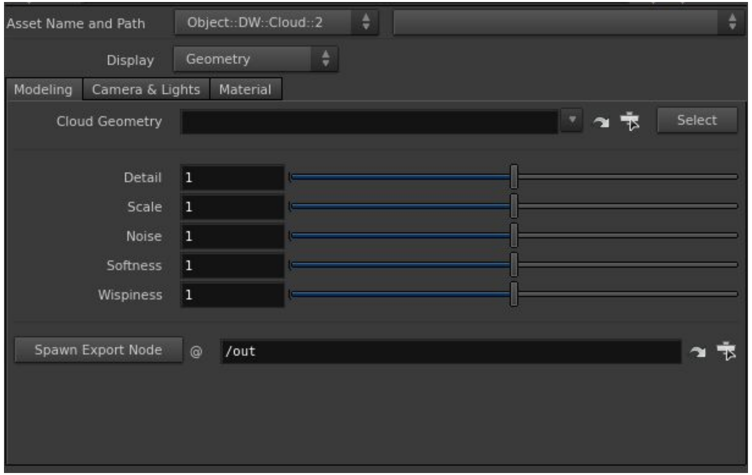
Ambient Occlusion



Composite


Setup
Copy Attr
Spreadsh...
Rndr CL
Rndr Occl
Rndr Frus...
Set Cloud...
Set Display
Save Attr
Load Attr
Set Fram...


world_cloudM
Cloudpipe_LevelSet
LS_check
Cloudpipe_grids
Cloudpipe_base
DW_Cloudpipe_wisp1
ORTHO
FRUST
calc_cloudlight
cache_occlusion
write_frust
write_CL
FRUST_OUT
CL_OUT
OCC_OUT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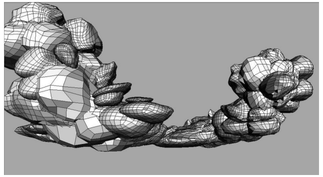
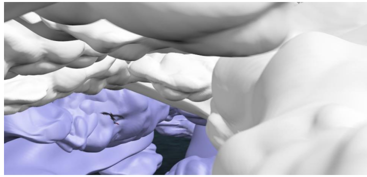
Object::DW::Cloud::2
Display
Geometry
Modeling
Camera & Lights
Material
Cloud Geometry
Select
Detail
1
Scale
1
Noise
1
Softness
1
Wispiness
1
Spawn Export Node
@
/out

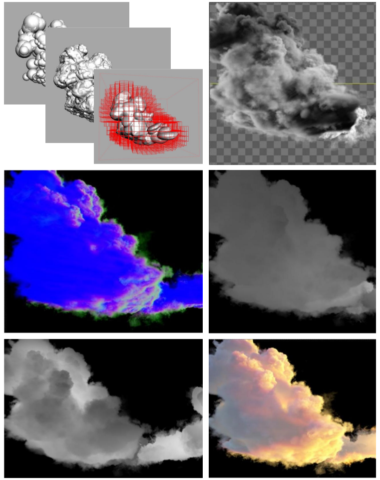
Modeling



Layout



FX



Lighting

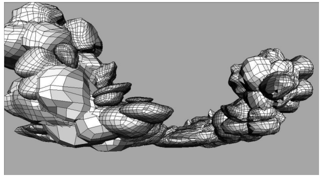

ANTONIO BANDERAS
DREAMWORKS
PUSS IN BOOTS
11.4.11
In Theatres, realD 3D and IMAX 3D

How to Train Your Dragon: Hidden World

- Meet the demand of more sophisticated Storytelling
    - Complexity that is far greater than before
- Modernized for a raytracer
    - A new dataflow approach between departments.
- Unify the fragmented lighting workflow

DreamWorks

Modeling



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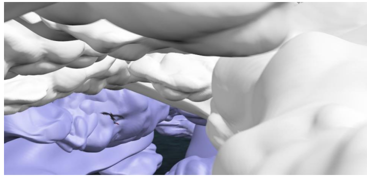
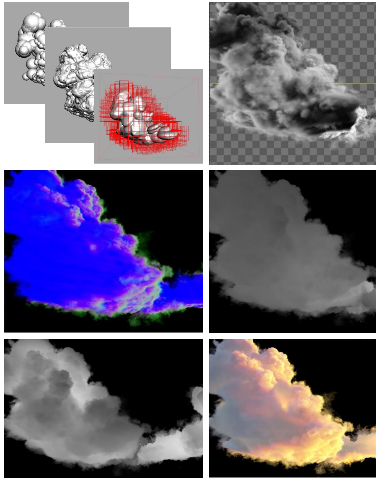


FX

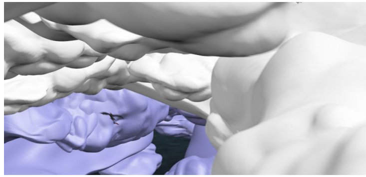


Lighting

Cloudpipe 3.0

Layout

Lighting

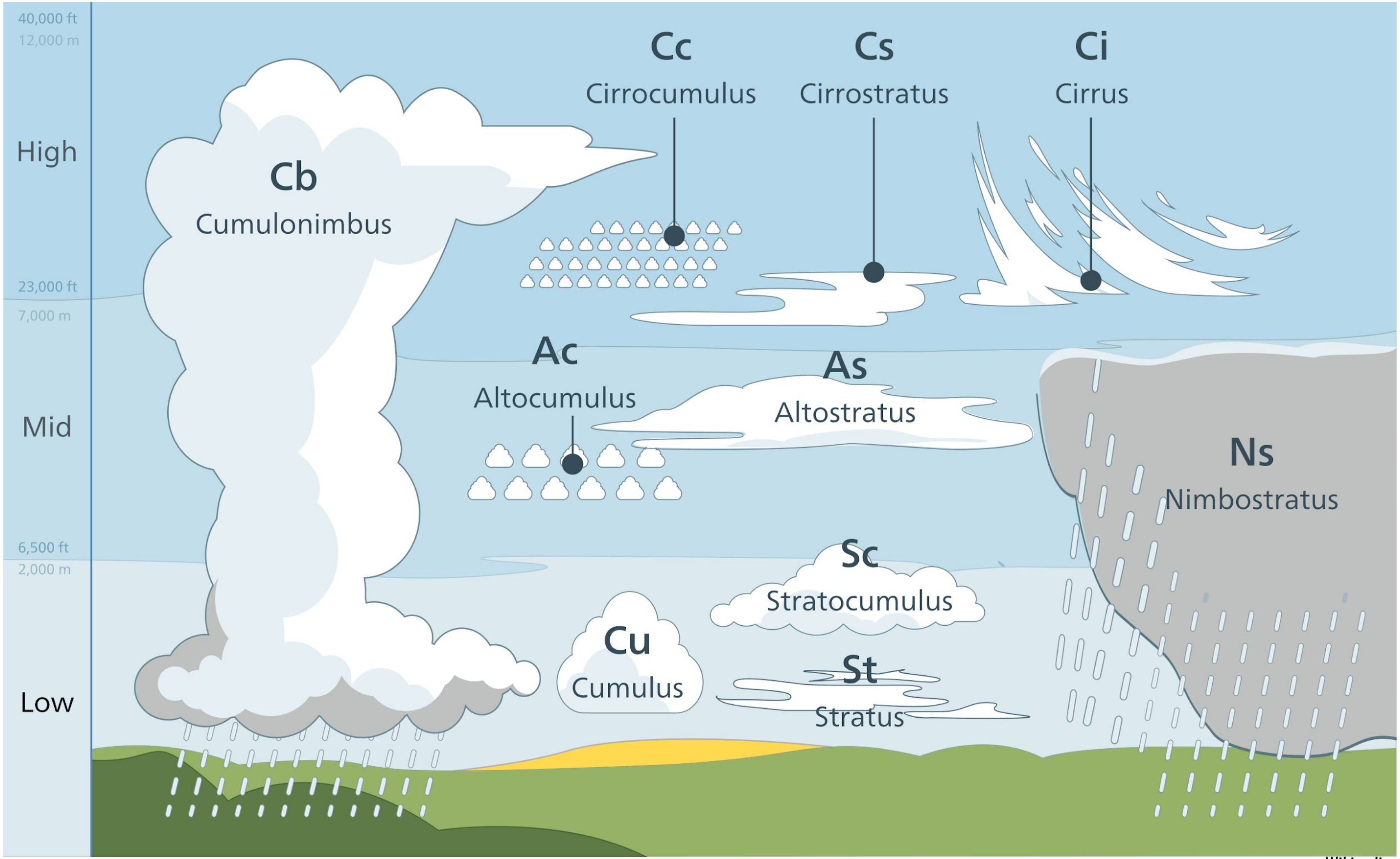


Cloudpipe 3.0

(Dragon 3+)

Modeling

Lighting

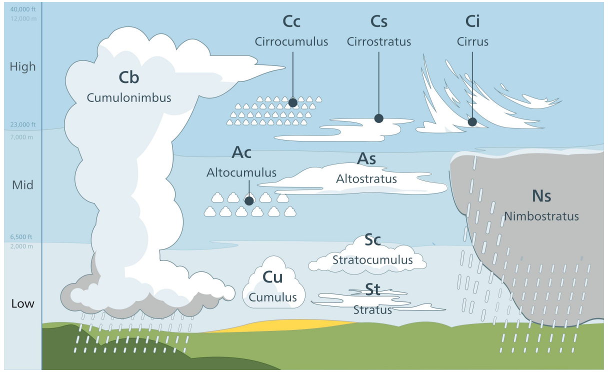


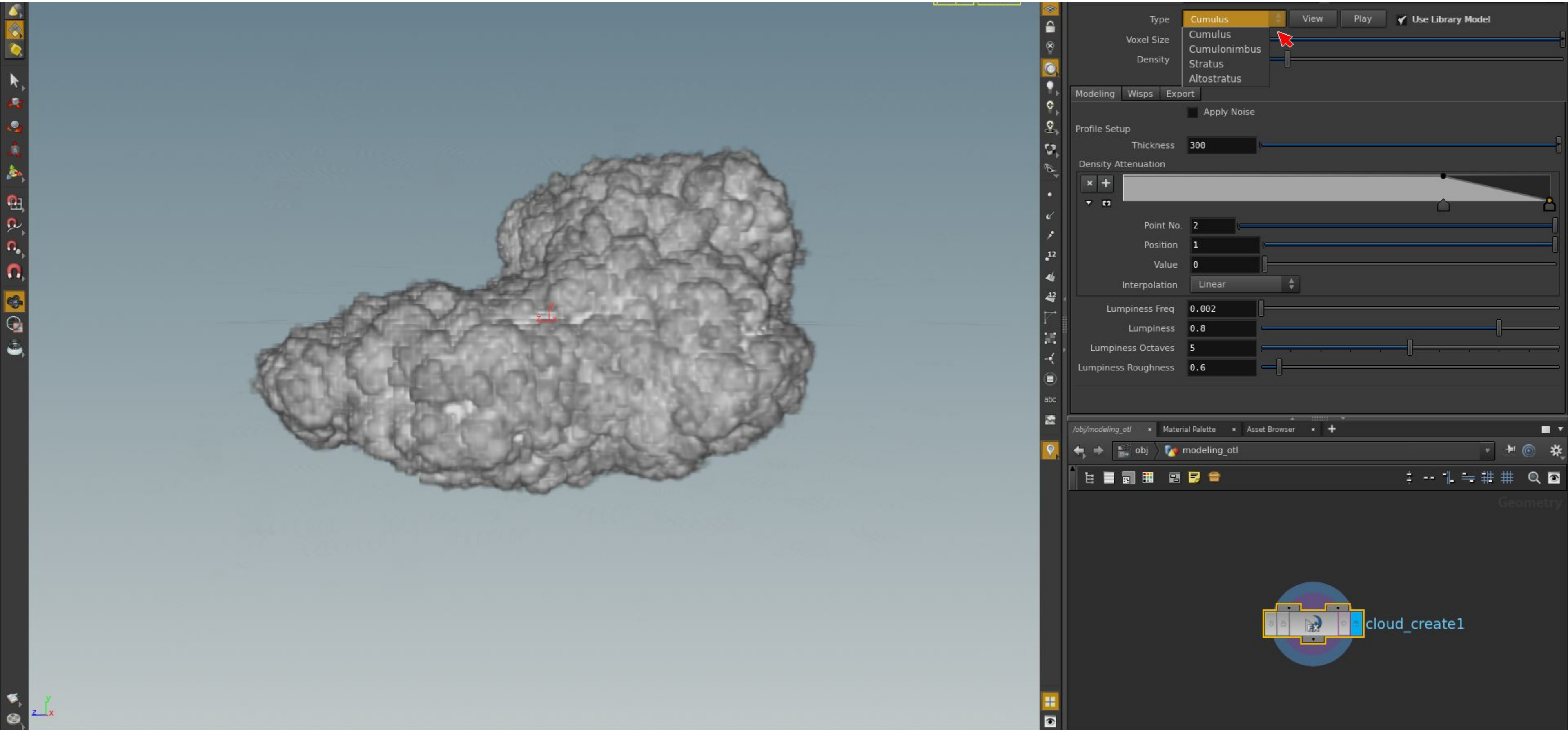
40,000 ft
12,000 m
High
23,000 ft
7,000 m
Mid
6,500 ft
2,000 m
Low
Cb
Cumulonimbus
Cc
Cirrocumulus
Cs
Cirrostratus
Ci
Cirrus
Ac
Altocumulus
As
Altostratus
Ns
Nimbostratus
Sc
Stratocumulus
Cu
Cumulus
St
Stratus

Wikipedia

Modeling

- They rise with heat from the earth
- Density increases at lower temperatures
- Temperature decreases over altitude
- Dense regions make round shapes as they rise
- Wind direction varies over altitude
- Atmospheric turbulence further distorts clouds
- Light regions diffuse like fog
- High densities precipitate as rain or snow




Type
Cumulus
View
Play
Use Library Model
Voxel Size
Density
Cumulus
Cumulonimbus
Stratus
Altostratus
Modeling
Wisps
Export
Apply Noise
Profile Setup
Thickness
300
Density Attenuation
Point No.
2
Position
1
Value
0
Interpolation
Linear
Lumpiness Freq
0.002
Lumpiness
0.8
Lumpiness Octaves
5
Lumpiness Roughness
0.6
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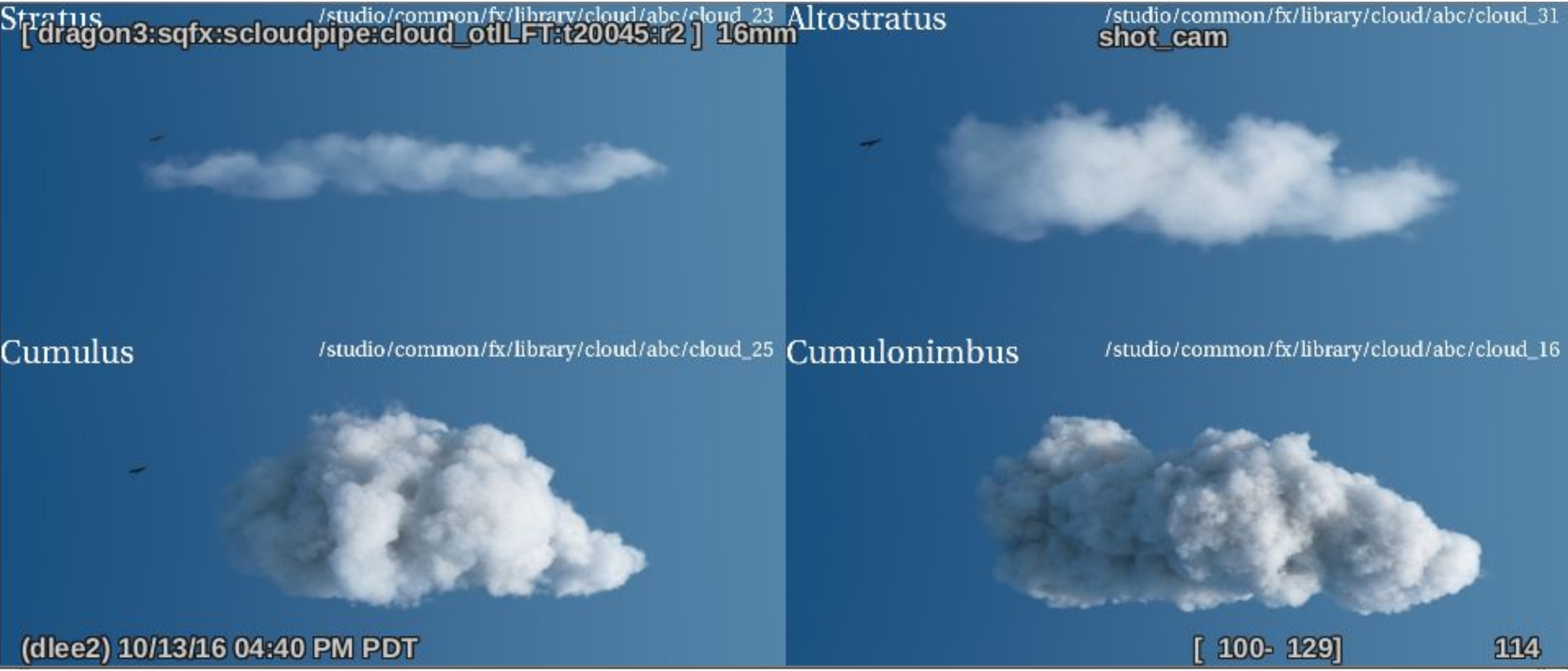
Material Palette
Asset Browser
obj
modeling_otl
cloud_create1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Cumulus
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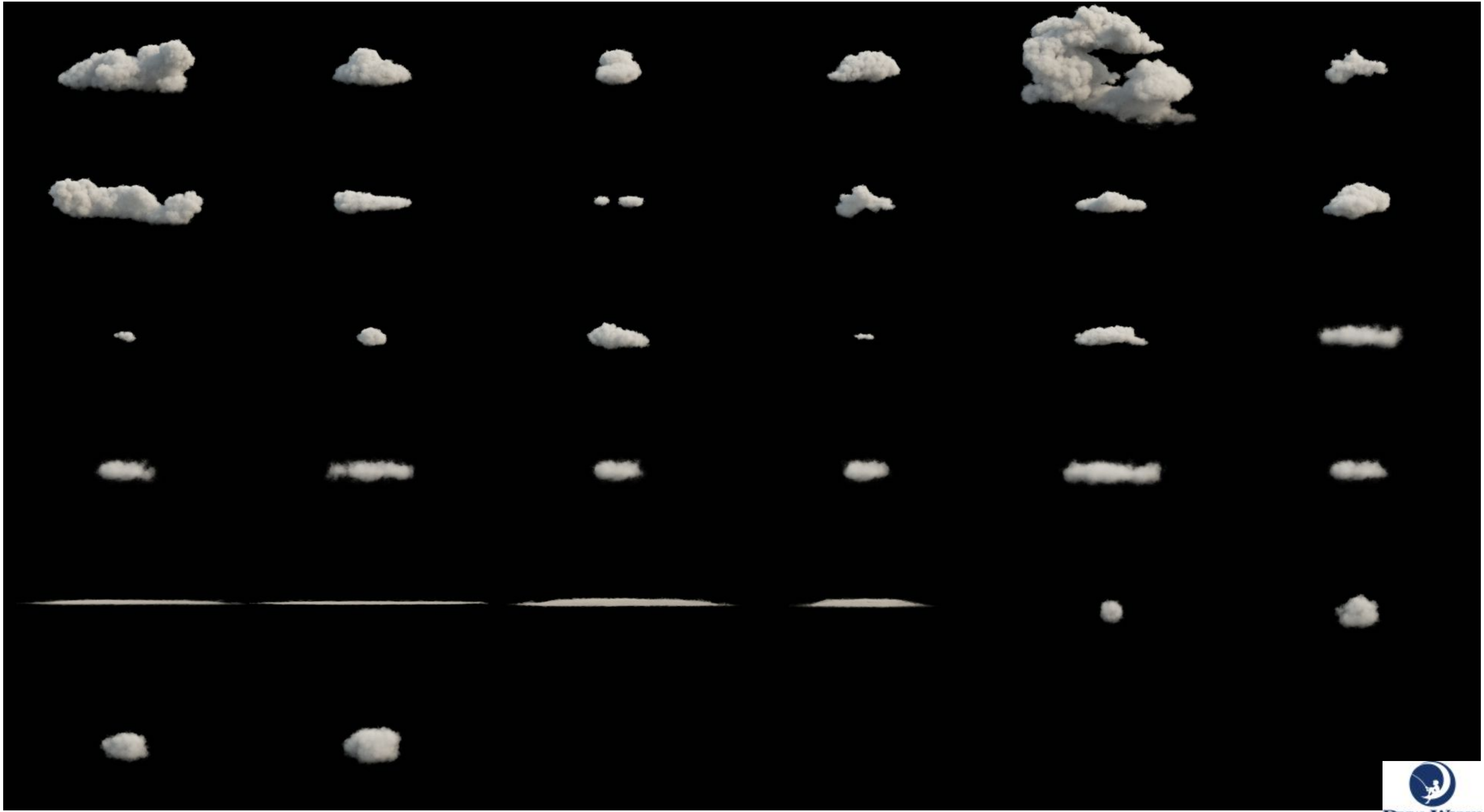
[100- 129]
114



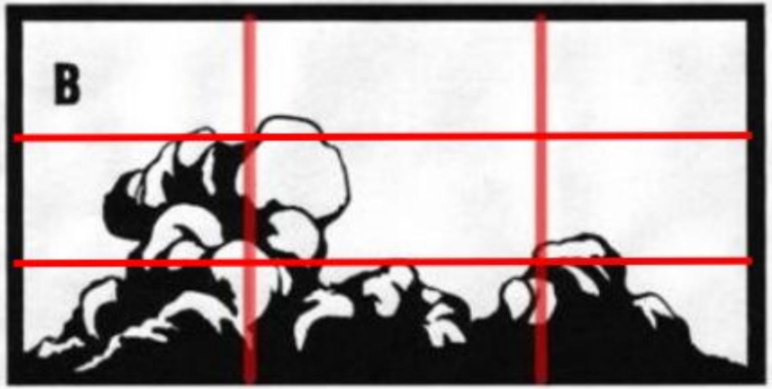
Design

General Consideration

- Help tell the story
- Realism is NOT the same as believability
- Simple is better
- Is effects Directable?
- Design Principles

SCREEN COMPOSITION RULE

THIS IMAGE IS CUTTING THE FRAME RIGHT DOWN THE MIDDLE....BAD!



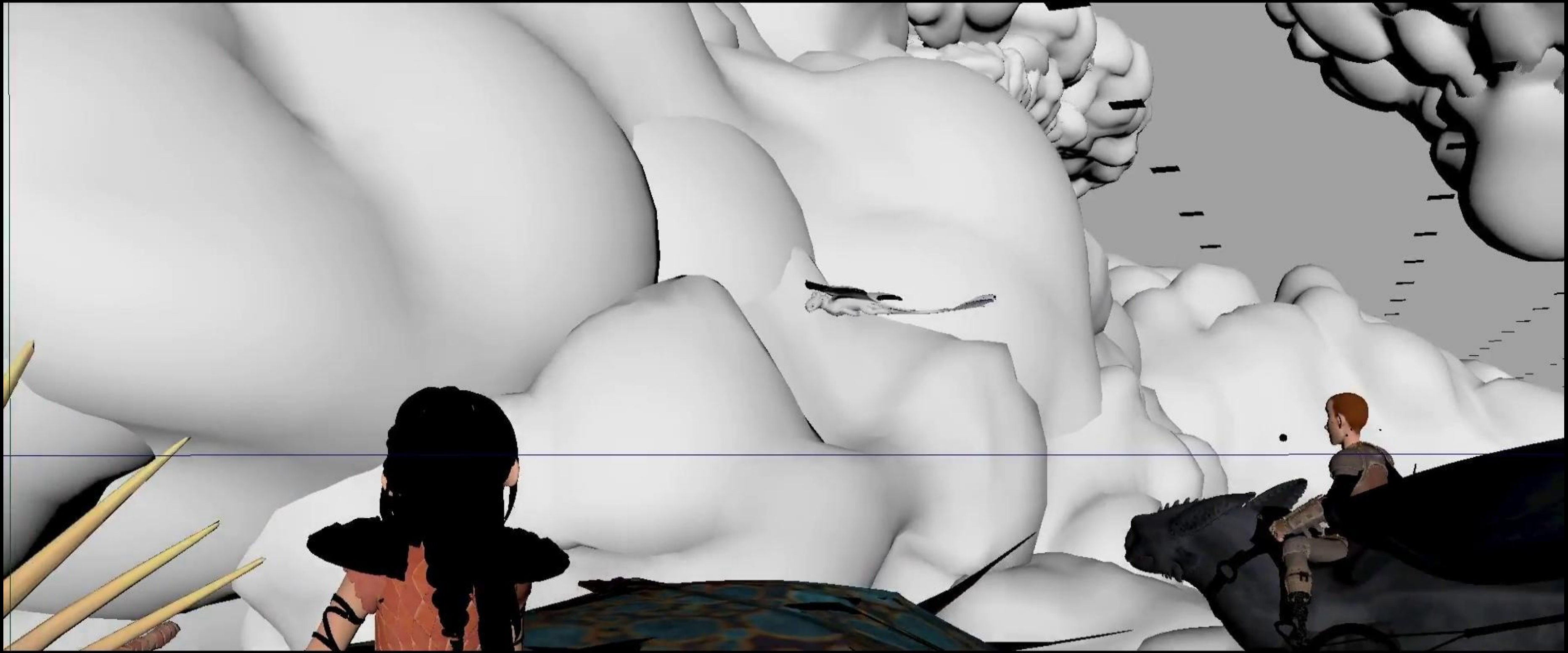
GOLDEN RULE OF THIRDS IS MORE PLEASING IN THE PERFORMANCE SPACE ...GOOD!

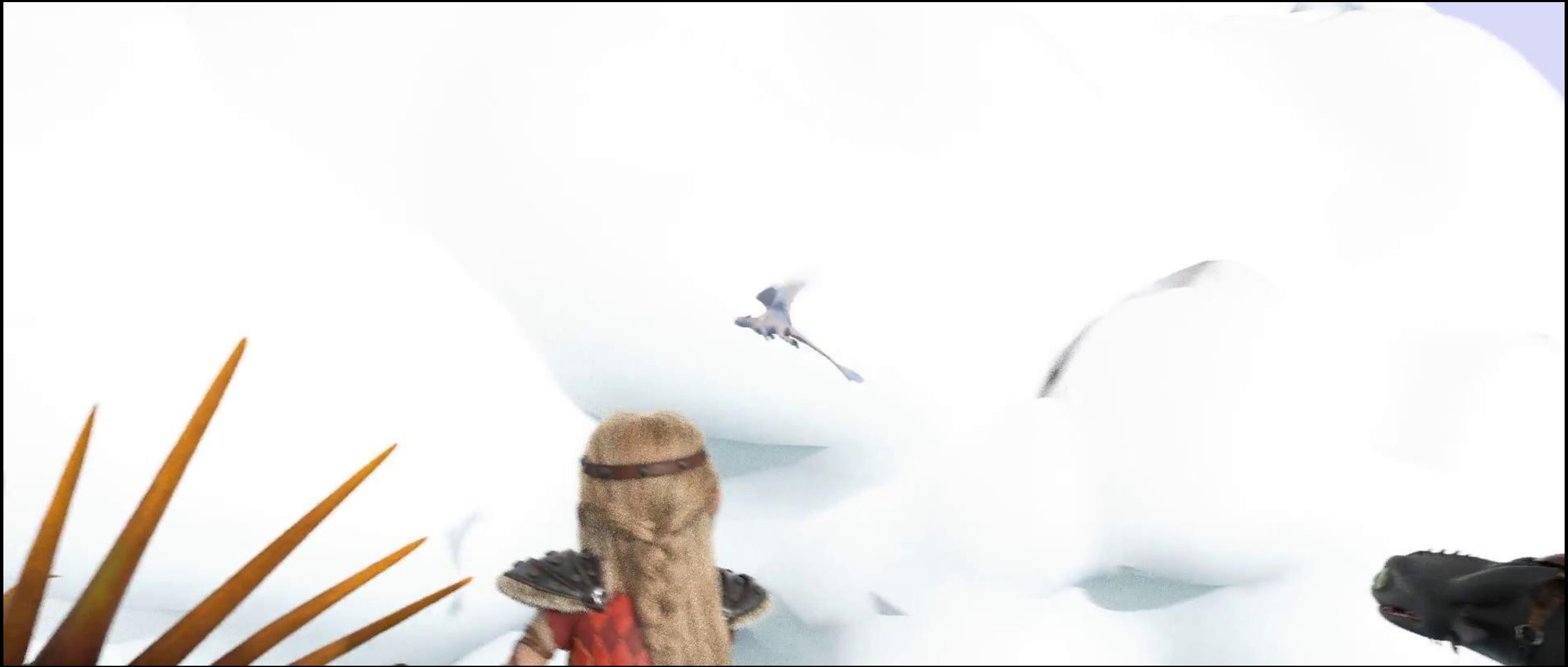
KUNG FU PANDA — FIRE ANALYSIS

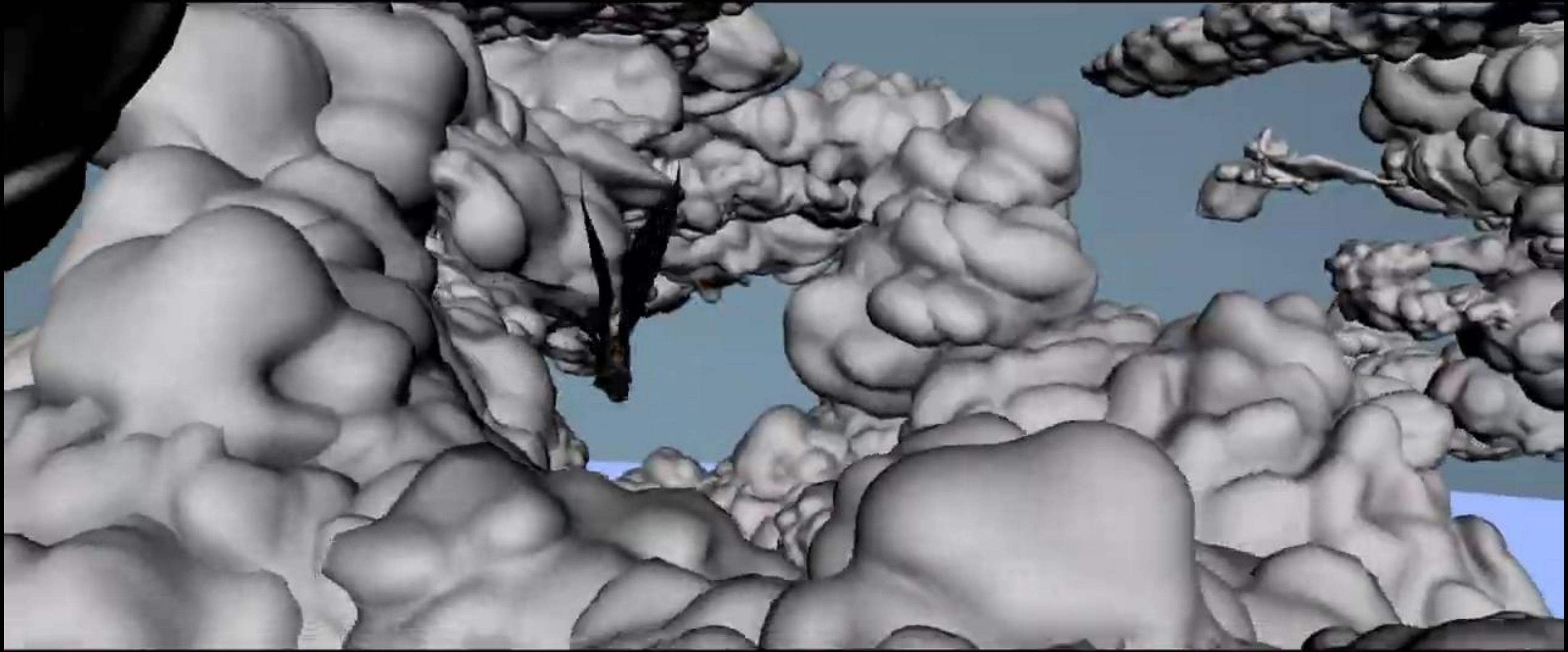
THE SCALE OF FIRE

MATCH FLAME | TORCH FLAME | CAMPFIRE | LARGE BRUSH OR STRUCTURAL FIRE

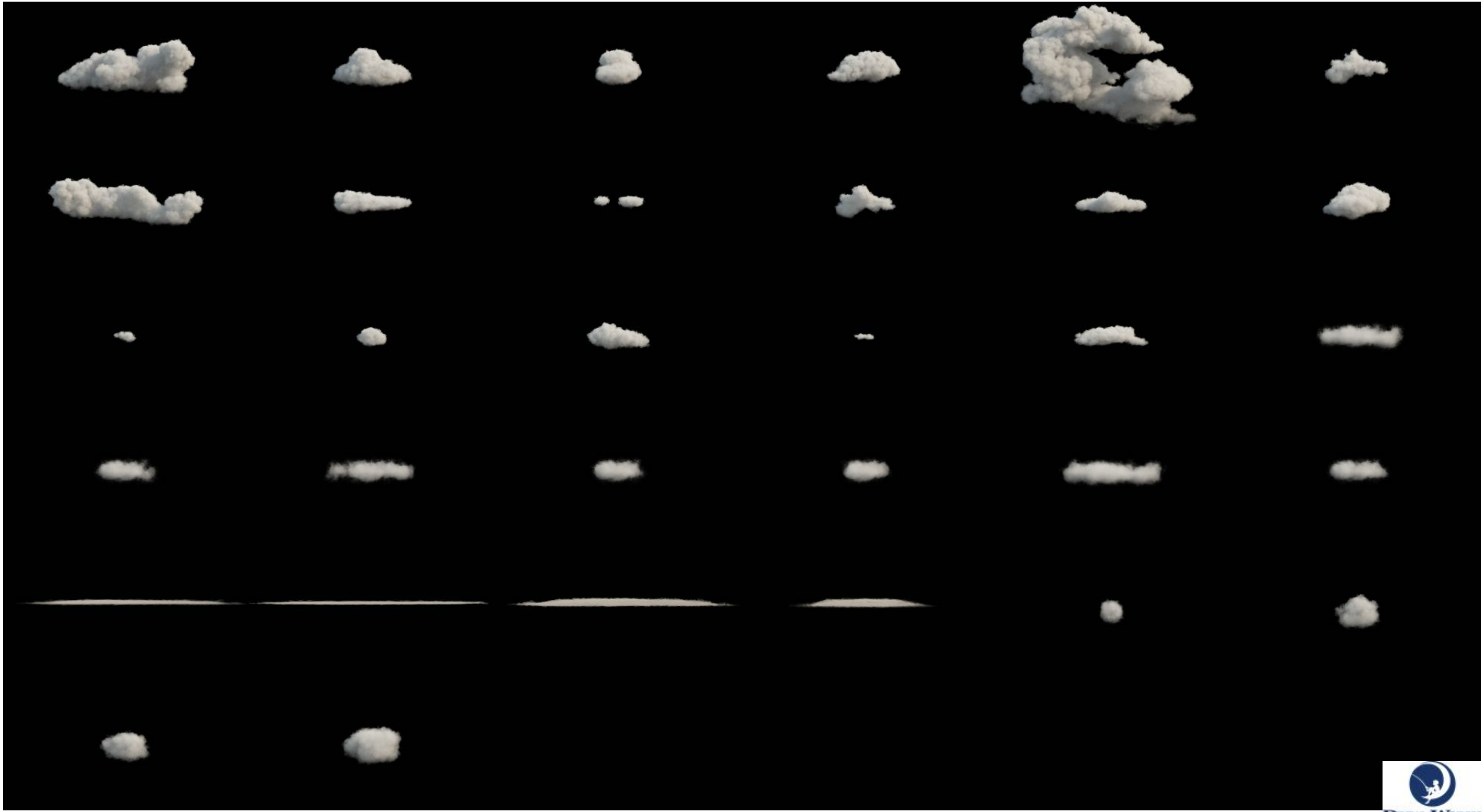
GENERAL GUIDELINES TO CONSIDER FOR FIRE SCALE....A MATCH OR CANDLE FLAME WILL HAVE NO FLAMLET DISCHARGE AT ALL A TORCH FLAME COULD DISCHARGE A FLAMLET FOR UP TO 2 FRAMES... WITH A CAMPFIRE FLAME YOU START TO GET INTO VARIATION AND WILL GENERALLY DISCHARGE A FLAMLET FOR UP TO 4 FRAMES.....LARGER SCALE FIRES WILL HAVE THE MOST VARIATION OF FLAMLETS AND THESE LARGE SHEETS WHICH TEAR OFF FROM THE MAIN BODY OF THE FIRE WILL TAKE 8 FRAMES TO DISIPATE. THE LARGER THE FIRE THE SLOWER THE FLAMLETS TAKE TO DIE OFF.







DreamWorks



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... > cloud_cumulonimbus1_render.usd > cloud_cumulonimbus1_heavy.usd > cloud_cumulonimbus1_heavy.usd

cloud_cumulonimbus1_heavy.usd

```
#usda 1.0
(
    defaultPrim = "cloud_cumulonimbus1"
)

def Xform "cloud_cumulonimbus1" (
    asset_type = "envir"
    assetInfo = {
        string name = "envir/clouds/cloud_cumulonimbus1"
    }
    kind = "component"
)
{
    def Scope "Geometry"
    {
        def "cloud_cumulonimbus1" (
            payload = @${a_lib_model_dir}/envir/clouds/cloud_cumulonimbus1/alembic/cloud_cumulonimbus1.abc@
        )
        {
            uniform token purpose = "proxy"
        }
        def Procedural "vdb_cloud_cumulonimbus1"
        {
           uniform token procedural:class = "OpenVdbGeometry"
           custom asset procedural:model = @/studio/dragon3/shdw_fx/lib/model/envir/clouds/cloud_cumulonimbus1/vdb/cloud_cumulonimbus1.vdb@
           uniform token purpose = "render"
           rel material:binding = </cloud_cumulonimbus1/Looks/cloud_mtl>
        }
    }

    def Scope "Looks"
    {
        def Shader "AmorphousVolume" (
            customData = {
                string[] creationPackages = ["houdini_moonray.moonray-1.17.6", "moonshine-0.121"]
            }
        )
        {
            color3f incandescence_gain_mult = (0, 0, 0)
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            vector3f outputs:moonray:volume
        }

        def Material "cloud_mtl"
        {
            rel connectedSourceFor:outputs:moonray:volume = </cloud_cumulonimbus1/Looks/AmorphousVolume.outputs:moonray:volume>
            vector3f outputs:moonray:volume
        }
    }
}
```

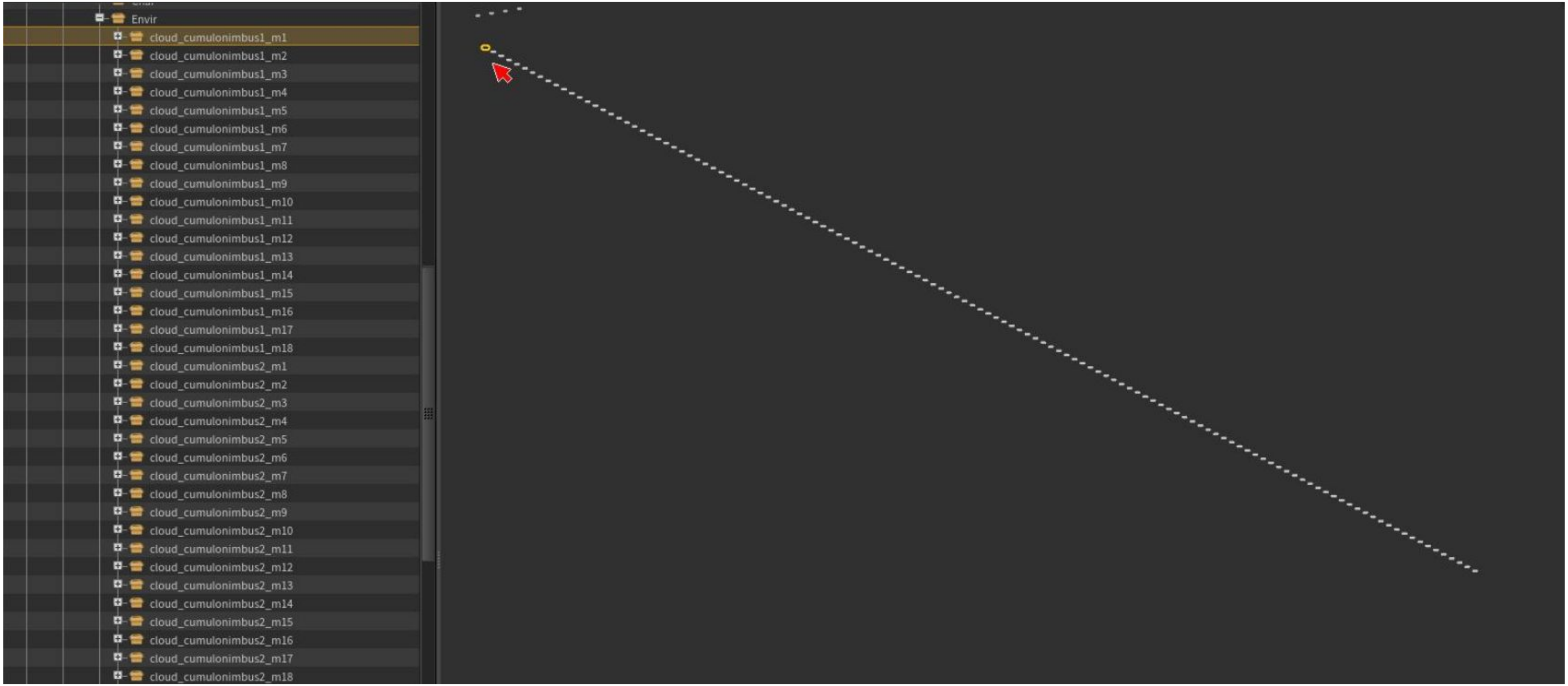
Envir
cloud_cumulonimbus1_m1
cloud_cumulonimbus1_m2
cloud_cumulonimbus1_m3
cloud_cumulonimbus1_m4
cloud_cumulonimbus1_m5
cloud_cumulonimbus1_m6
cloud_cumulonimbus1_m7
cloud_cumulonimbus1_m8
cloud_cumulonimbus1_m9
cloud_cumulonimbus1_m10
cloud_cumulonimbus1_m11
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cloud_cumulonimbus2_m12
cloud_cumulonimbus2_m13
cloud_cumulonimbus2_m14
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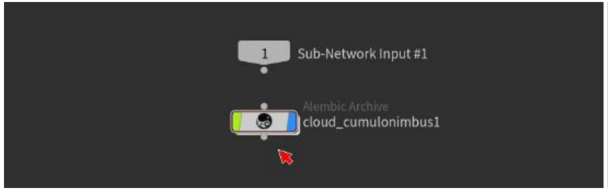
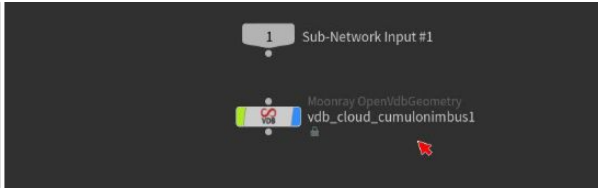
cloud_cumulonimbus2_m18


1
Sub-Network Input #1
Alembic Archive
cloud_cumulonimbus1


1
Sub-Network Input #1
Moonray OpenVdbGeometry
vdb_cloud_cumulonimbus1

DreamWorks

- /studio/dragon3/shdw_fx/lib/model/envir/clouds/sqcloud/cloud_cumulonimbus1/cloud_cumulonimbus1_LOD[0,1,2,3].vdb
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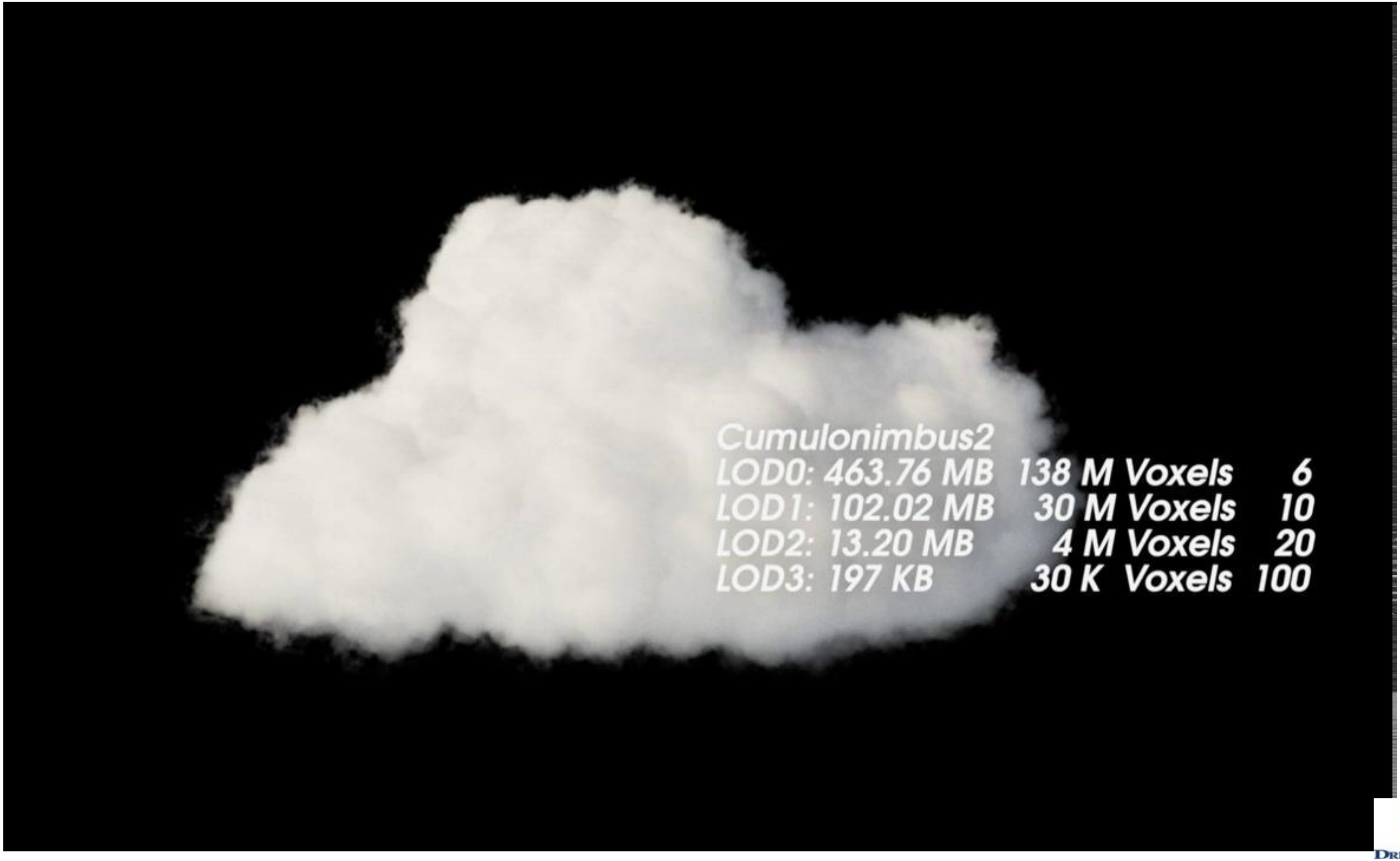
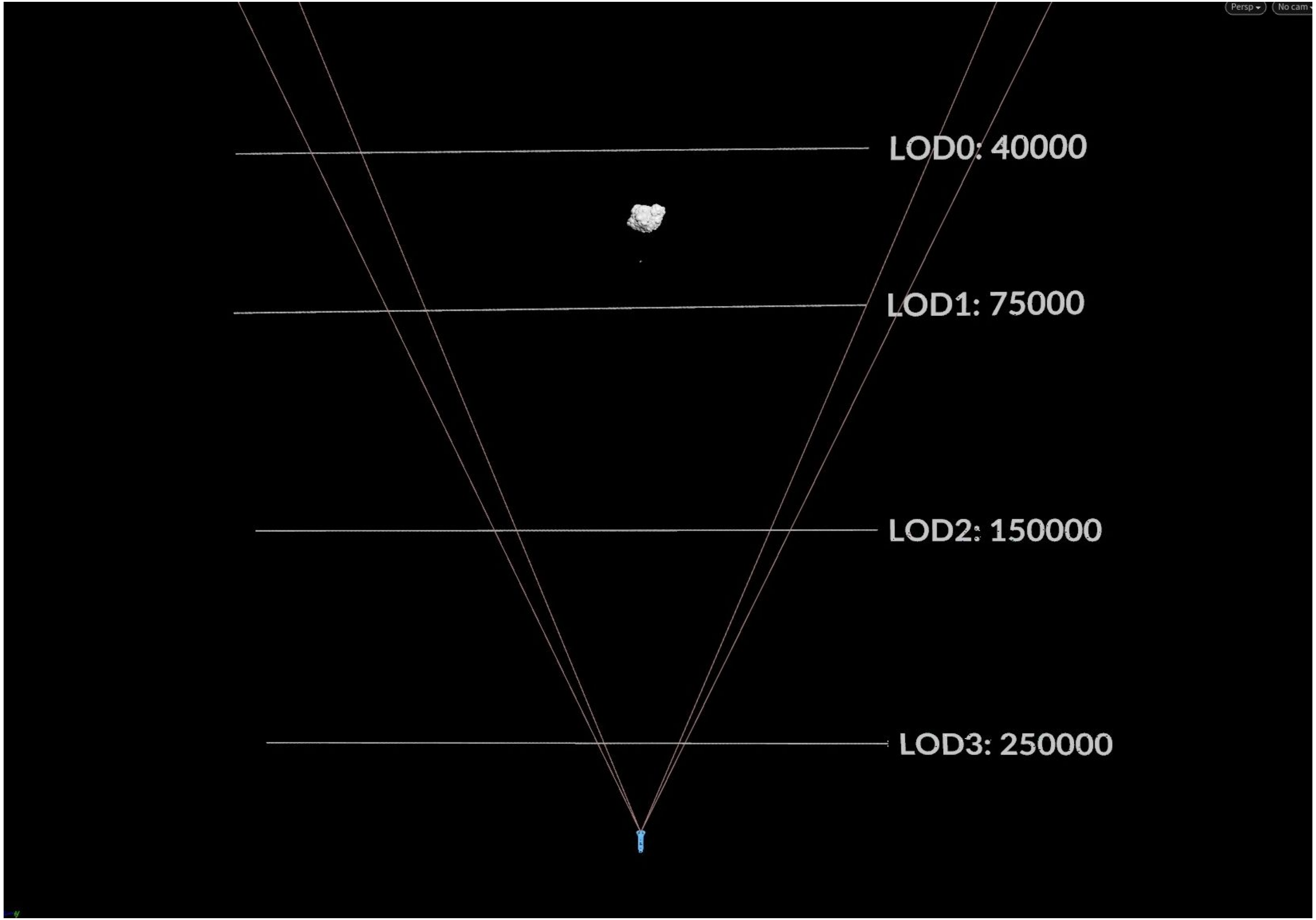

Cumulonimbus2
LOD0: 463.76 MB 138 M Voxels 6
LOD1: 102.02 MB 30 M Voxels 10
LOD2: 13.20 MB 4 M Voxels 20
LOD3: 197 KB 30 K Voxels 100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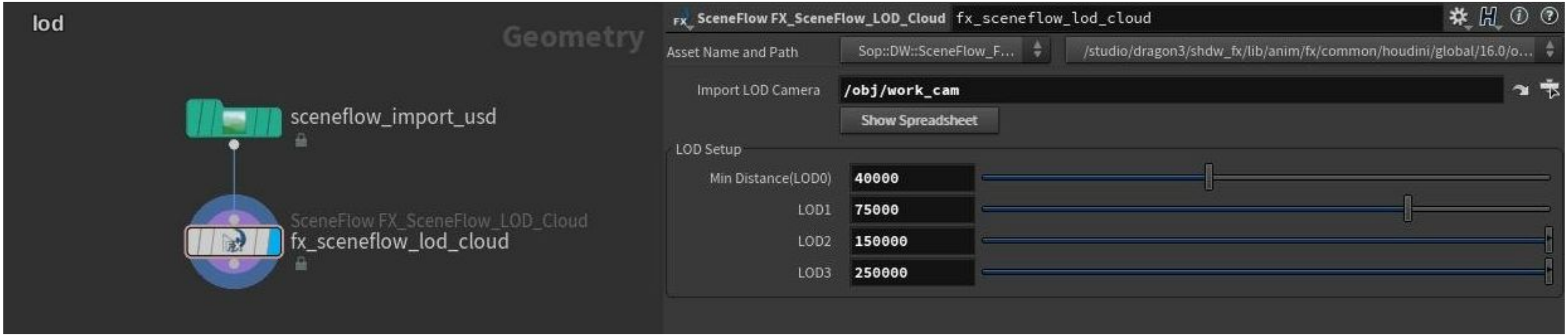
No cam
LOD0: 40000
LOD1: 75000
LOD2: 150000
LOD3: 250000

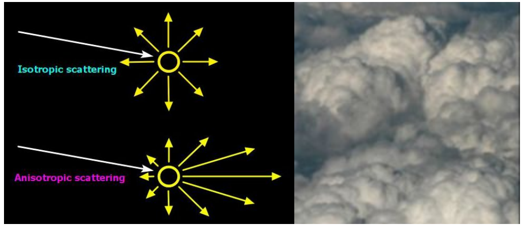

lod
Geometry
sceneflow_import_usd
SceneFlow FX_SceneFlow_LOD_Cloud
fx_sceneflow_lod_cloud
SceneFlow FX_SceneFlow_LOD_Cloud
fx_sceneflow_lod_cloud
Asset Name and Path
Sop::DW::SceneFlow_F...
/studio/dragon3/shdw_fx/lib/anim/fx/common/houdini/global/16.0/o...
Import LOD Camera
/obj/work_cam
Show Spreadsheet
LOD Setup
Min Distance(LOD0) 40000
LOD1 75000
LOD2 150000
LOD3 250000

Simulation

Lighting / Compositing

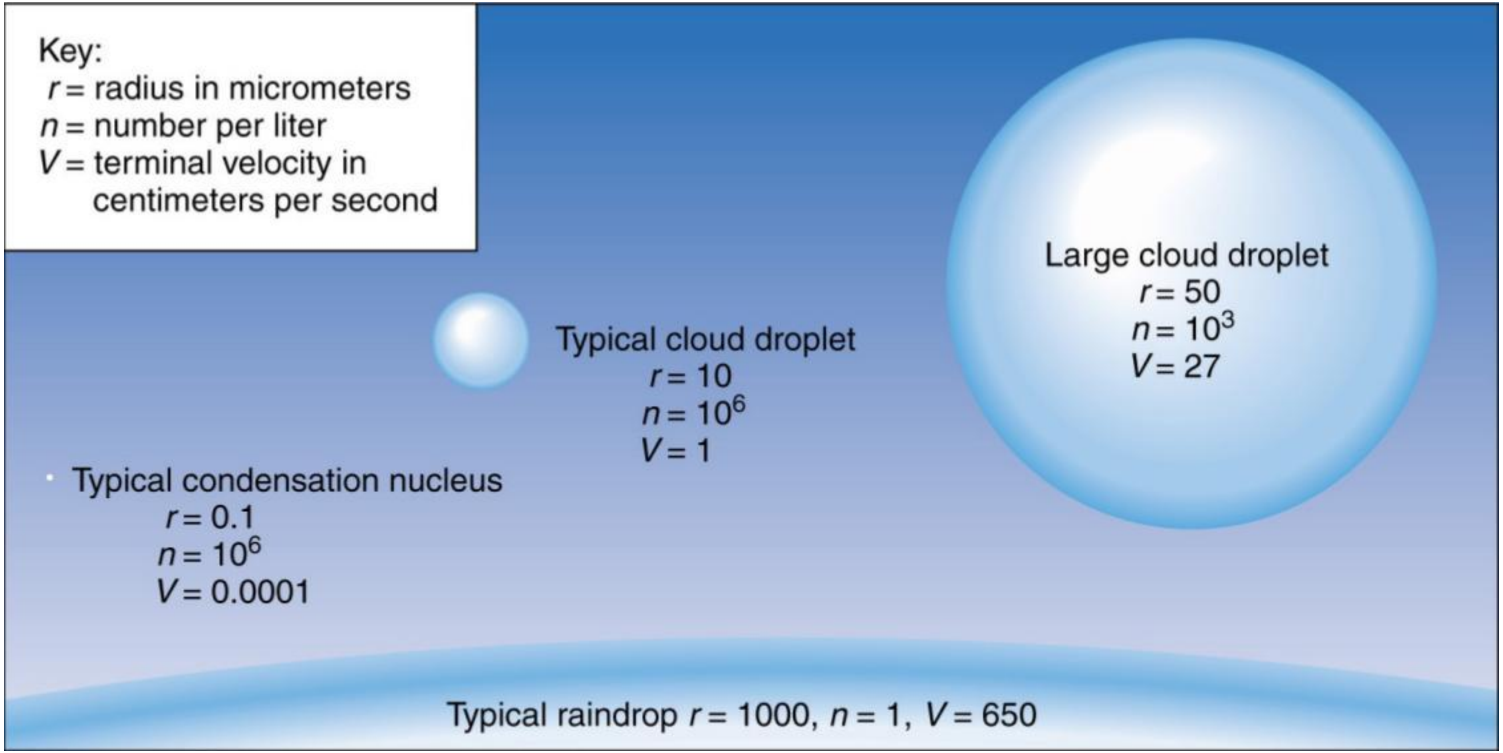
Lighting

- Anisotropic Scattering
- Dark Edges



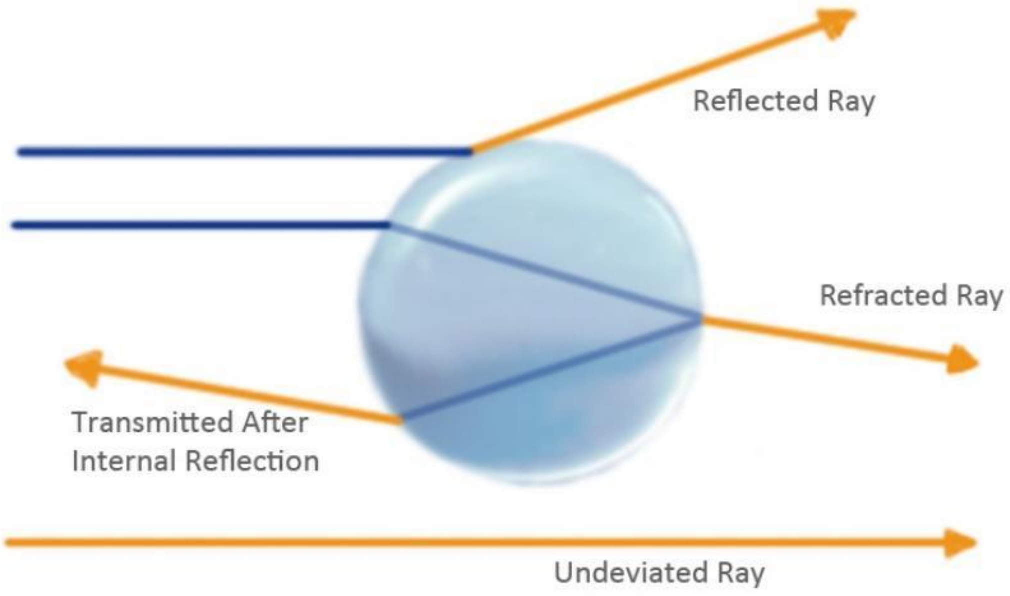
- Pixar's Good Dinosaur Paper
  http://magnuswrenninge.com/wp-content/uploads/2010/03/Webb-MakingADinosaurSeemSmall.pdf
- Sony's Horizon Game Paper
  https://www.guerrilla-games.com/read/the-real-time-volumetric-cloudscapes-of-horizon-zero-dawn
- Raytrace with Multiple-bounces and Anisotropic Scattering

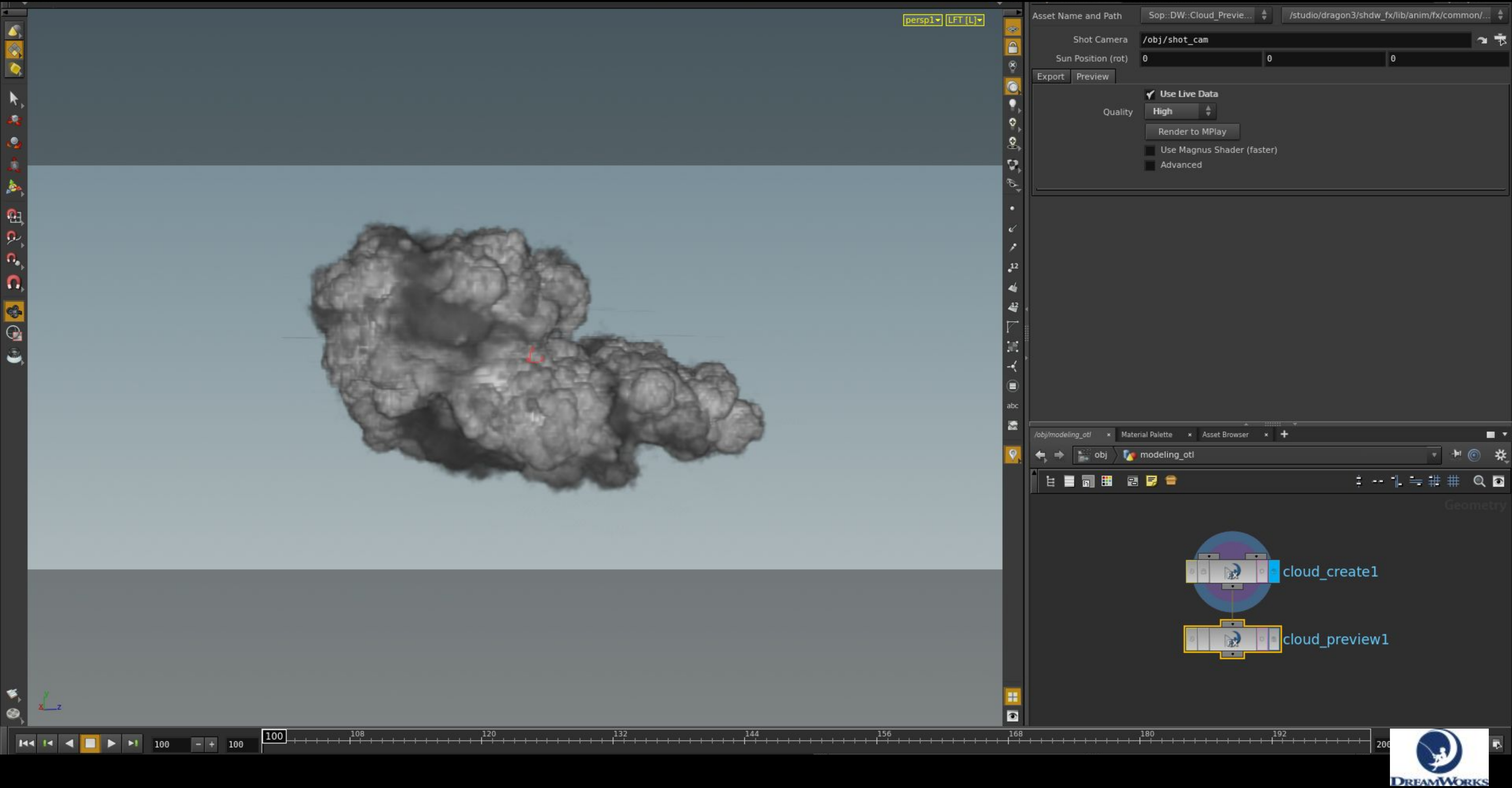
What is Cloud



Deep Shadows don't work

Clouds Scatter Light




persp1
LFT [L]
Asset Name and Path
Sop::DW::Cloud_Previe...
/studio/dragon3/shdw_fx/lib/anim/fx/common/...
Shot Camera
/obj/shot_cam
Sun Position (rot)
0
0
0
Export
Preview
Use Live Data
Quality
High
Render to MPlay
Use Magnus Shader (faster)
Advanced
/obj/modeling_otl
Material Palette
Asset Browser
obj
modeling_otl
Geometry
cloud_create1
cloud_preview1
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100
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108
120
132
144
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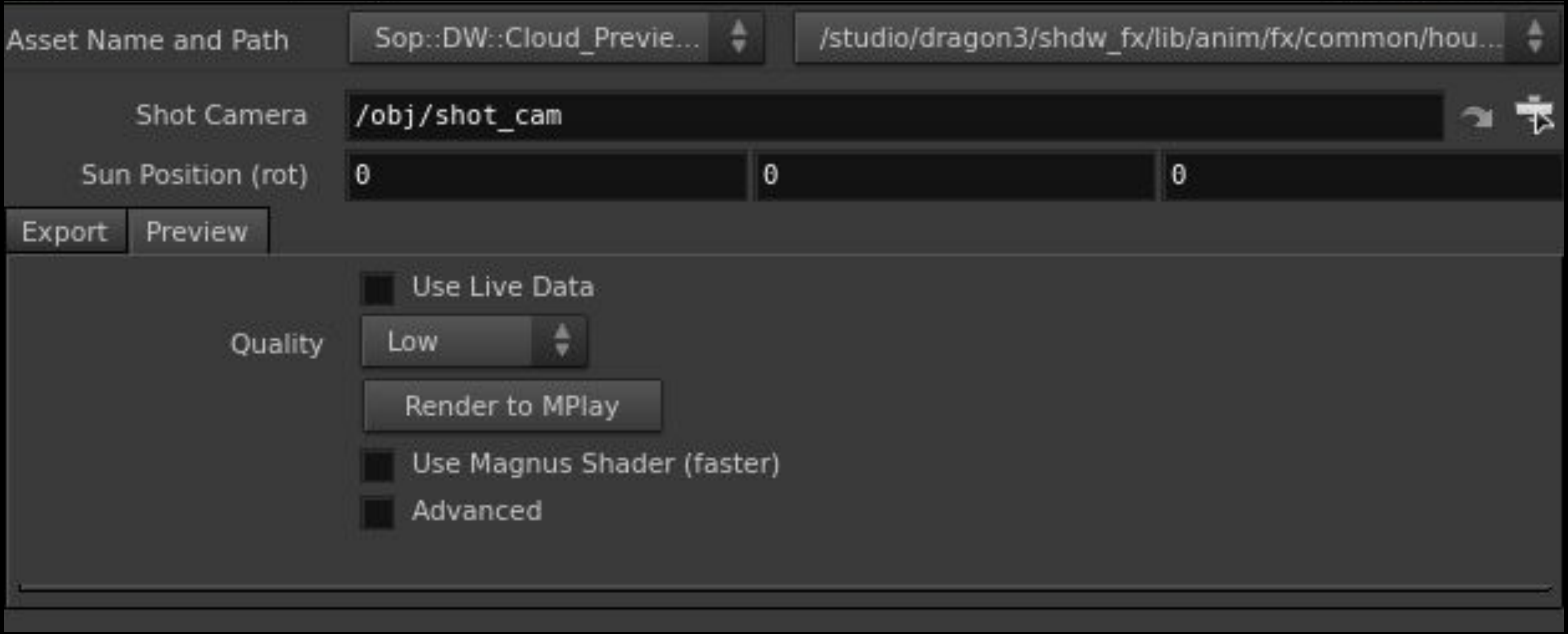
192
200
DREAMWORKS


Asset Name and Path
Sop::DW::Cloud_Previe...
/studio/dragon3/shdw_fx/lib/anim/fx/common/hou...
Shot Camera
/obj/shot_cam
Sun Position (rot)
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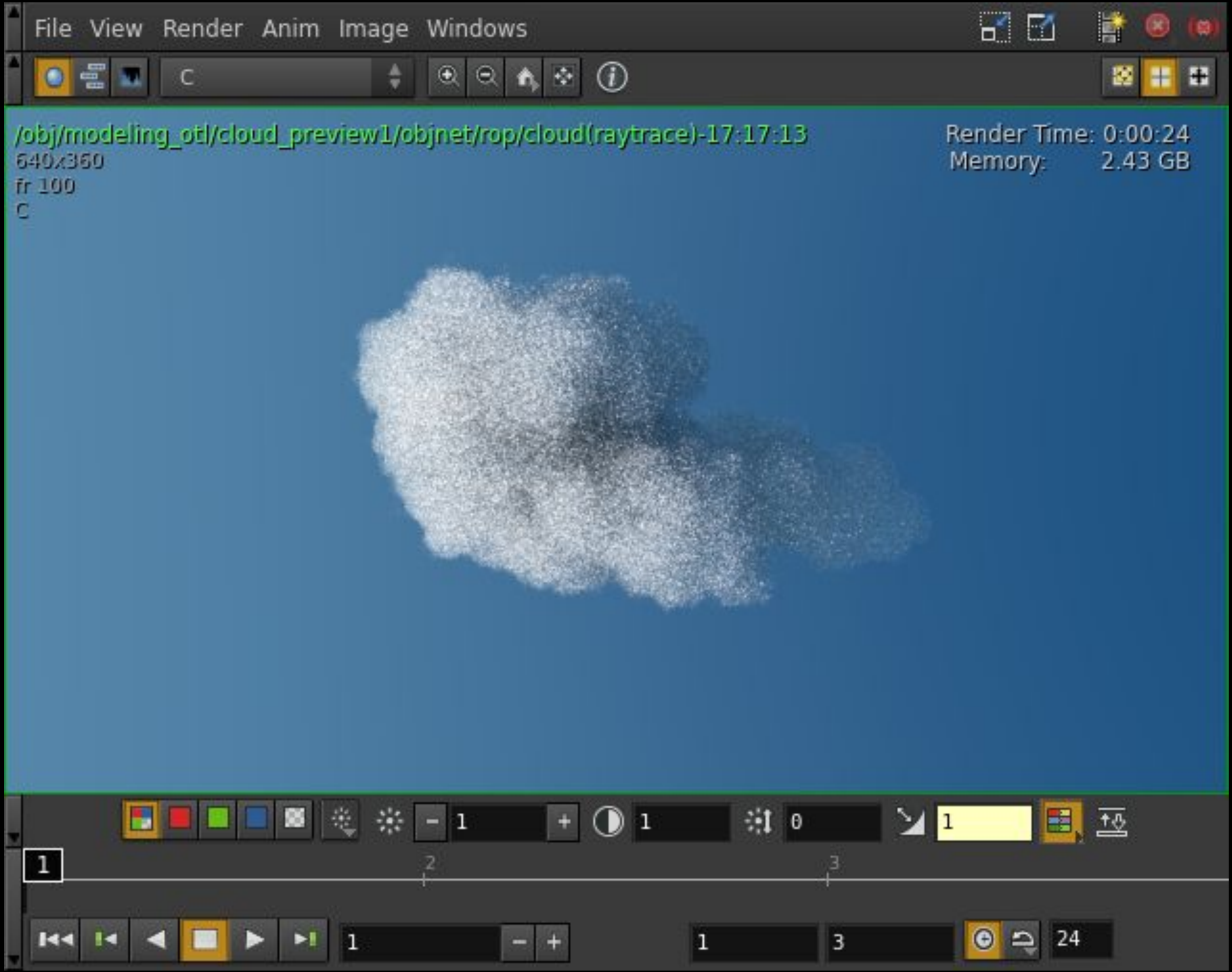
Export
Preview
Use Live Data
Quality
Low
Render to MPlay
Use Magnus Shader (faster)
Advanced


File
View
Render
Anim
Image
Windows
C
/obj/modeling_otl/cloud_preview1/objnet/rop/cloud(raytrace)-17:17:13
640x360
fr 100
C
Render Time: 0:00:24
Memory: 2.43 GB
1
1
0
1
1
2
3
1
1
3
24

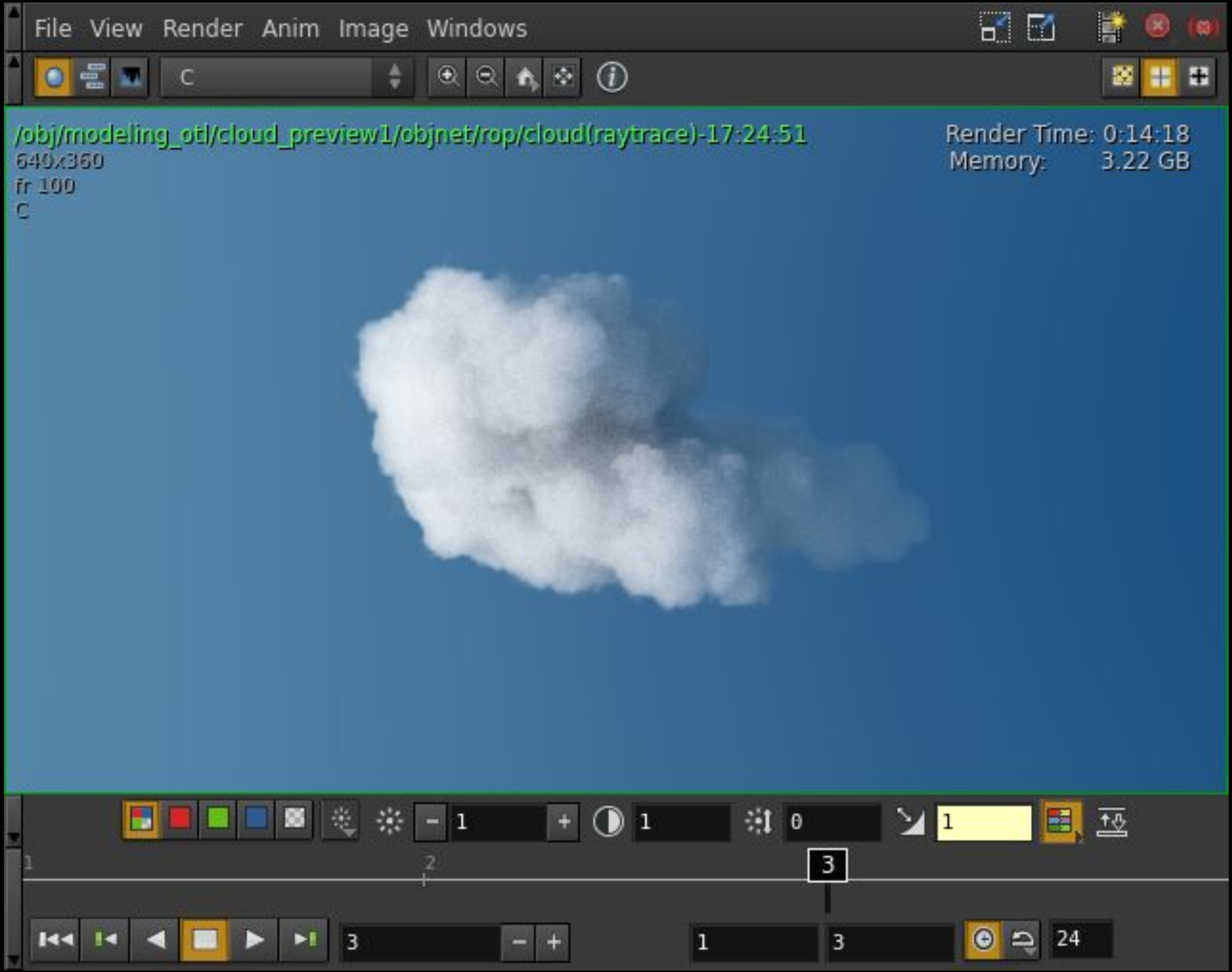

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Image
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640x360
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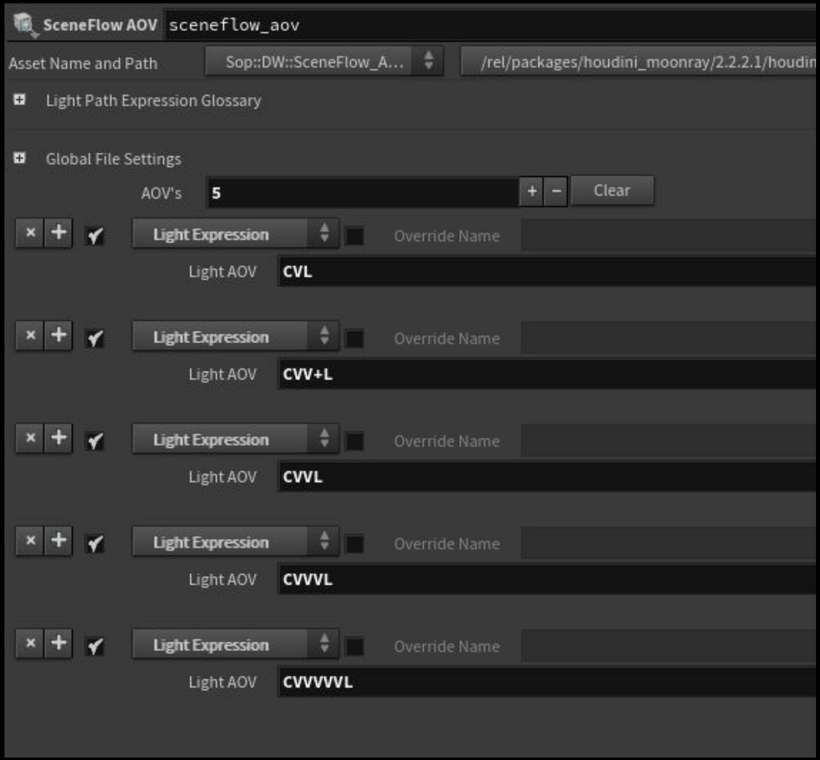
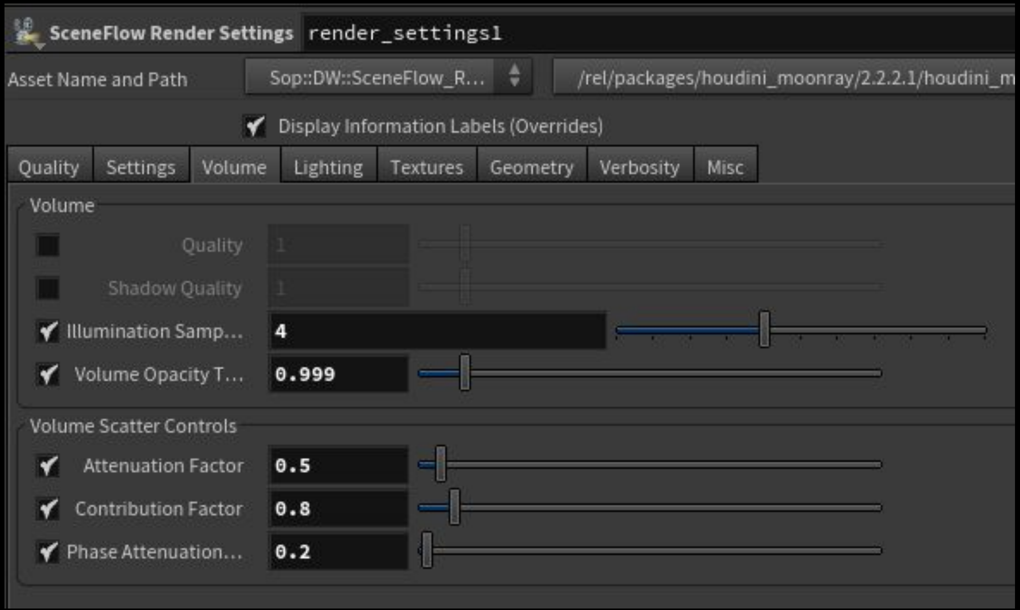

SceneFlow AOV
sceneflow_aov
Asset Name and Path
Sop::DW::SceneFlow_A...
/rel/packages/houdini_moonray/2.2.2.1/houdin
Light Path Expression Glossary
Global File Settings
AOV's
5
Clear
Light Expression
Override Name
Light AOV
CVL
Light Expression
Override Name
Light AOV
CVV+L
Light Expression
Override Name
Light AOV
CVVL
Light Expression
Override Name
Light AOV
CVVVL
Light Expression
Override Name
Light AOV
CVVVVVL


SceneFlow Render Settings
render_settings1
Asset Name and Path
Sop::DW::SceneFlow_R...
/rel/packages/houdini_moonray/2.2.2.1/houdini_m
Display Information Labels (Overrides)
Quality
Settings
Volume
Lighting
Textures
Geometry
Verbosity
Misc
Volume
Quality
1
Shadow Quality
1
Illumination Samp...
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Volume Scatter Controls
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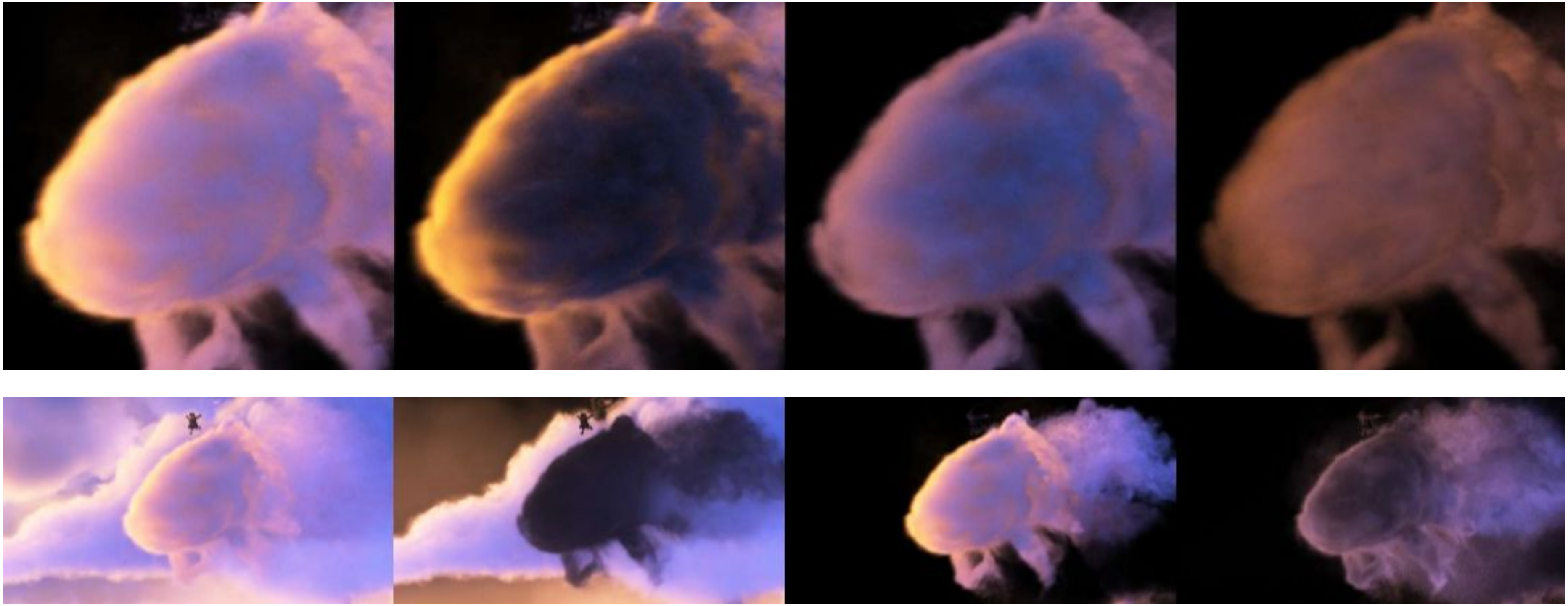
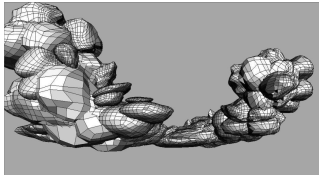
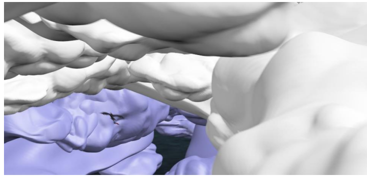
Contribution Factor
0.8
Phase Attenuation...
0.2



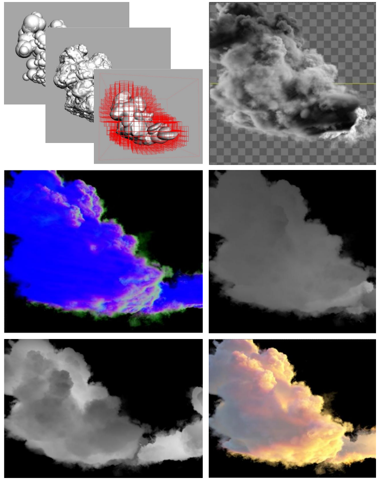
Modeling



Layout



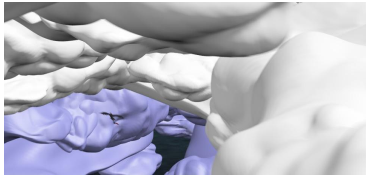
FX



Lighting

Cloudpipe 3.0

Layout



Lighting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Question?