HurricaneVis – Geospatial Visualization Using Hardware Accelerated Real-Time Volume Rendering

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Abstract

We present a visualization framework using direct volume rendering techniques that achieves real-time performance and high image quality. The visualization program runs on a desktop as well as in an immersive environment. The application is named HurricaneVis, and it uses OpenGL, GLSL, and VTK. For immersive visualization VRJuggler is added.

To achieve real-time rendering rates for 4D scalar data we use the programmability of the GPU, and in particular store the transfer function as well as the 3D volume of scalar data on the GPU in texture memory.

We conducted a user study to compare the implemented volume rendering technique with state-of-the-art isosurface rendering. The subjects were students in the *Dynamic Meteorology II* and *Physical Meteorology* classes at Mississippi State University.

The results establish that both volume rendering and isosurface visualizations are effective in examining data from numeric models 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.

Datasets Used

- Hurricane Isabel WRF simulation dataset – used in the user study
- Hurricane Lili MM5 simulation dataset – used as training data for the user study

Highlights of the Desktop Environment

- Extensible and adaptive framework for Hurricane Visualization
- Real-time performance using GPUs
- Post-classification for interactive editing of transfer function
- Object-aligned and view-aligned texture slicing as a fragment shader
- Ray-casting as a fragment shader

Porting to a 3D Immersive Environment

- Room sized 3D immersive environment consists of three back-projected walls and a front-projected floor
- Used VRJuggler for multi-wall display and interaction

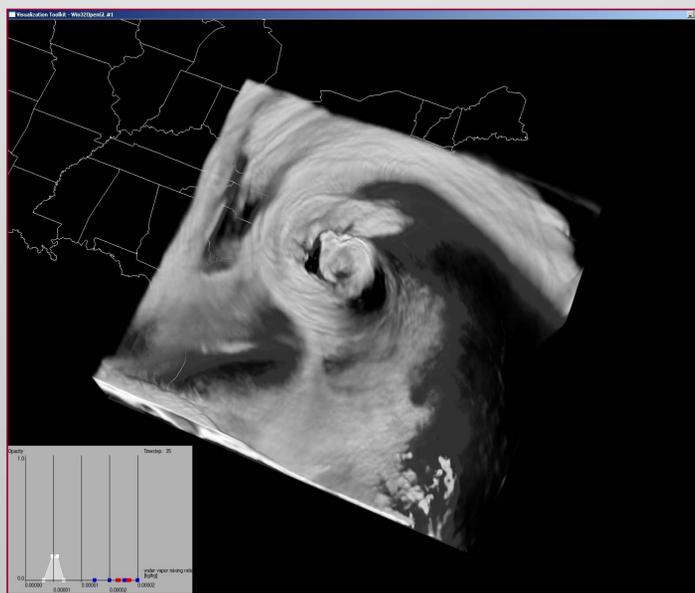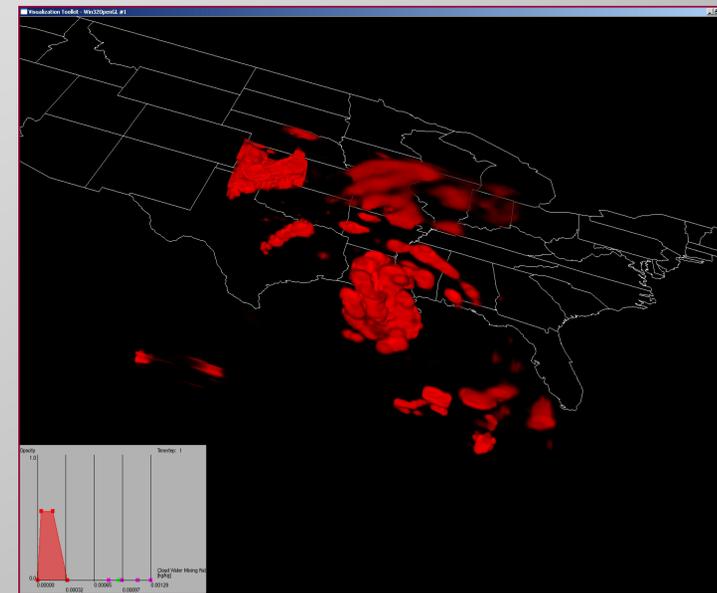## Acknowledgement

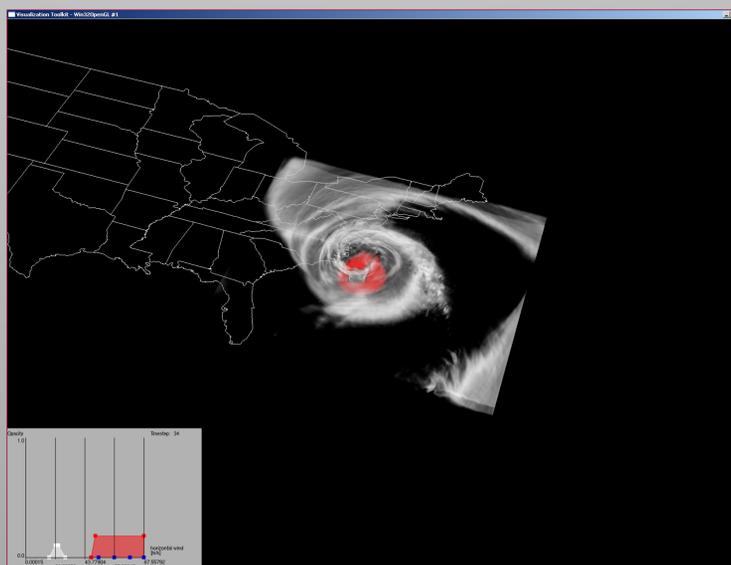Figure 1: Isabel Q variable

Figure 2: Lili CLW variable

Figure 3: Isabel UV variable

Figure 4: Isabel UV variable in CAVE

The User Study

- To compare iso-surface and direct volume rendering for visualization and analysis of hurricanes
- Subjects were students in *Dynamic Meteorology II* and *Physical Meteorology* classes at Mississippi State University
- Results – both volume rendering and iso-surface visualizations are very useful to the interpretation of hurricane data
- Because of the higher image quality and the higher frame rate, direct volume rendering using either ray-casting or view-aligned slices was preferred