

# Elementacular

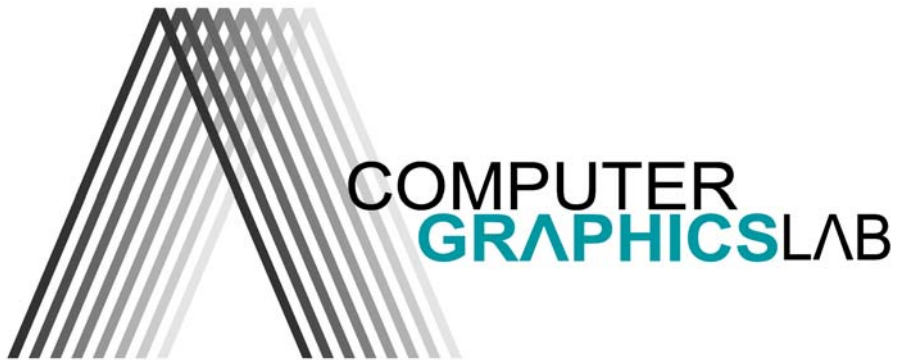
**A new generation of Maya plugin for interactive modeling  
and instant visualization of volumetric clouds and rocks**

Jesper Børlum

# Partners



SUNDAY®



JAVIA

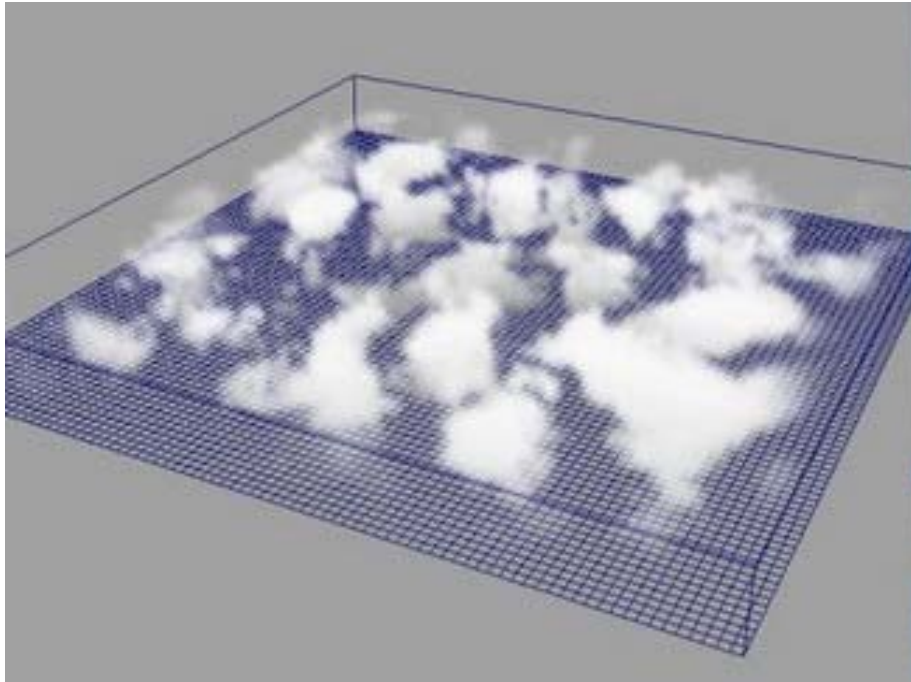


# Background

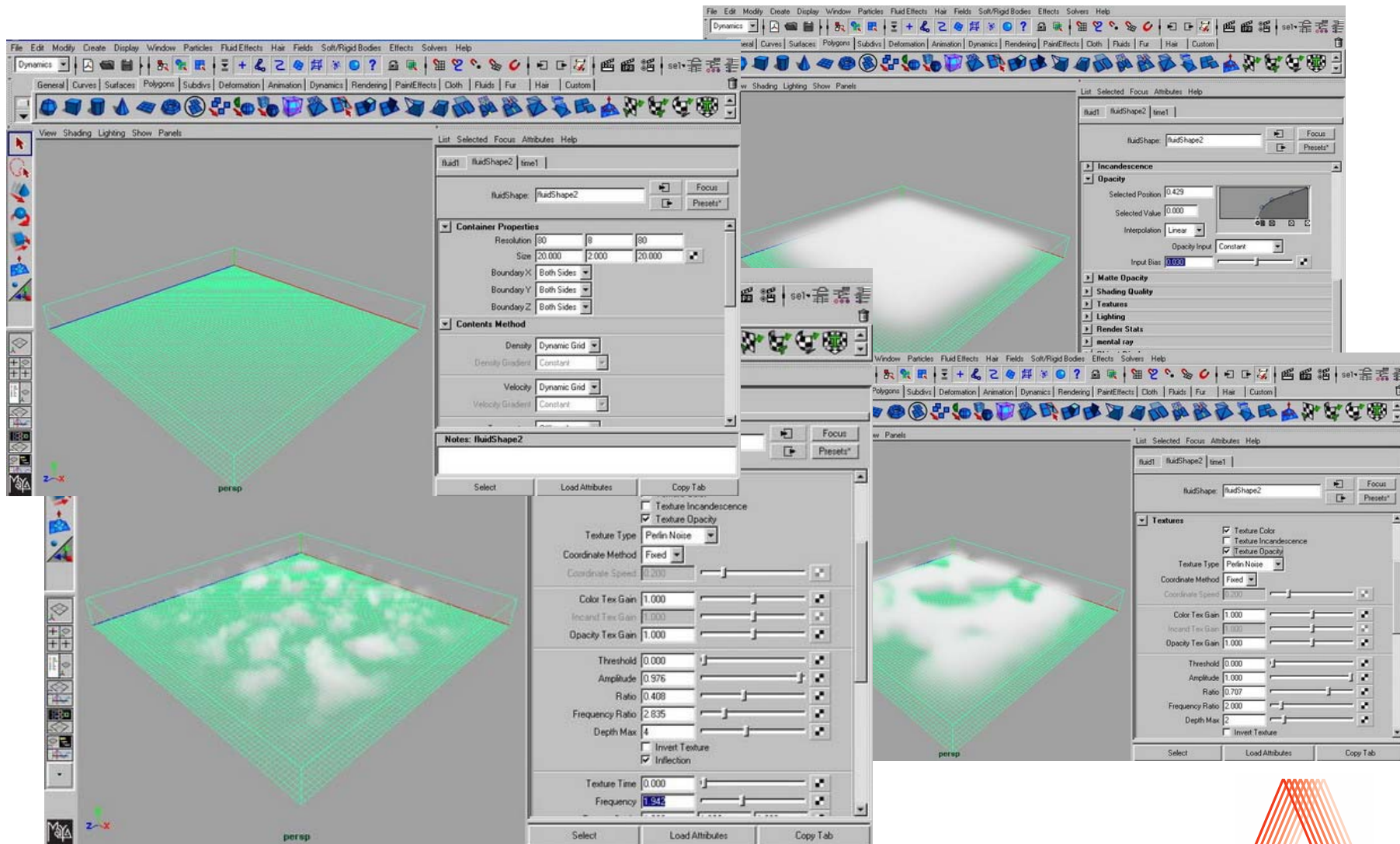


- Creating complex organic objects like clouds or rocks is difficult.
- Requires a highly specialized knowledge about simulation and rendering.
- Danish creative companies are not large enough to support these specialists.

# Background



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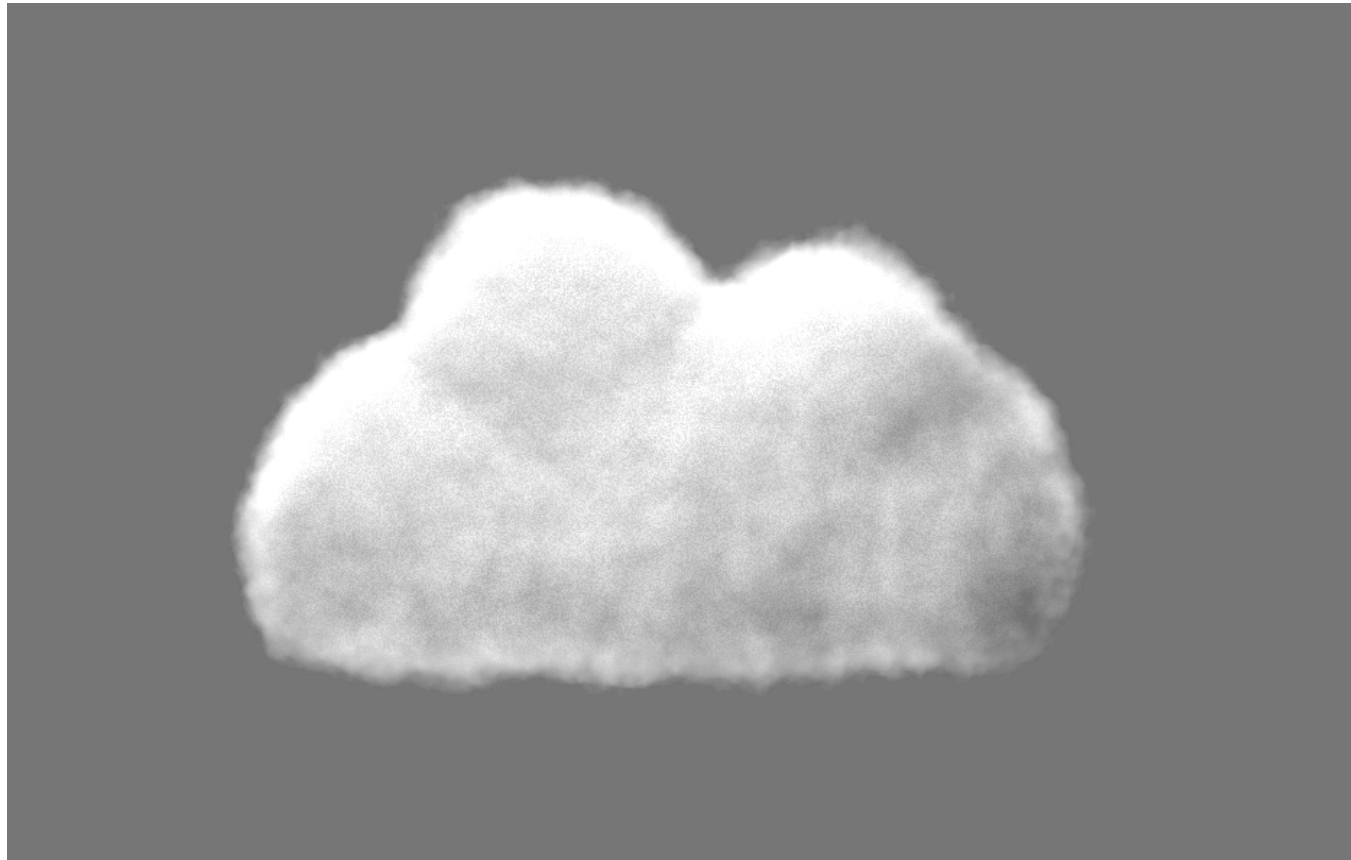
# Taming the Elements



- User-guided procedural content generation with instant feedback to make even the most advanced setups possible.
- High-quality real-time rendering which allows for continuous visual quality tweaking.
- Less time spent waiting.
  - More time for what really matters – Happy customers!



# I present to you – Elementacular!



- Oh well! – Turns out it's pretty hard to get right.

# Current Results – Cloud Module

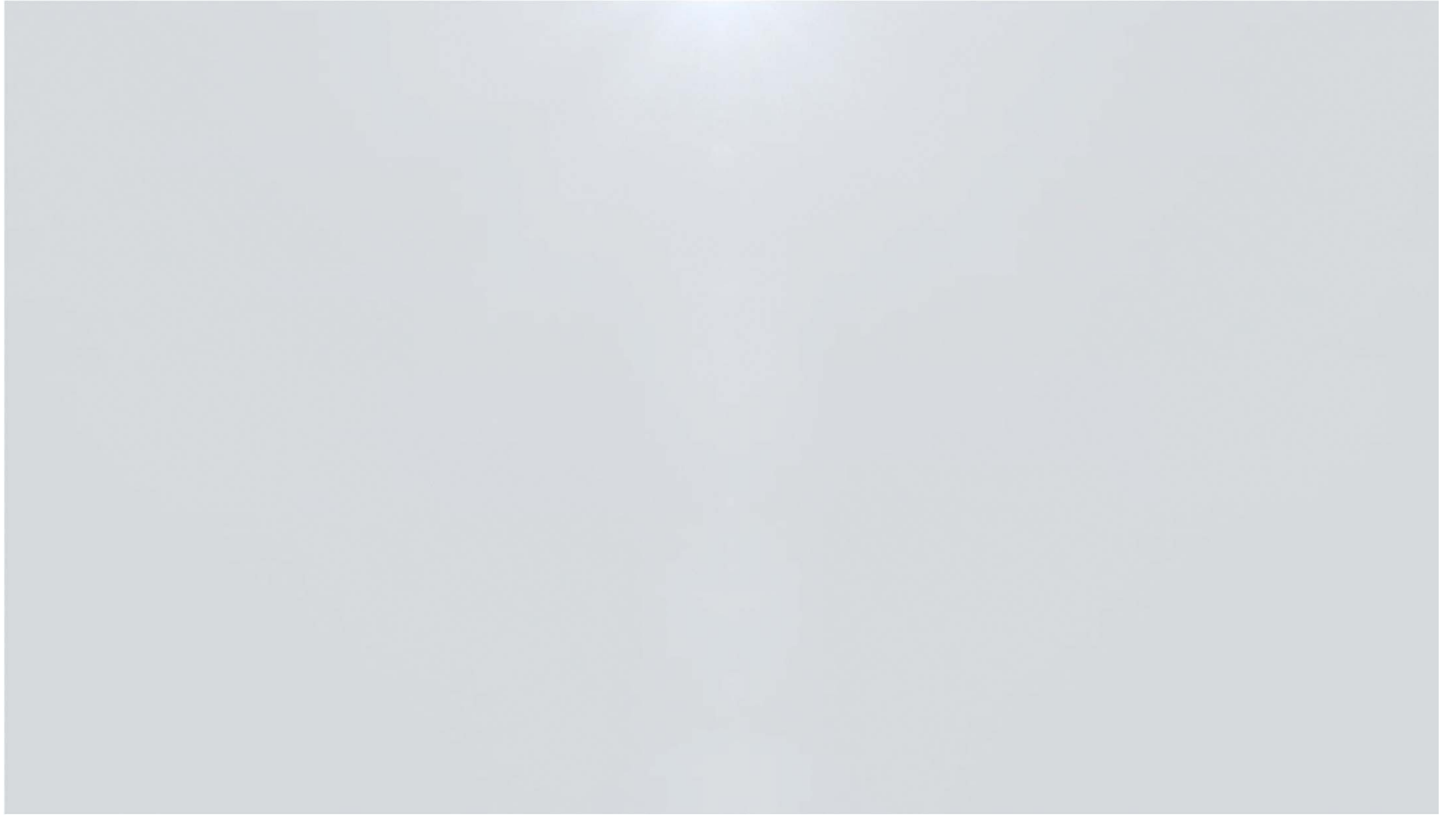




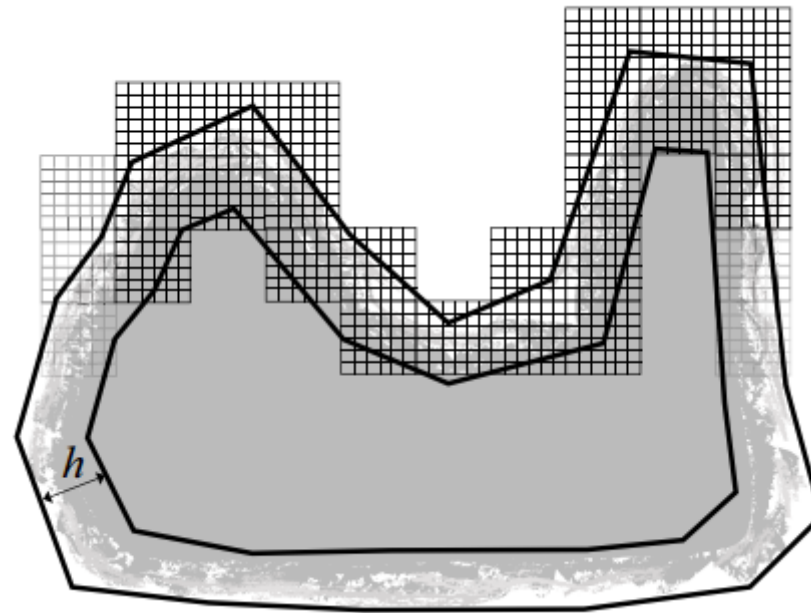
# Current Results – Rock Module





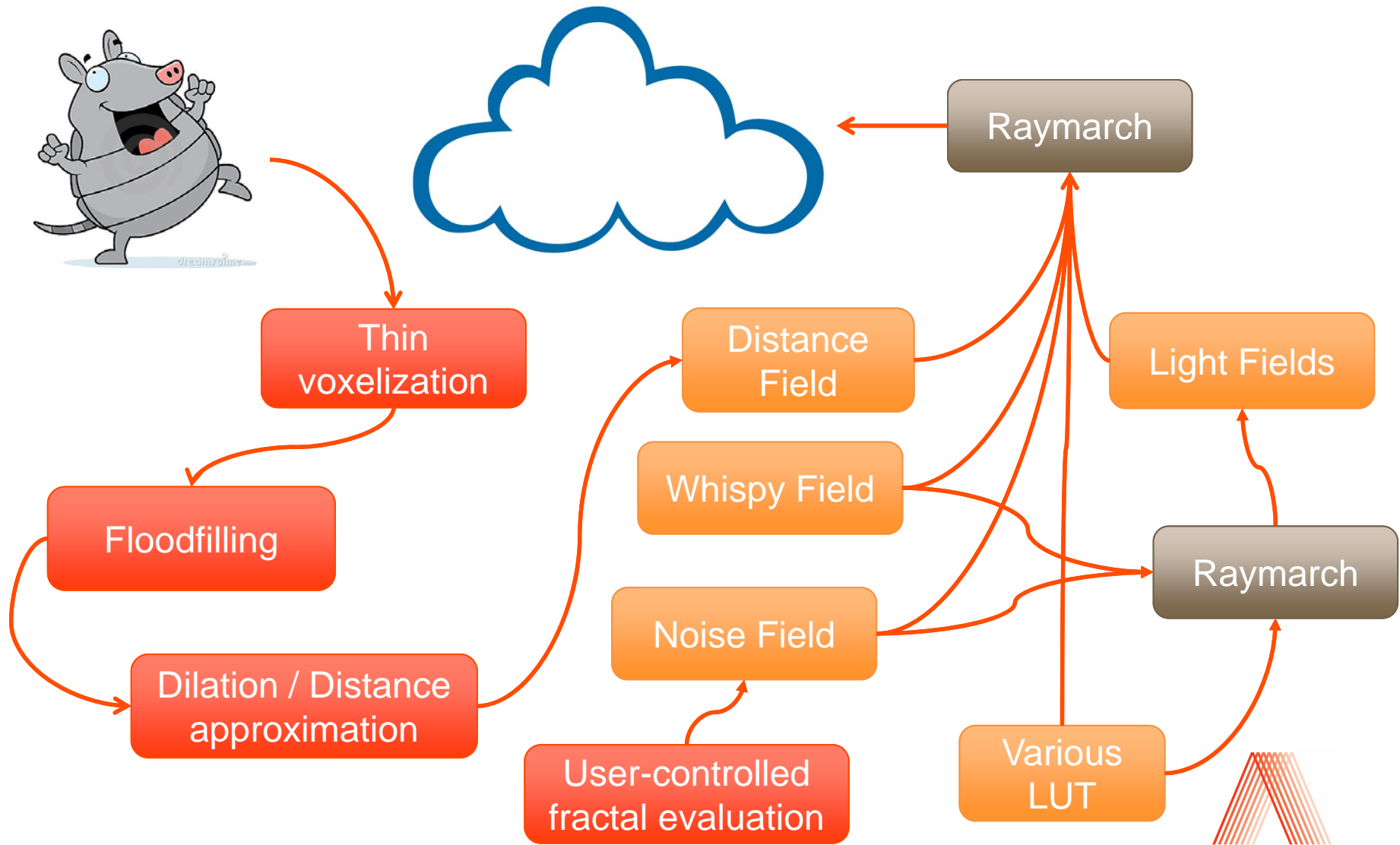


# Data Representation



Antoine Bouthors et. al.: *"Interactive multiple anisotropic scattering in clouds"*

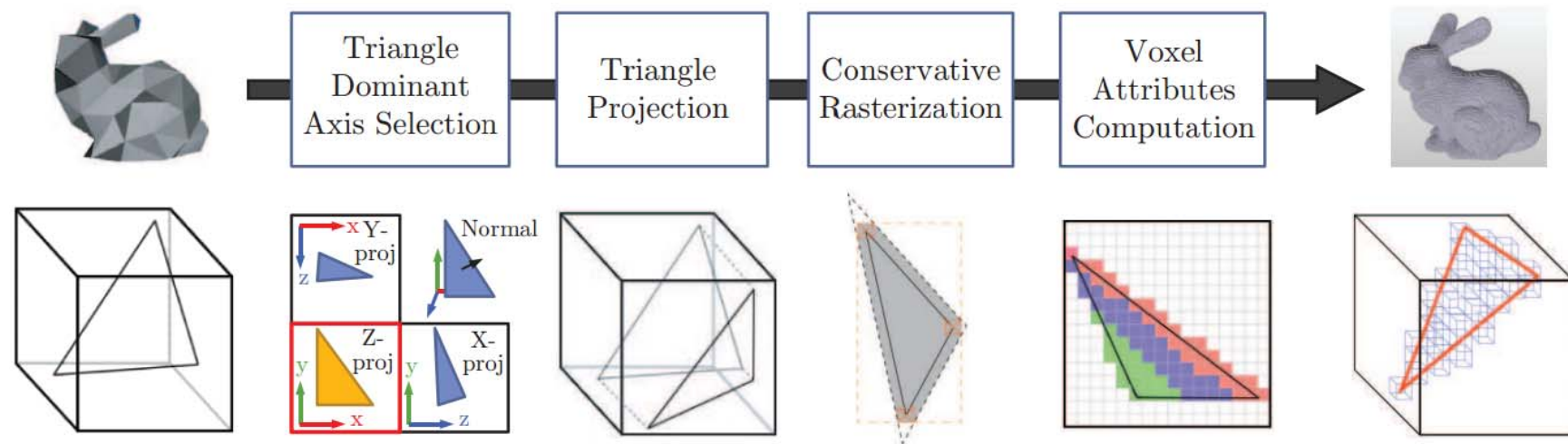
# Technique Overview



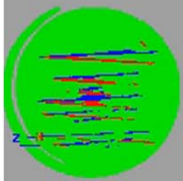
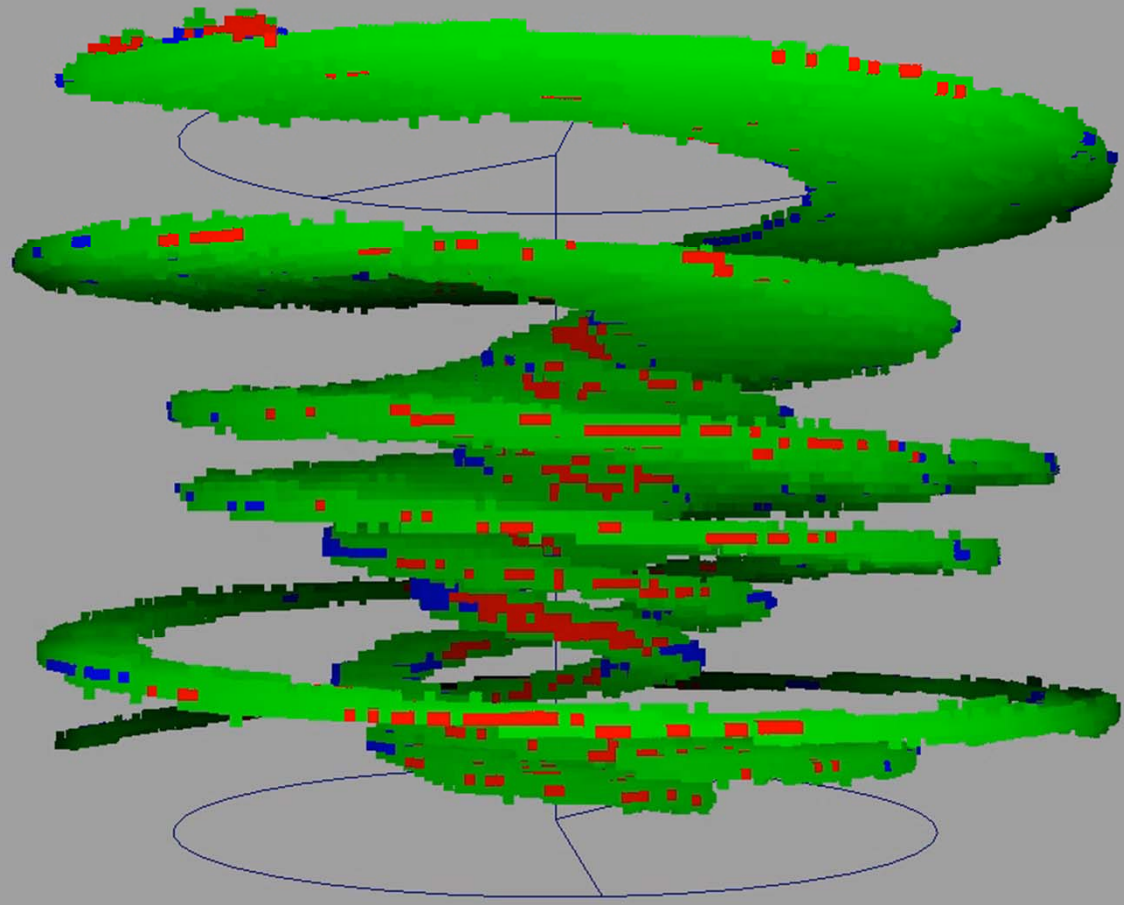
# Rasterization-based voxelization



- Based on Cyril Crassin and Simon Green: *“Octree-Based Sparse Voxelization Using the GPU Hardware Rasterizer.”*



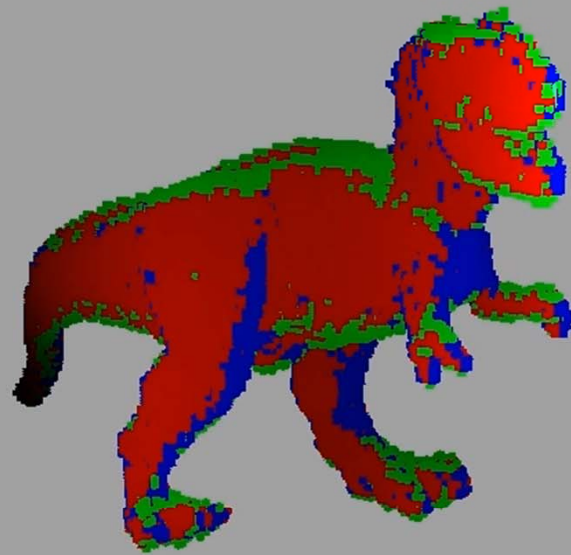
Viewport 2.0



persp



Viewport 2.0

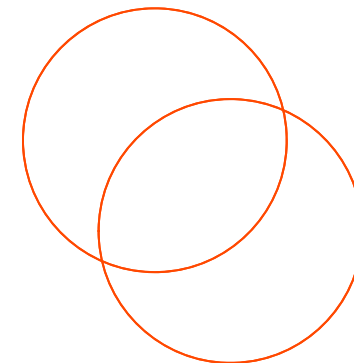


persp

# Why do we need to floodfill?



- Voxelization produces voxels for each triangle fragment.
- Trouble in paradise – A lot of geometry is self-intersecting.
- We need only the outer voxels.
- Tag known outer voxels and floodfill.



# Compute Shaders – Finally!



- Easy-to-use general-purpose compute.
- OpenGL 4.3 feature.
- Very powerful coupled with Image load/store.
  - Read/write to 3D texture at arbitrary positions.
  - Perform atomic operations on storage.

# Floodfilling on the GPU



- Comprised of two compute shaders.
- Compute Shaders execute per voxel.
- Tag initial outside voxels if visible from all three axes.
- Grow outside voxels by iterating.

# Dilation and Distance Estimation



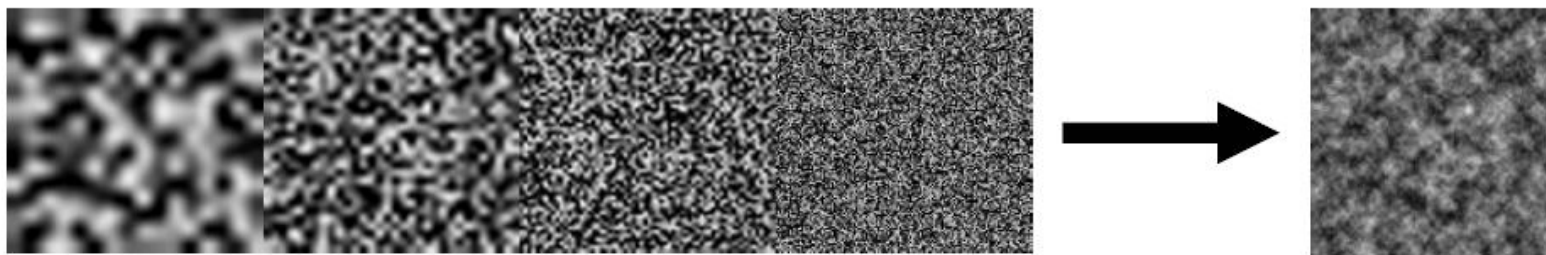
- Single compute shader.
- Propagate distance information from initial surface voxels:
  - If voxel is tagged as outside and not part of the initial surface, pull minimum distance.
  - Combine using imageAtomicMin.
  - Complicated by the fact that atomic operations only work on 32bit integers.

# Making Some Noise



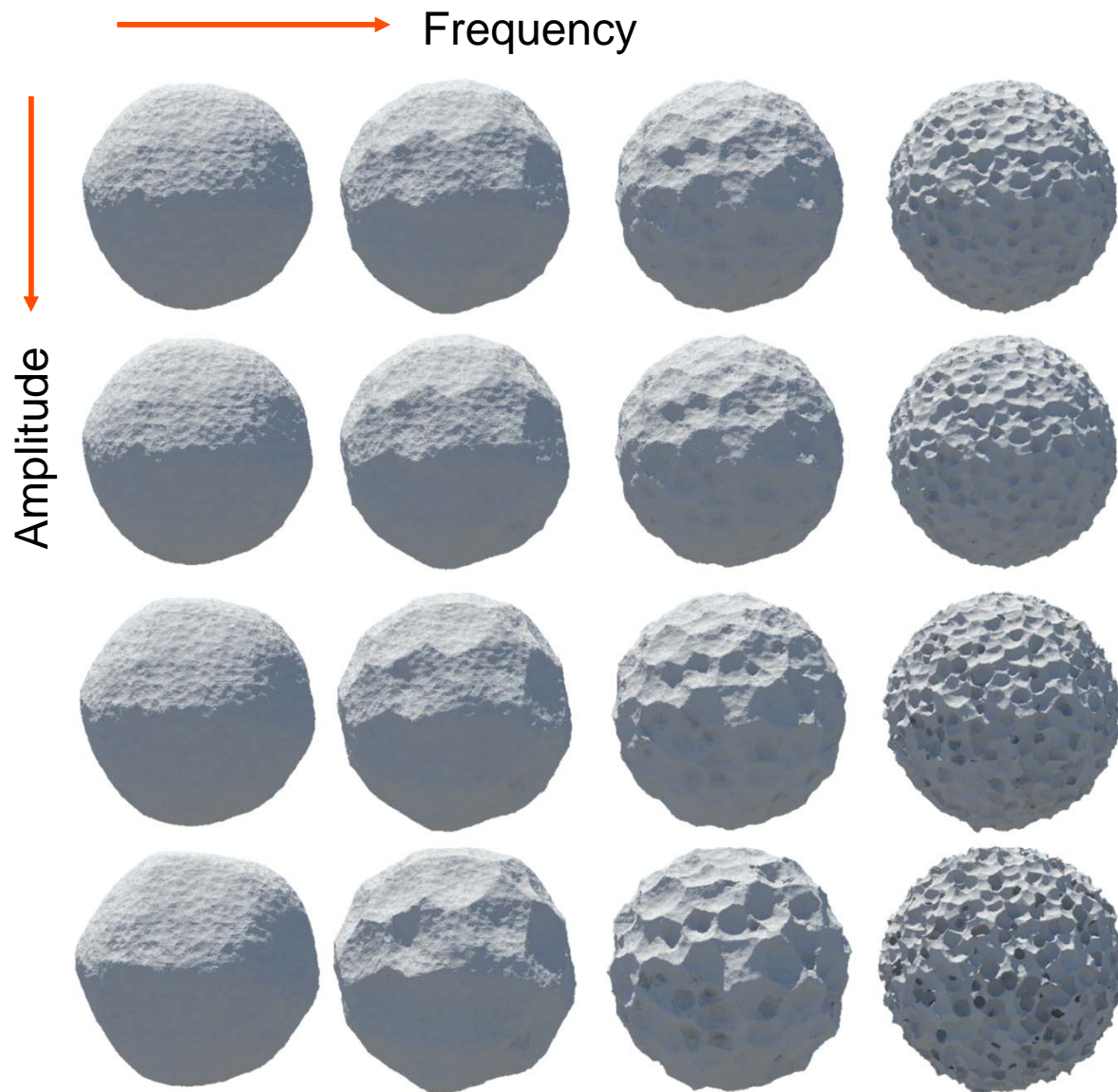
- Specialized compute shaders.
- A major part of getting the look right.
- Fractals based on GPU generated Simplex and Worley noise.
- Based on techniques outlined in Siggraph 2011 Course “Production Volume Rendering Systems”.

# Making Some Noise





# Making Some Noise



# Lighting the Volumes



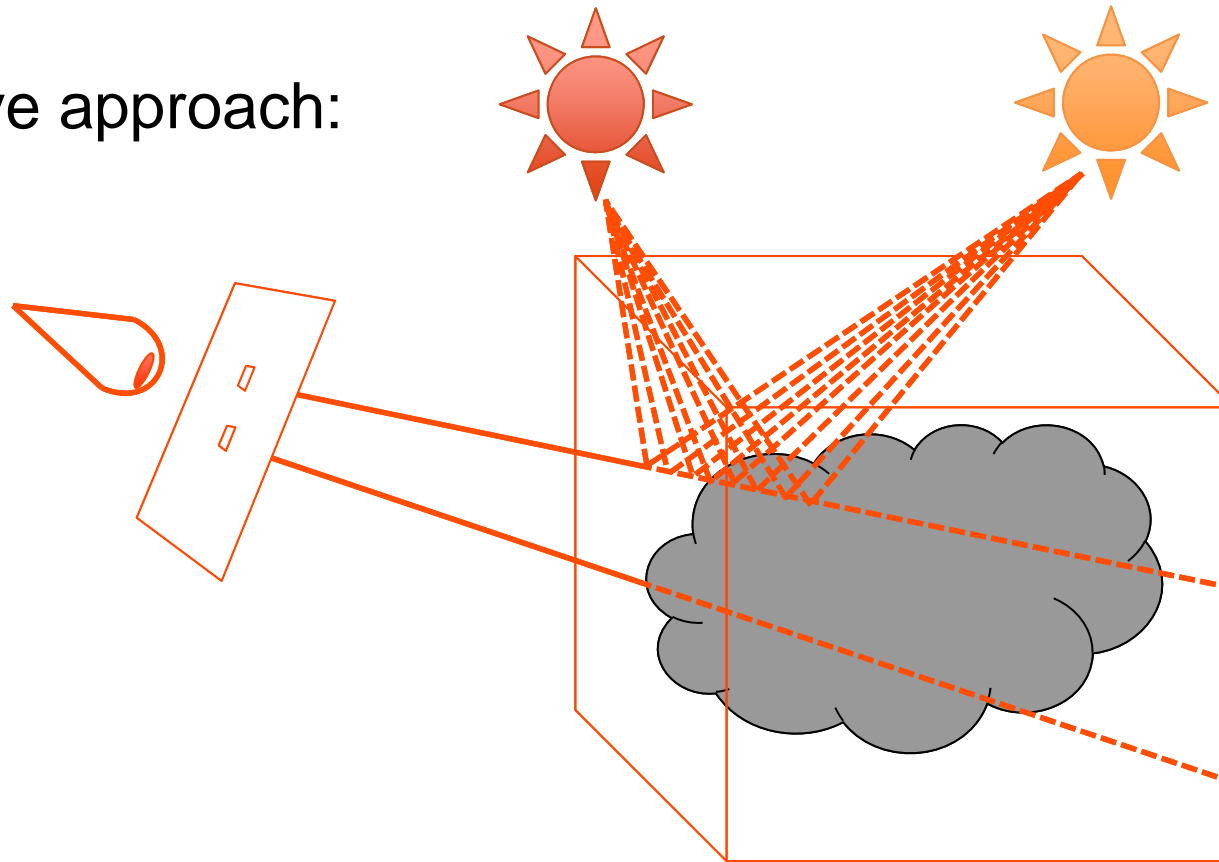
- Inside participating media light changes direction by hitting the particles.
- Usually handled separately.
  - Single scattering events.
  - Multiple scattering events.



# Real-time single scattering



- Naïve approach:



- Prohibitively slow for real-time.

# Real-time single scattering



- Exploit the fact that inscattered irradiance can be separated from primary ray absorption.
- Update only when lights are dirtied.
- March towards each light accumulating the irradiance into a separate light buffer using compute shader.
- When raymarching – Use light buffer instead of marching to light.

# Faking multiscatter effects



- Clouds diffuse most of the light.



# Faking multiscatter effects



- Hard to do in real-time using known techniques.
- Exploit the fact that clouds are very diffuse.
- Simply add a colored emissive term to marching.



# Looking ahead



- Focus has been on stills / matte / static volumes.
- Procedural fluid dynamics.
- Reparameterization of noise generation to allow animated models.

# Apply for Beta



- Come help us test it out!
- Maya 2013 / 2014.
- <http://www.elementacular.com>



# Funding

# *Shareplay*

DEN EUROPÆISKE UNION



Den Europæiske Fond  
for Regionaludvikling

Vi investerer i din fremtid



Questions?

Thank you for your attention

