STRIELAD – A Scalable Toolkit for Real-time Interactive Exploration of Large Atmospheric Datasets

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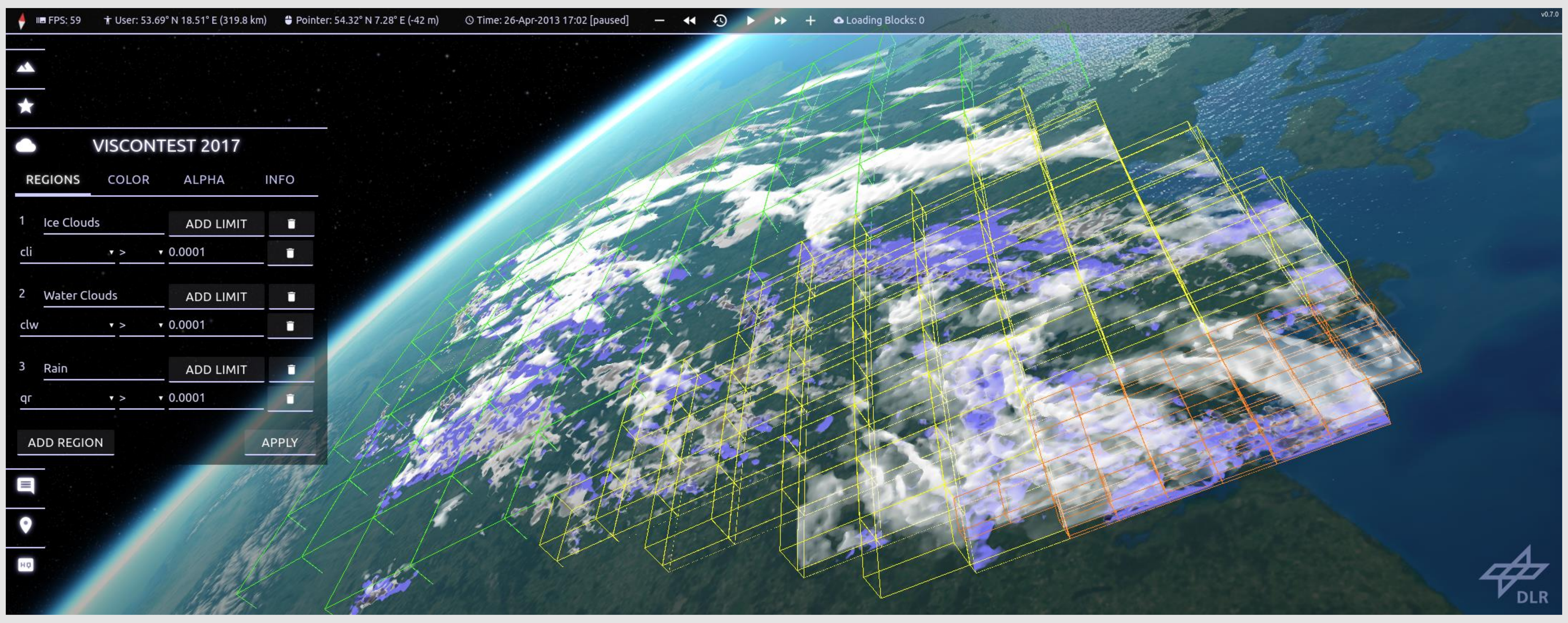
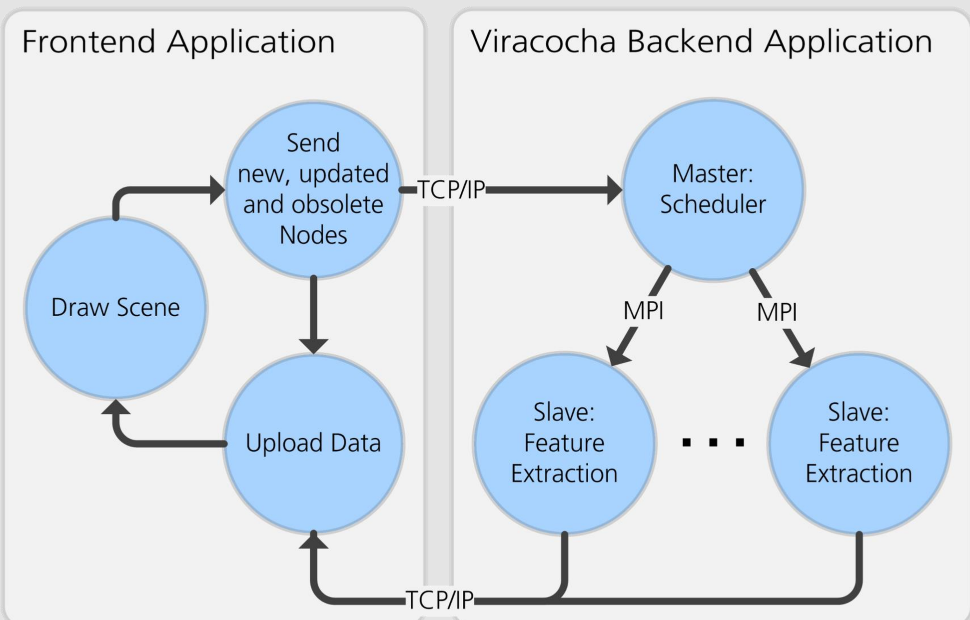


Real-time volumetric visualization of ice, water, and rain bands using our sub-volume selection mechanism in the graphical user interface. In addition, large terrain data is combined with the weather simulation to analyze their correlations.

Technological advances in high performance computing and maturing physical models allow scientists to simulate weather and climate evolutions with an increasing accuracy. We present STRIELAD, a scalable weather analytics toolkit, which allows for interactive exploration and real-time visualization of such large scale datasets. It combines parallel and distributed feature extraction using high-performance computing resources with smart level-of-detail rendering methods to assure interactivity during the complete analysis process. Users can select sub-volumes bounded by scalar thresholds and define their color with complex shading operations.



The rendering frontend selects nodes of the Level-of-Detail data structure for parallel processing. The backend executes the feature extraction on a cluster system and streams results back.

System architecture

- Based on the viewer's position, a frontend application selects nodes of a Level-of-Detail data structure which should be rendered
- For each node, a backend application generates a parallel feature extraction task which is then executed on a HPC-cluster

Data preprocessing

- For each time step, the dataset is partitioned in many small blocks
- An octree with nodes containing lower resolution data is generated

Parallel feature extraction

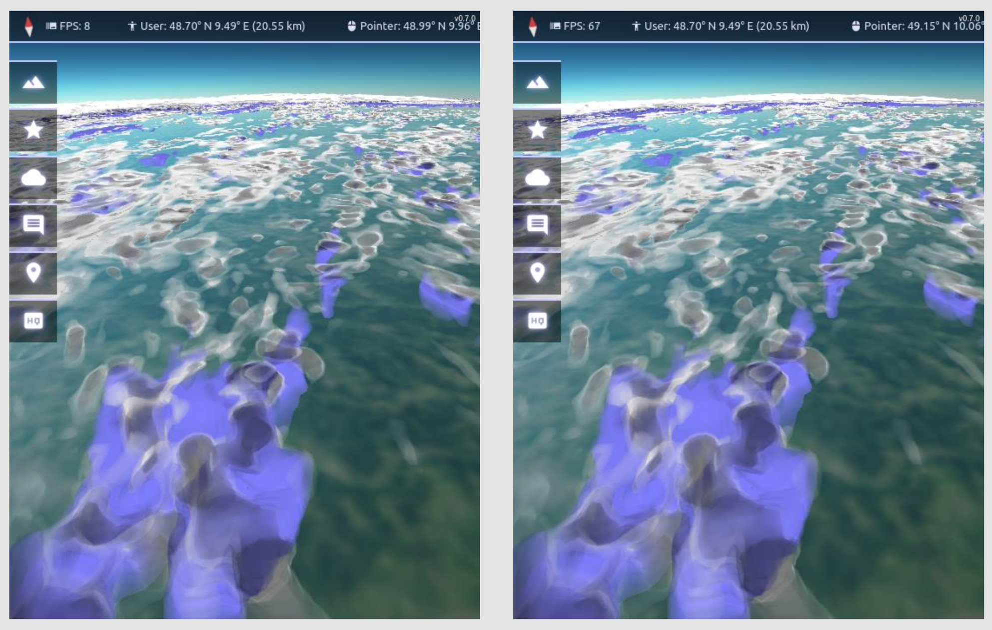
- Octree nodes close to the viewer are updated first (importance-driven)
- Due to the lower resolution in the distance, feature extraction is fast

Pseudo volumetric rendering

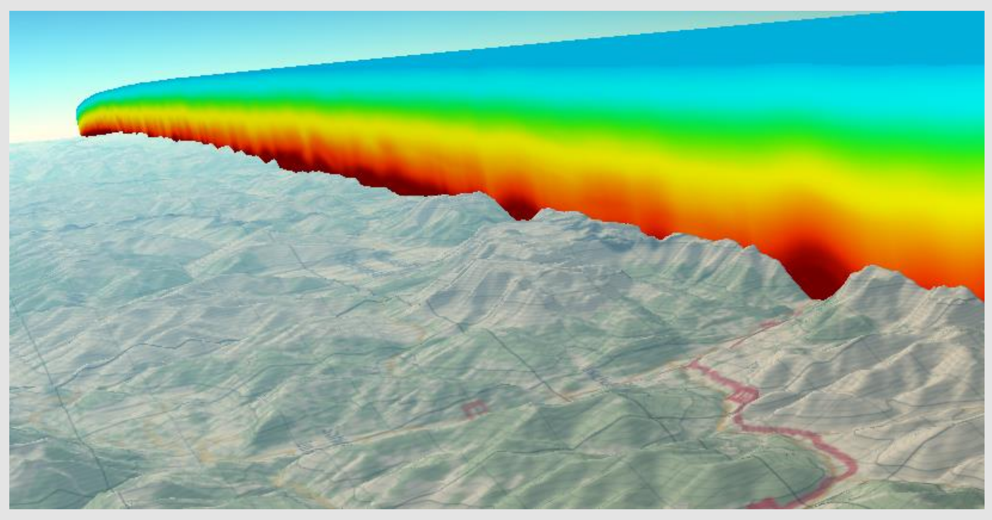
- The extracted geometry is rasterized into an A-Buffer
- Corresponding entry and exit points along each view ray are identified
- Based on their distance, the opacity is modulated

Level of detail rendering

- Rendering low resolution octree nodes in the background drastically reduces the amount of triangles of the virtual scene
- This allows for freely navigating through the dataset in 3D space
- When time step or volume bounds are modified, foreground nodes are updated within milliseconds, the entire update will take few seconds



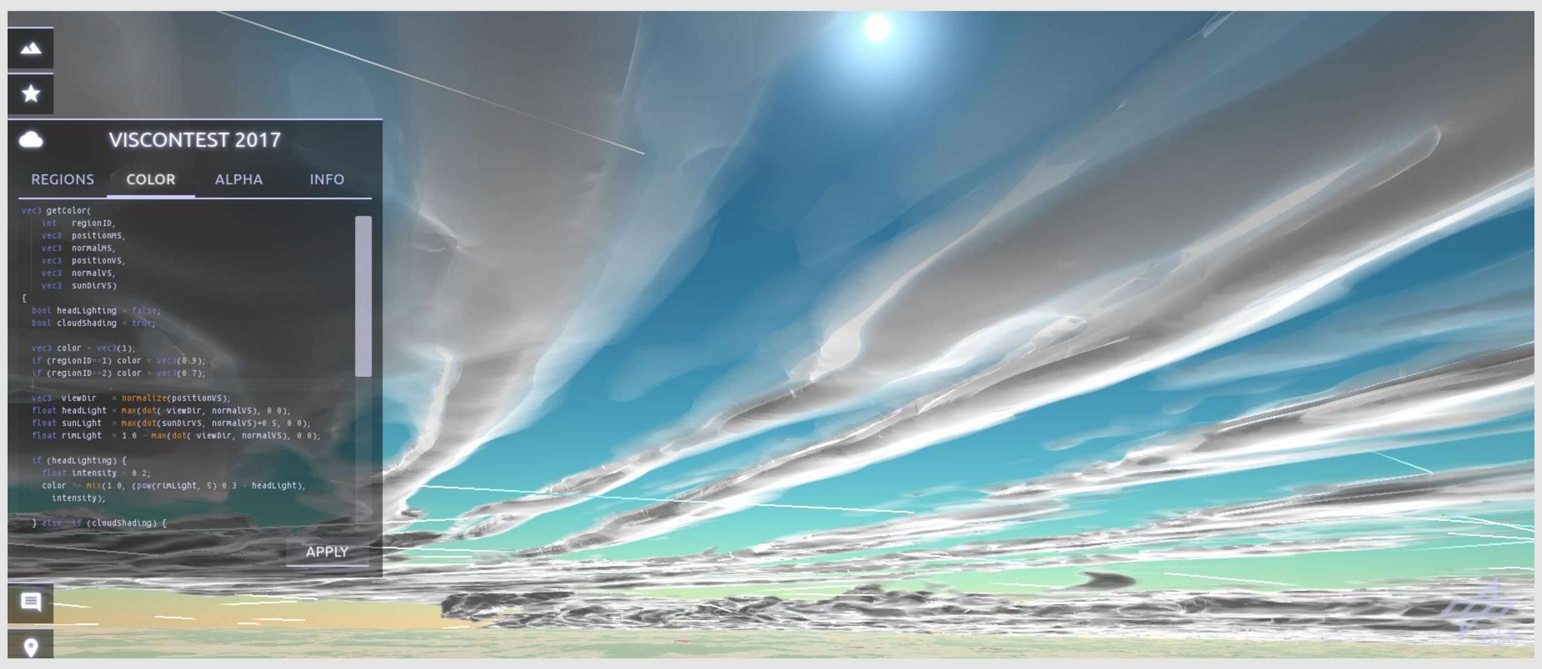
The full dataset cannot be rendered at interactive frame rates (left, 8 FPS). However, this is possible if a lower, view dependent resolution is used in the distance (right, 67 FPS). The error in is barely noticeable.



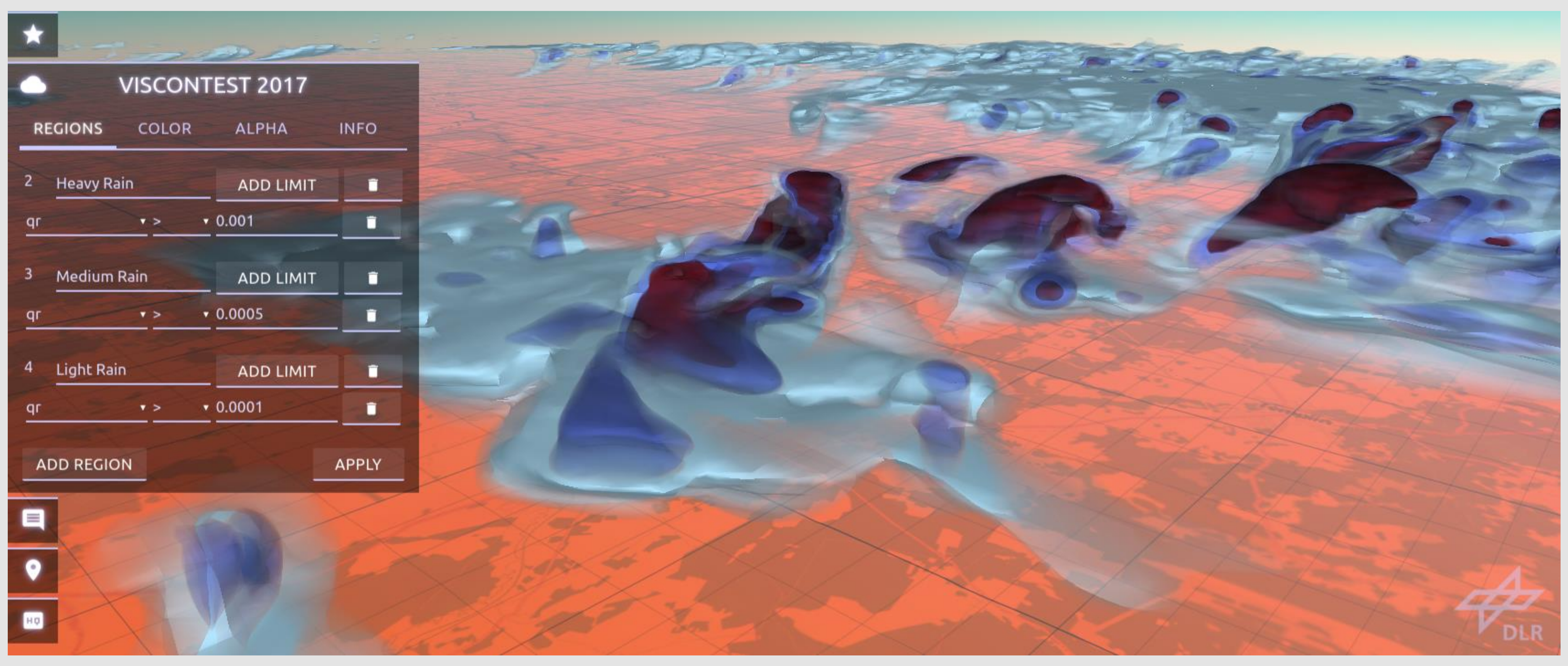
The southern border of the dataset with color-coded temperature shown with SRTM30 digital elevation model and Open Street Map data. The correlation between terrain and temperature distribution is apparent.

Future work

- In-depth benchmarking
- Support for global features, such as topology information or particle tracing
- Comparison with raytracing
- Add support for Virtual Reality and tiled display systems



High altitude clouds in the southern part of the simulation domain. On the left hand side, the shader editor in the user interface can be seen. There are also some airplane trajectories visible in this image.



This is an example of intersecting volumes. Sub-volumes for three rain mixing ratios are inside each other. The pseudo-volumetric effect helps to understand the depth of the extracted regions.

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