Real-time Volumetric Fog Simulation

Project Defense

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https://github.com/todoval/CloudsShader

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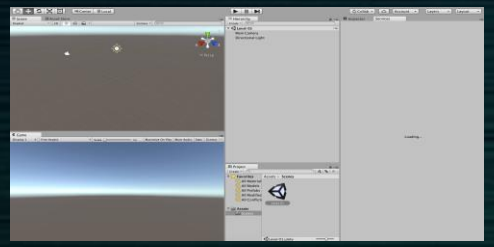
Volumetric Fog and Clouds

- Procedural real-time generation
- Different types of clouds
  - Cloud height
  - Cloud coverage
  - Stratus, cumulus...
- Lighting
  - Beer-Lambert's law
  - Powder effect
  - Phase function
- Optimizations

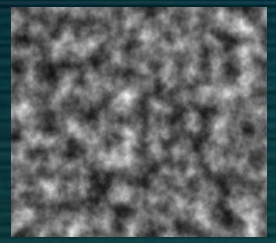
[Link to video]

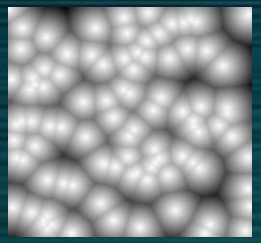
Project timeline

Empty Unity Project →

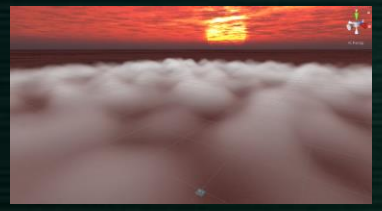


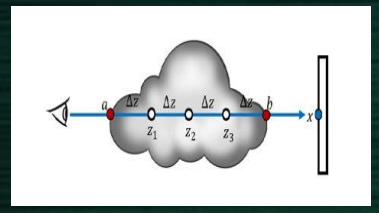
Noise Generation →



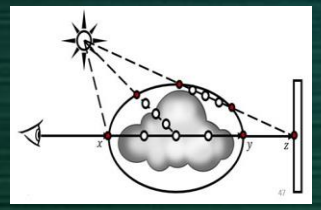


→ Visualization →





Lighting →



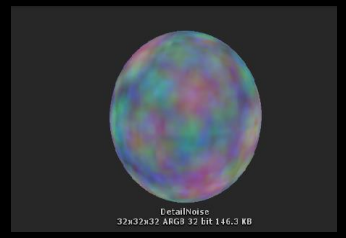
Optimizations

Starting the project

Empty Unity Project

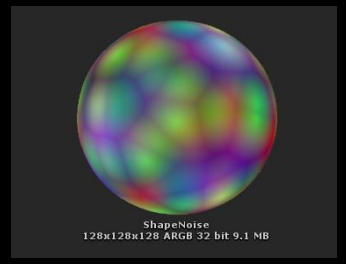
- Architecture setup
  - scripts, shaders, compute shaders, helper functions
- Research
  - Unity ShaderLab language, rendering pipeline…
  - Procedural cloud properties, lighting
- Resources:
  - Fredrik Haggstrom: Real-time rendering of volumetric clouds
  - Rurik Hogfeldt: Convincing Cloud Rendering
  - Dean Babić: Volumetric Atmospheric Rendering
  - Juraj Páleník: Real-time rendering of volumetric clouds
  - Horizon Zero Dawn: Real-time Volumetric Cloudscapes

Noise Generation



Detail Noise

+



Shape Noise

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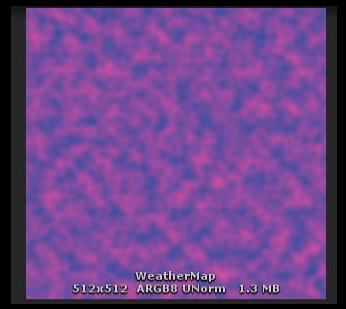

Weather Map

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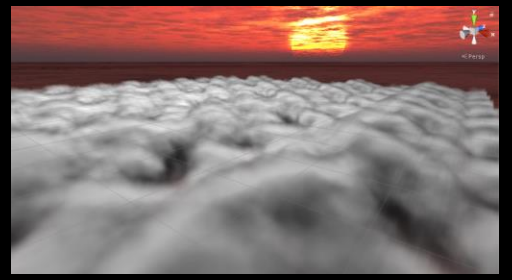
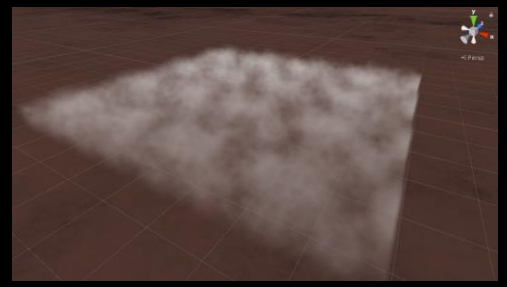
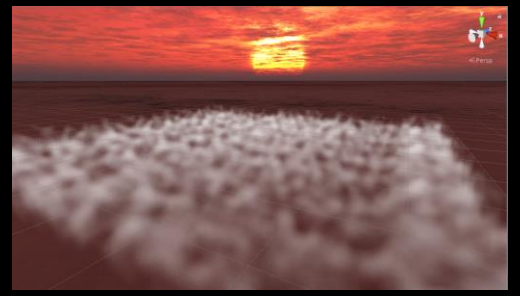
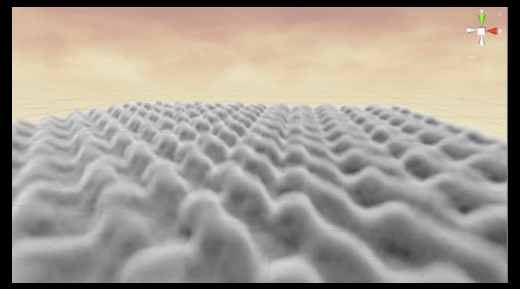


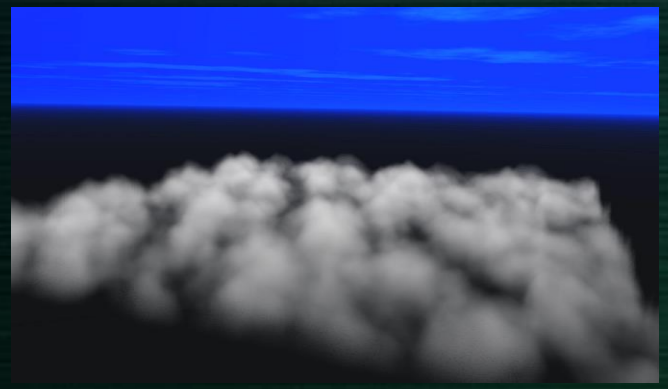






Visualization & Lighting

Beer-Lambert's Law



Powder Effect

Henyey-Greenstein
Phase Function

Optimizations

- Raymarch + Lightmarch
  - step size, step decrease
- Blue Noise
- Temporal Upsampling
  - only skyboxes

24 fps

55 fps

11 fps

60 fps

92 fps

132 fps

Main issues:

- Unity ShaderLab language
- Creating 3D textures
- Performance problems
  - Temporal upsampling
- *If it looks good, it works!*

Future work:

- Performance
  - Temporal upsampling check
  - Temporal reprojection
- Nice to have:
  - Random number generation
  - Directional light support
  - User-friendly wind direction

Thank you for your attention!

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