SAND2013-10238P

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Sandia National Laboratories

SDAV Progress Report

Sandia National Laboratories

Kenneth Moreland

January 30, 2013

U.S. DEPARTMENT OF ENERGY

NNSA Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Milestone Progress

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- 3.3.1, Y2: Integrate VisIt and ParaView with ADIOS for pre-processing
  - Working with Roselyne Tchoua and Norbert Podhorszkhi (ORNL) on ADIOS Schema specification
    - Filling in specification gaps
    - Addressing usability concerns
  - Building ADIOS Schema reader
    - Based on previous PIXIE reader
      - But more general data formats
    - Current progress: Uniform and Curvilinear grids implemented (serial)
      - Changes in shifting Schema will mean minor back changes in reader

Other Activities

Sandia National Laboratories

- UltraVis Paper: “The SDAV Software Frameworks for Visualization and Analysis on Next-Generation Multi-Core and Many-Core Architectures”
- UltraVis Paper: “Oh, $#*@! Exascale!: The effect of emerging architectures on scientific discovery”
- Visualization and Data Analysis Poster: “Optimizing Threshold for Extreme Scale Analysis”
- Talk with Tom P. about integration of DIY with various VTK algorithms (currently D3)
- ASCR Proposal Reviews

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SDAV, Dax, Cosmology, and Stuff

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Robert Maynard Kitware Inc.

May 28, 2013

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Quick Overview of Dax

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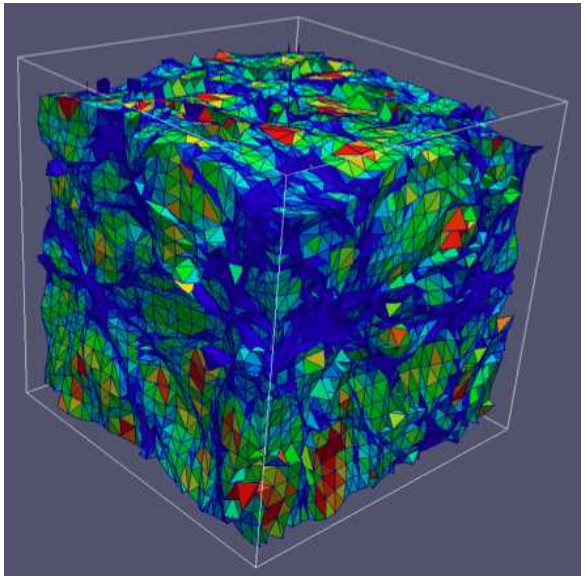
- Goal: Reduce challenges of writing highly concurrent algorithms
  - "Everybody who learns concurrency thinks they understand it, ends up finding mysterious races they thought weren't possible, and discovers that they didn't actually understand it yet after all." –Herb Sutter
- Algorithms written as "worklet" implementations
  - Safe efficient access. Hazards and conflicts not possible.
  - Provides high level visualization building blocks (field calculation, interpolation, geometry generation, neighborhood finding, etc.).
  - Template metaprogramming builds customized scheduling for arbitrary function parameters.
- Device Adapter simplifies porting across different hardware
- Array Handle interface directly with arbitrary memory layout

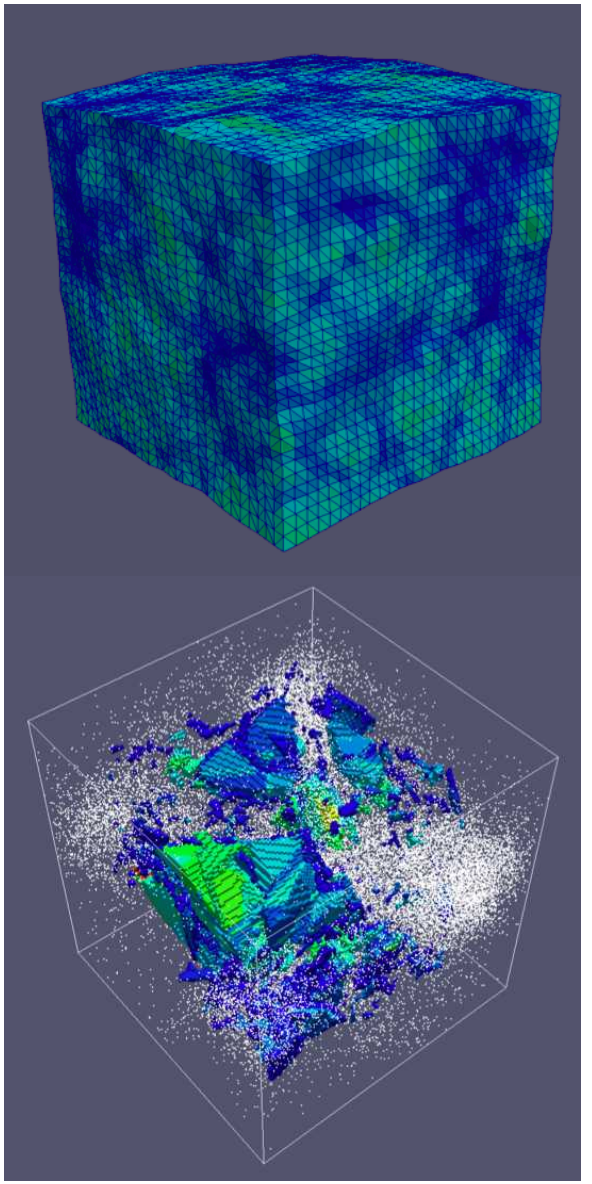
N-Body Cosmological Simulations

Sandia National Laboratories

Simulation starts with tetrahedral grid derived from structured mesh.



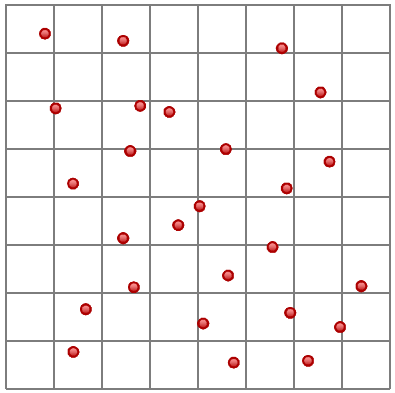
Vertices advect as particles. Mesh elements deform, fold, and intersect.



Intersecting tetrahedra form regions of multiple “streams” of flow. Intersection counts determine features.

Counting Intersecting Tetrahedra

Search structure is a regular grid of buckets with a list of intersecting tetrahedra for each bucket.



Parallel operation identifies bucket index for each probe point.

6	56	21	42	57	33	12	0	18	

Indices are sorted to identify groups of probe points in the same bucket.

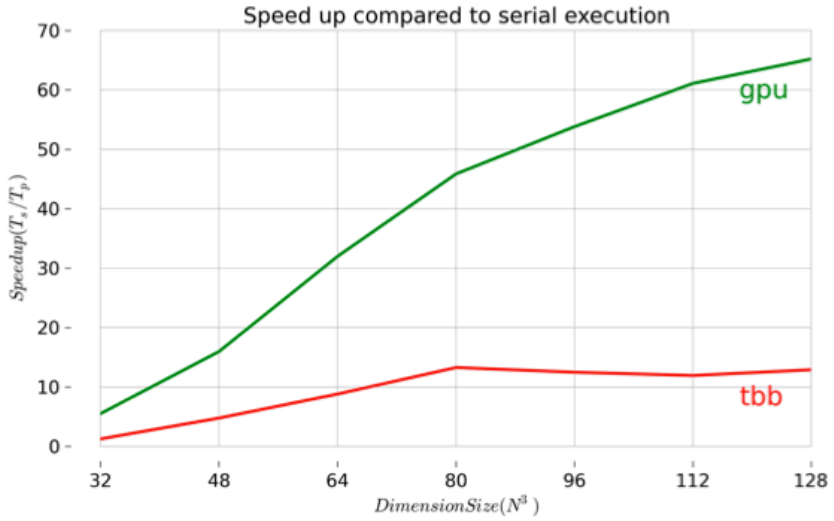
For each probe in a group in parallel perform an intersection test with all triangles in bucket and count.

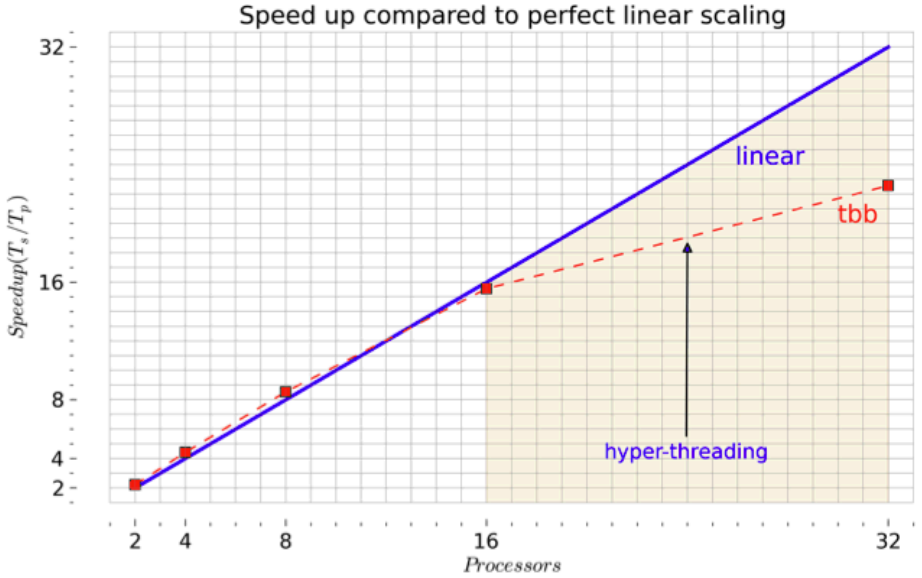
	41	42	42	42	42	42	42	42	43	

Intersection Counts

Classify with GPU/Dax Assistance

- Dax tetrahedralizes mesh and finds tets containing probes
  - More operations to follow.





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Polygon Intersection for Incremental Remap Analysis

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Xin Tong Ohio State University

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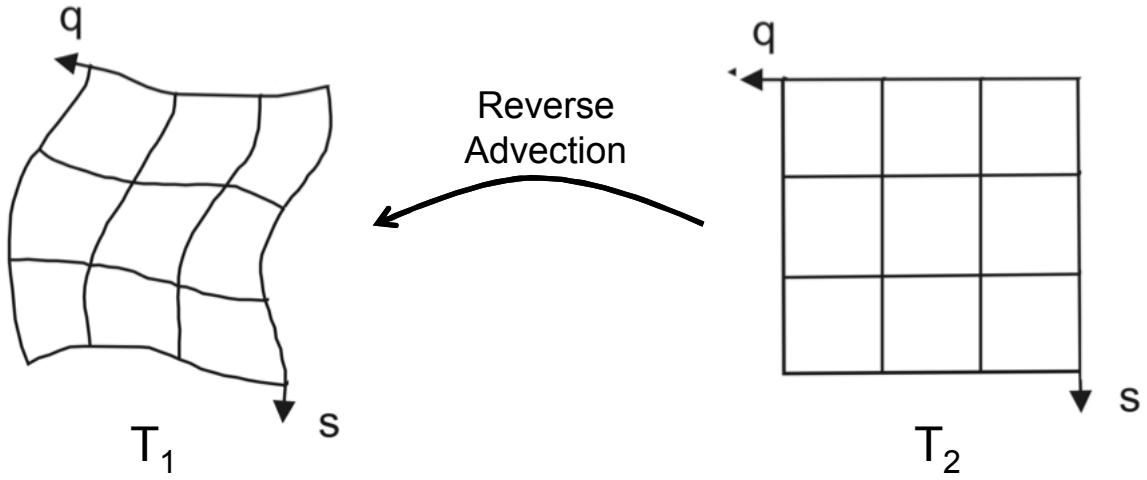
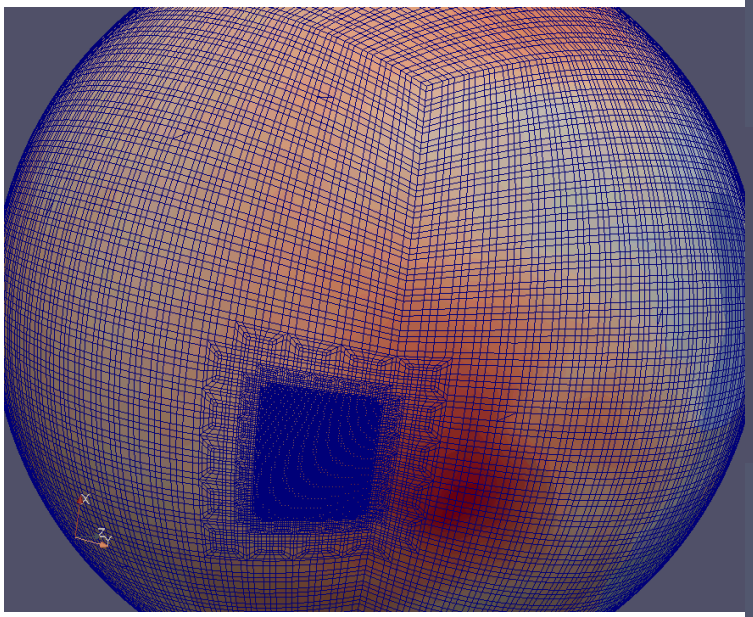
Problem Domain

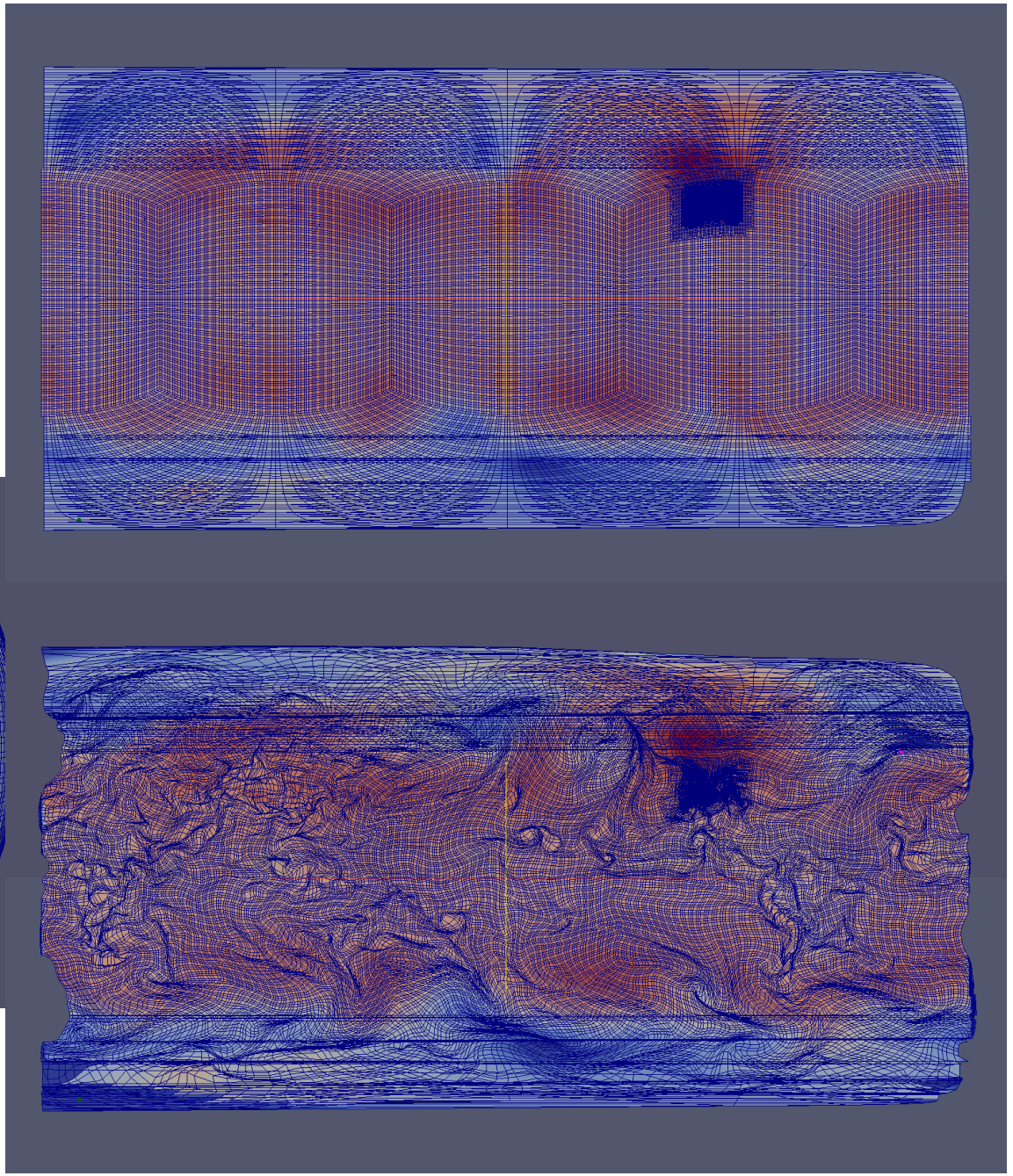
- Mark Taylor (SNL)
  - Works with Community Atmosphere Model (CAM)
  - A component in Community Earth System Model (CESM)
- Interested in “Incremental Remapping”
  - Advect the vertices of a probe mesh backwards in a stream
  - At some earlier time, integrate field properties on “warped” grid
  - Requires intersection of warped grid polys with constraint grid polys



Data

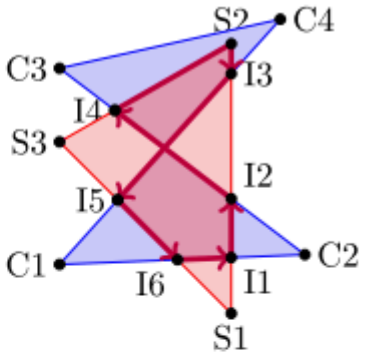
Unstructured polygons on the sphere with refined areas





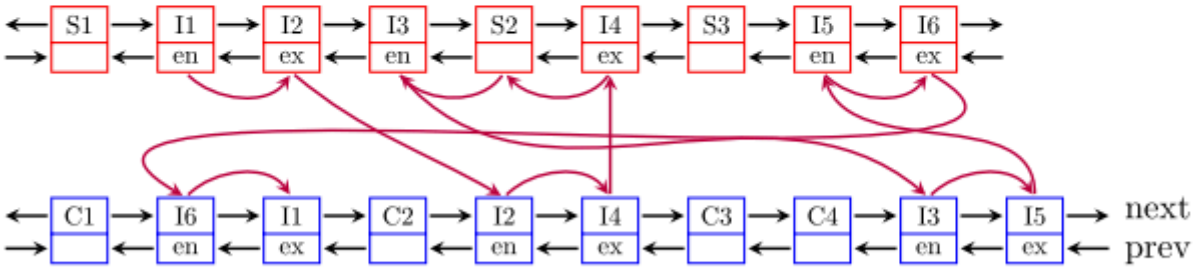
Existing Polygon Clipping Algorithm

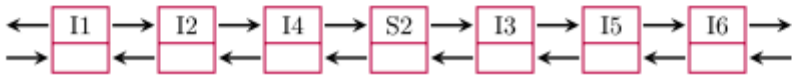
- Existing implementation uses linked lists, independent for each polygon pair.
- Can we intersect many en masse on the GPU?



Subject polygon:

Constraint polygon:





Clipped Polygon

Progress So Far

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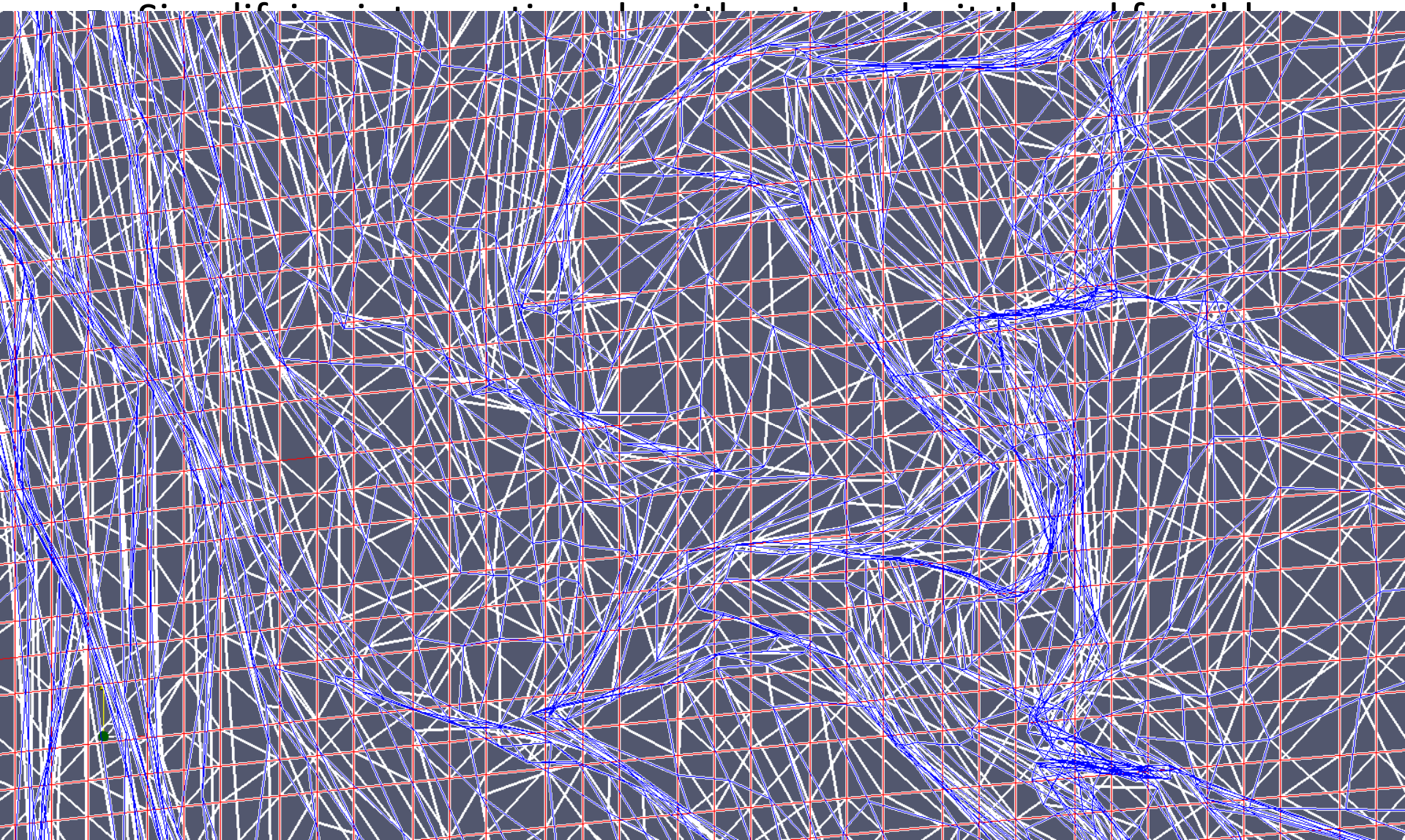

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Kenneth Moreland

September 24, 2013

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Milestone Progress

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- 3.3.1, Y2: Integrate VisIt and ParaView with ADIOS for pre-processing
  - Participated in August ADIOS Code Sprint
  - Generic schema-based reader in progress

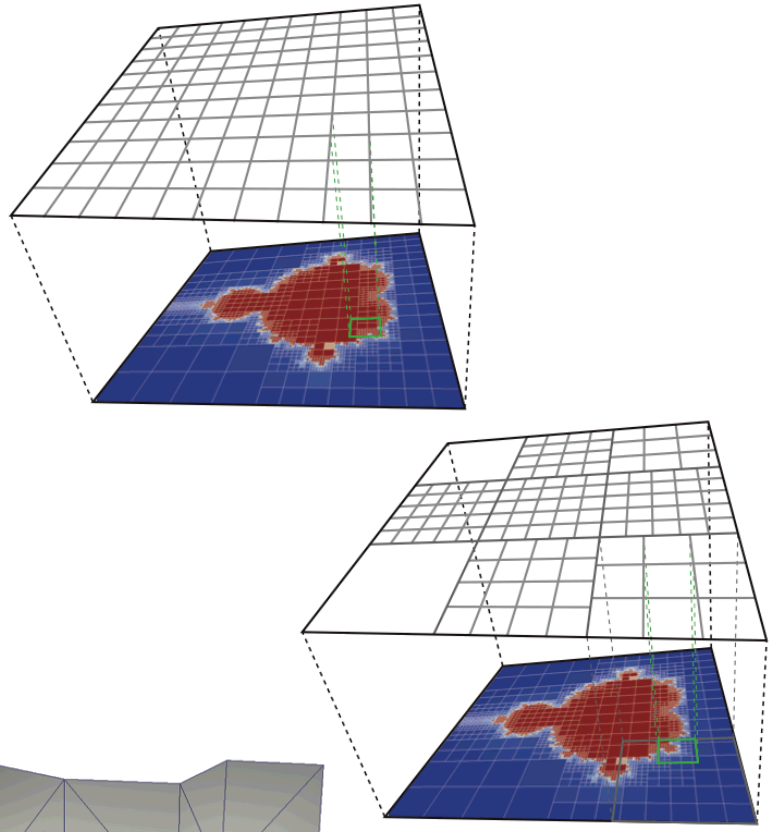
Related Activities

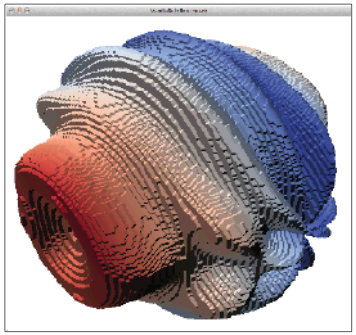
Sandia National Laboratories

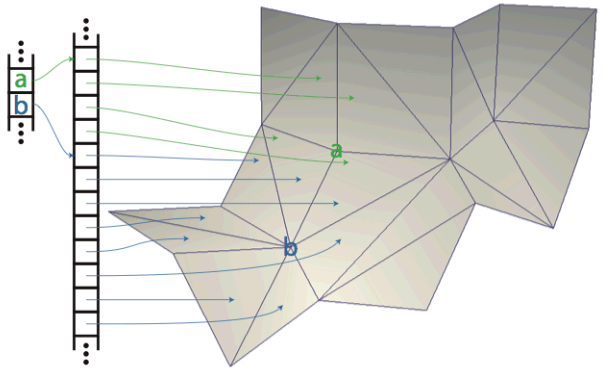
- Recent release of ParaView 4.0
  - Rework of GUI interaction
  - Modularization of code (smaller *in situ* libraries)
- Catalyst
  - Reduced memory footprint
    - Modular libraries
    - Zero-copy adaptors
  - Integration with Sandia codes (Sierra, CTH, Alegra, Albany)

Related Activities

- Upcoming Dax features
  - GPU-friendly spatial search structures
  - Better topology connection support
    - Vertex welding
    - C0 continuous gradient
    - Smooth normal generation
    - Curvature
  - Build links functionality
    - Neighborhood finding
  - OpenGL Interop







Other Activities

Sandia National Laboratories

- Poster at ASCR Extreme Scale Research PI Meeting
- Vis Panel: “Challenges for Scientific Visualization Software”
- Vis TVCG Paper: “A Survey of Visualization Pipelines”
- Supercomputing Tutorial: “Large-Scale Visualization with ParaView”
- Recent Program Committees: SC13, LDAV 2013, BigDataVis 2013, UltraVis 2013.

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Kenneth Moreland

November 12, 2013

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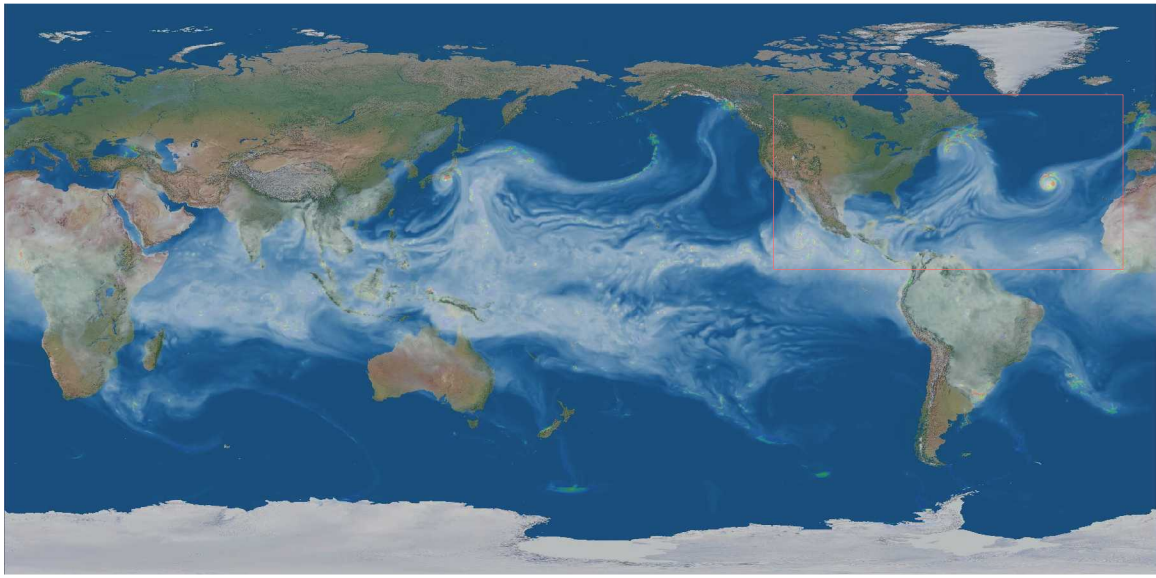
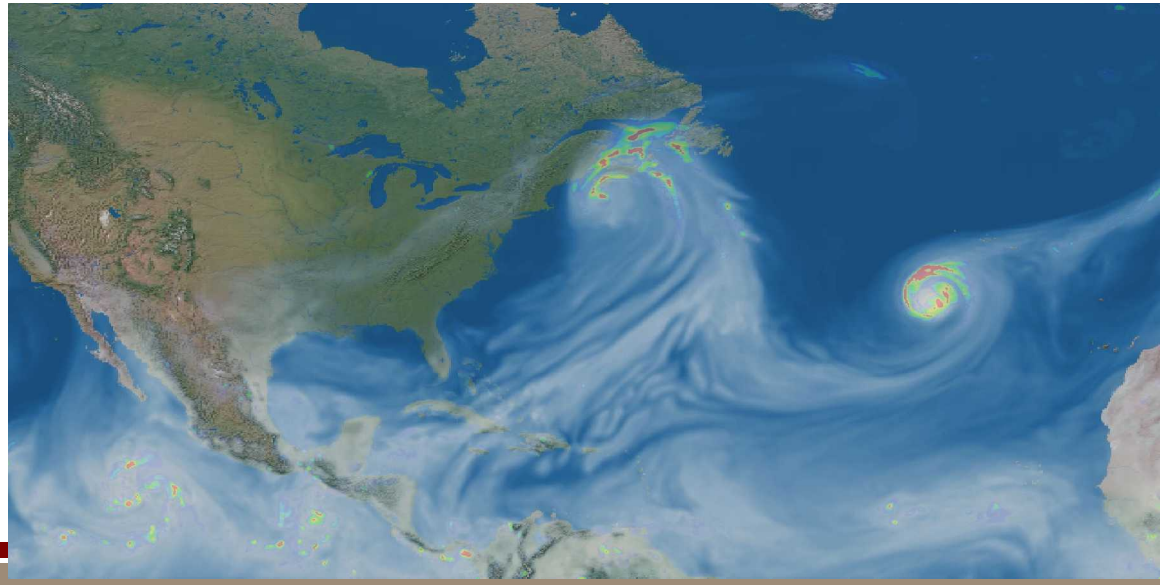
Atmospheric Climate Visualization

Sandia National Laboratories

- Community Earth System Model (CESM) V1.2
  - Mark Taylor – Multi-Resolution Climate Modeling
  - ~1/8 degree resolution
  - 128K cores of Mira
  - 20M core-hours
- Visualization
  - ParaView 4.0.1 in batch mode
  - Showing precipitable water (white) and precipitation rate (green/red)
  - To be featured at the DOE booth at SC





Related Activities

Sandia National Laboratories

- ParaView 4.1 release eminent
  - Improved interaction
  - Just in time for SC
- Catalyst
  - Reduced memory footprint
    - Zero-copy adaptors
    - Editions (base, essentials, extras)
  - Integration with Sandia codes (Sierra, CTH, Alegra, Albany)
- Dax
  - Expose device adapter layer (for “raw” algorithm development)
  - Simplify development of new device adapters
    - Need only scheduling (parallel for) and, possibly, host $\longleftrightarrow$ device copies
    - Operations won’t be optimized, but gets you up and running with new devices quickly

Other Activities

Sandia National Laboratories

- Supercomputing Tutorial: “Large-Scale Visualization with ParaView”
- UltraVis Paper: “A Classification of Scientific Visualization Algorithms for Massive Threading”
- Vis Panel: “Challenges for Scientific Visualization Software”
- Vis TVCG Paper: “A Survey of Visualization Pipelines”
- Recent Program Committees: SC13, LDAV 2013, BigDataVis 2013, UltraVis 2013.