Visualizing climate and weather processes in PG County

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Objectives

- Develop scientifically accurate, data-driven virtual reality (VR) visualizations of local weather processes in Prince George's County, MD and the broader DMV region
- Build a reusable and scalable data visualization framework for future VR applications

Datasets

- Multi-Radar/Multi-Sensor System (MRMS): Radar-based precipitation and storm structure data
- Geostationary Lightning Mapper (GLM): Lightning observations from NOAA's GOES satellites

Figure(s)

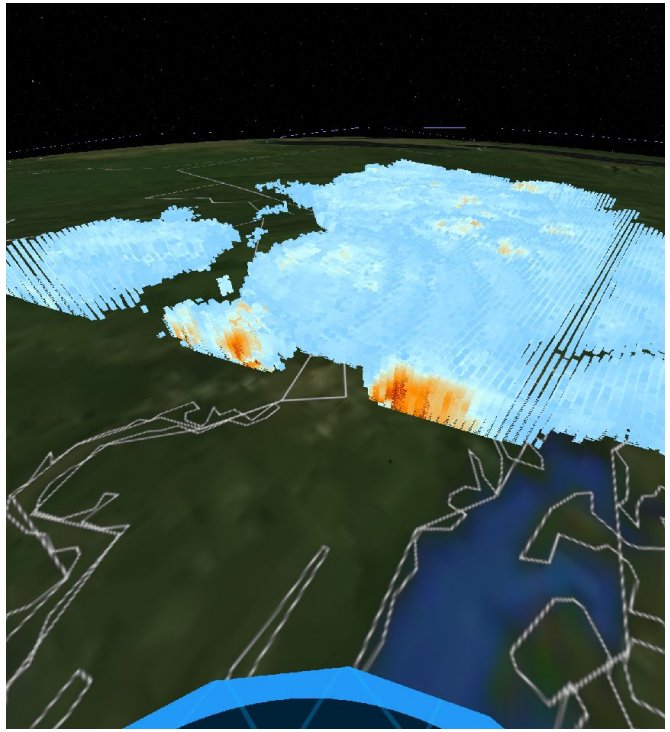


Figure 1: cross-section of storm over P.G County on May 16th, 2025 in VR

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Large scale data visualization

Challenges:

- A single time series can require several gigabytes of storage
- Loading raw data caused long delays and out-of-memory crashes on the Meta Quest 2/3

Solution:

- Process data with *geomake* and *geomedia*
- Encode time-series values as pixel hue, allowing data to be stored as video frames (Sonoda et al., 2021)
- Up to nine datasets in one video, reducing **~4 GB to ~200 MB** per dataset collection

Figure(s)

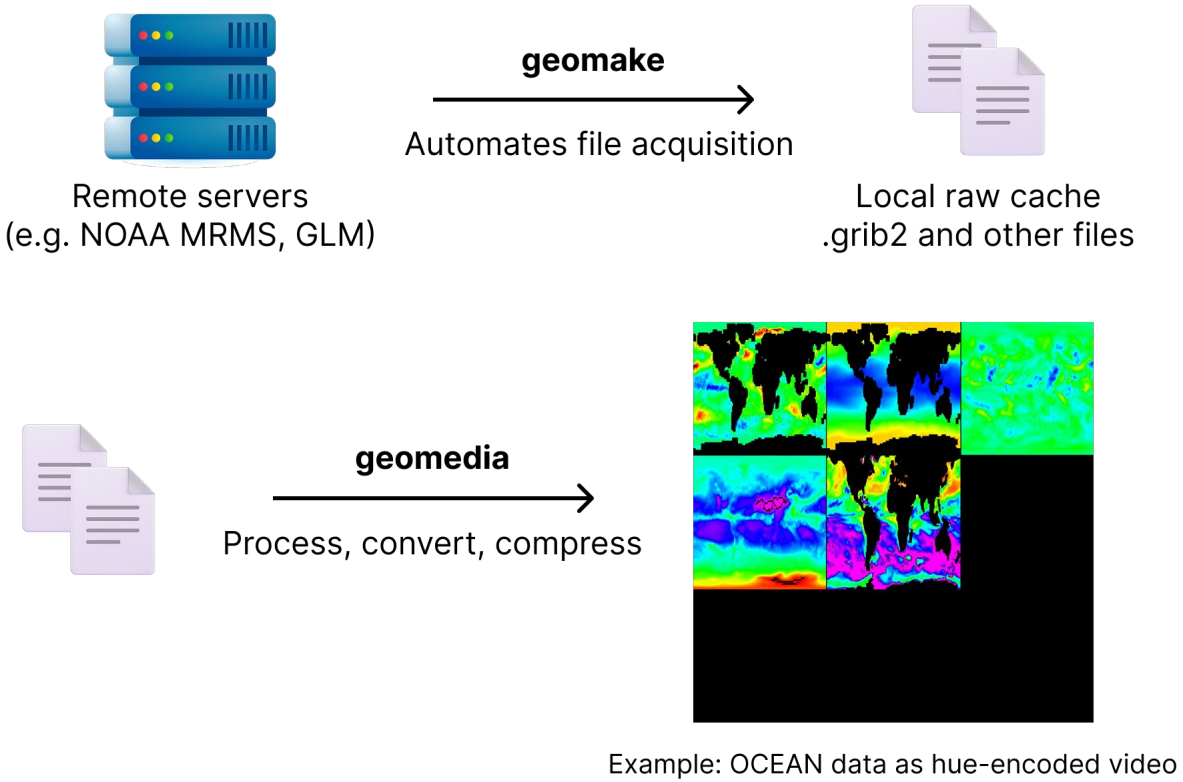


Figure 2: Environmental data preprocessing and encoding workflow

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TerralityKit for reusable workflow

- Terrality was tightly coupled to one application, making reuse across future VR projects difficult
  - **TerralityKit:** extracted Terrality's core VR visualization systems into a reusable Unity package for future applications
- Cesium is the new globe model, providing detailed terrain, borders, landmarks, and other geographic context.
  - Terrain mesh and rasters processed ahead of time, 100% offline
- Together, they create a scalable foundation for future data-driven visualizations

Figure(s)

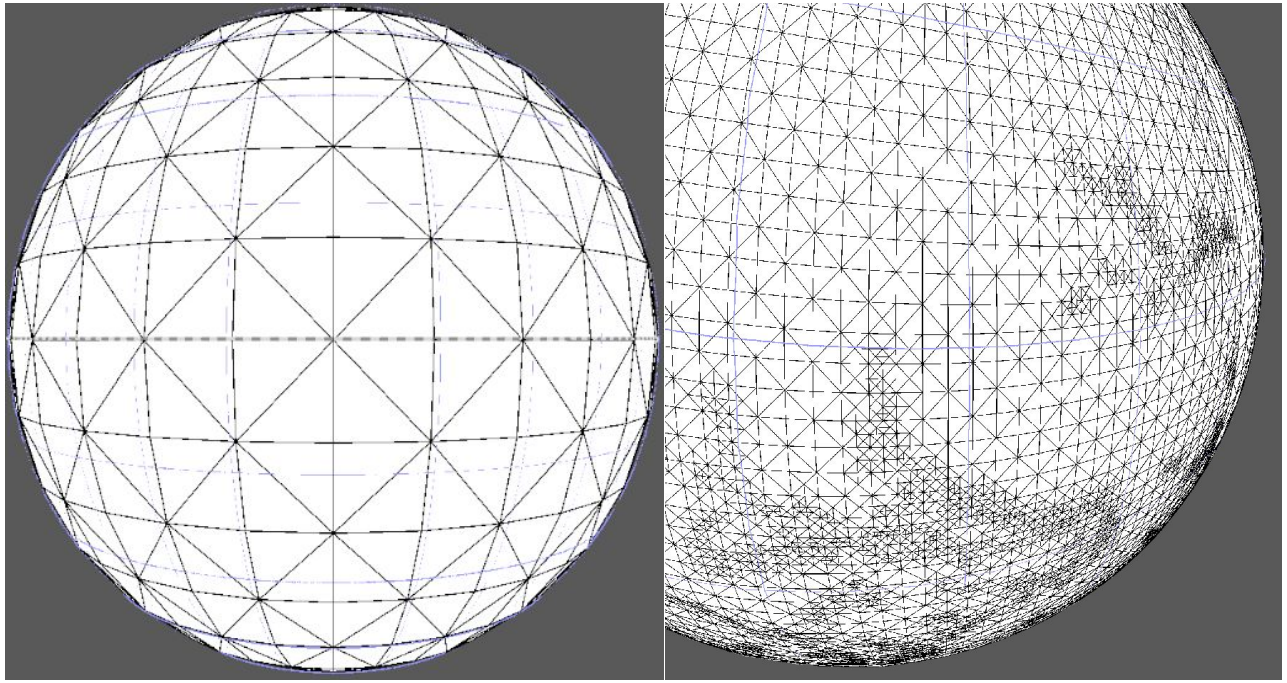


Figure 3: Cesium's adaptive level-of-detail quantized mesh

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Results

- Visualized MRMS and GLM data in VR
- Achieved near-instant loading without out-of-memory crashes, enabled fully offline use on the Quest
- Built TerralityKit as a reusable foundation for future VR applications

Acknowledgements

- Dr. Guangyang Fang for mentorship and datasets
- Special thanks to Damian Figueroa for technical support and hue-encoded value videos

Future Work

- Integrate TerralityKit into the Virtual Proving Ground and Training Center application in a dedicated regional Terrality module
- Expand from Prince George's County to larger regional domains, including Maryland, the broader DMV region, and the Chesapeake Bay region
- Include more high resolution datasets

Citations

- Sonoda, Tetsuri, and Anders Grunnet-Jepsen. "Depth image compression by colorization for Intel RealSense depth cameras." Intel, Rev 1.0 (2021)

