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# HurricaneVis – Geospatial Visualization using Hardware Accelerated Real-Time Volume Rendering

M. Berberich[1,2], Phil Amburn[1], Robert Moorhead[1], Jamie Dyer[1], M. Brill[2]

[1]Mississippi State University, Mississippi, U.S.A.
[2]University of Applied Sciences Kaiserslautern, Germany

## 1. Introduction

Because of the catastrophic effect of hurricanes, severe tropical storms are studied by weather forecasting agencies and meteorologists. A more detailed and more interactive visualization tool would enhance the understanding of hurricanes and answers open questions in weather forecasting, enabling better predictions that will save human lives and reduce damage.

Weather data are collected by sources such as satellites, airplanes, and surface weather observatories. After the initial data acquisition the data is input into mathematical models of the atmosphere to run a simulation and thereby predict the weather. The output of these simulations are floating point numbers representing a volume of scalar and vector data in 3D space. Volume visualization techniques include iso-surfaces with marching cubes and direct volume rendering algorithms like ray casting and texture slicing [EMK*06].

We present a visualization framework using direct volume rendering techniques with real time performance and high image quality. The visualization is designed to run on the desktop as well as in an immersive environment. The application named *HurricaneVis* uses OpenGL, GLSL, and VTK [SML06]. For immersive visualization VR Juggler is used.

## 2. Our Approach

To use volume rendering techniques the scalar data are classified using transfer functions, assigning color and transparency and storing the result as a 3D RGBA texture. The transfer functions can be edited interactively. To make sure the corresponding rendering can be done in real-time, the transfer functions are applied a-posteriori. The transfer functions are stored as a 1D RGBA texture, and the classification is done in a fragment shader. Direct volume rendering is also implemented as a fragment shader.

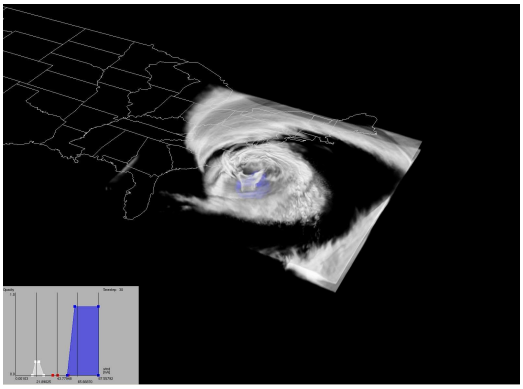

**Figure 1:** *Horizontal wind speeds in Hurricane Isabel*

To compare the implemented volume rendering techniques, a user study was conducted. The subjects were students in the *Dynamic Meteorology II* and *Physical Meteorology* classes at Mississippi State University. The results prove that both volume rendering and iso-surfaces visualizations are very useful for the interrogation of hurricanes. Because of the higher image quality and the higher frame rates, direct volume rendering using ray-casting or view-aligned texture slicing was preferred.

### Acknowledgements

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### References

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