SDAV

Technologies for Scientific Visualization

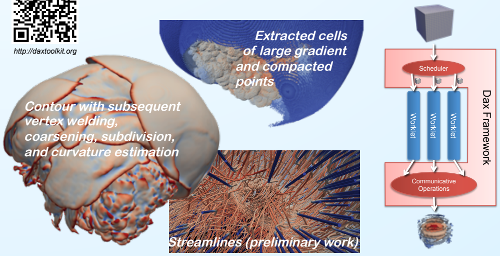
http://sdav-scidac.org

New Algorithms and Languages for Efficient, Portable Performance on Next-Generation Architectures

Dax: *A Toolkit for Analysis and Visualization at Extreme Scale*

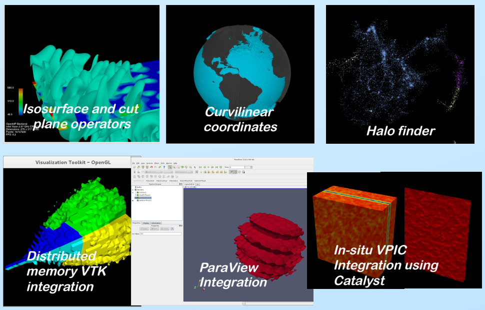
- The primitives necessary to design finely-threaded algorithms
- "Worklets" ease design in serial, scheduled in parallel
- Basic visualization design objects (think VTK for many-core)
- Communicative operations provide neighborhood-wide operations without exposing read/write hazards

http://daxtoolkit.org



PISTON: A Portable Cross-Platform Framework for Data-Parallel Visualization Operators

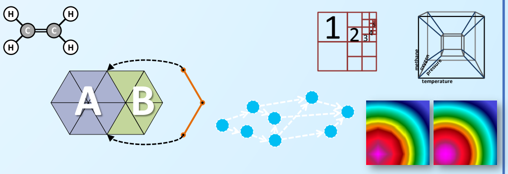
- Goal: Portability and performance for visualization and analysis operators on current and next- generation supercomputers
- Main idea: Write operators using only data-parallel primitives (scan, reduce, etc.) PISTON is built on top of NVIDIA's Thrust library
- We have run visualization algorithms on GPUs and on multi-core CPUs using the exact same operator code by compiling to CUDA and to OpenMP backends
- Project homepage: http://viz.lanl.gov/projects/PISTON.html
- VTK integration allows for distributed memory execution, splitting the input across the nodes, running with PISTON on each node, and compositing results back together
- Our in-situ adapter for VPIC (Vector Particle in Cell), a kinetic plasma simulation code, makes use of PISTON via the ParaView Co-Processing Library (Catalyst)



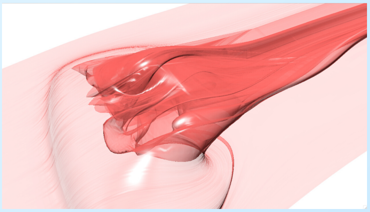
EAVL: Extreme-scale Analysis and Visualization Library

- Targets approaching hardware/software ecosystem:
- Update traditional data model to handle modern simulation codes and a wider range of data.
- Investigate how an updated data and execution model can achieve the necessary computational, I/O, and memory efficiency.
- Explore methods for visualization algorithm developers to achieve these efficiency gains and better support exascale architectures.

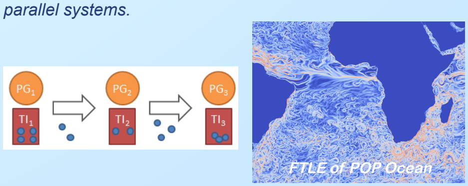
http://ft.ornl.gov/eavl



Advanced/Improved Vector Field Visualization



Stream surfaces, which provide a geometric interpretation to flow, require new integral curves to be added continuously during execution making these difficult to calculate on large scale parallel systems.



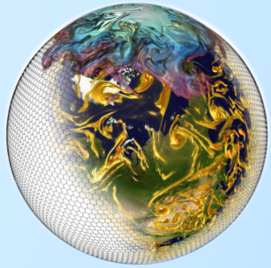
A novel graph based representation of the vector fields was created to balance the workload of integral curves computation for tens of thousands processes, and to compute Finite-Time Lyapunov Exponent (FTLE) for time-varying flow fields with smaller I/O overhead and less advection time.

D. Camp, H. Childs, C. Garth, D. Pugmire, K. Joy. Parallel Stream Surface Computation for Large Data Sets. To appear at LDAV 2012.

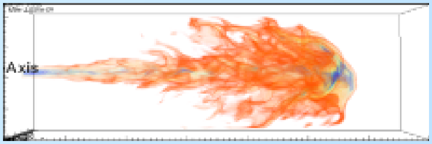
B. Nouanesengsy, T.-Y. Lee, K. Lu, H.-W. Shen, and T. Peterka. Parallel Particle Advection and FTLE Computation for Time-Varying Flow Fields. To appear in Supercomputing 2012.

Advanced/Improved Rendering

Visualization of climate data on geodesic grid output by GCRM (Global Cloud Resolving Model) code:
We have developed a direct rendering solution for such data. No pre-partitioning of the cells into tetrahedra is required, thus no storage overhead. The renderer is GPU accelerated.

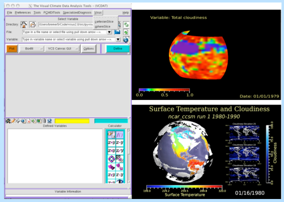


Improved Volume Rendering in VisIt
We have fixed GPU shader bugs in the GLSL code of the SLIVR render option in VisIt.
These will be committed to the VisIt trunk for release in the next release version.

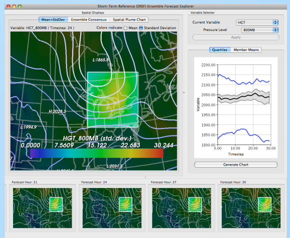


Visual and Analytical Comparison of Ensembles of Scientific Datasets and Understanding Uncertainty

- Visualization of ensembles for exploration of parameter space.
- Utilization of statistics to aggregate data for visualization.
- Interactive prototypes for data exploration and hypothesis forming.
- Understanding uncertainty by exploring the space of possible outcomes.



Visus Prototype with climate data



VTK Prototype with ensembles of climate data