



VACET

*Meet the SciDAC Visualization
and Analytics Center for
Enabling Technologies*

E. Wes Bethel (Coordinating PI)

LBNL

23 October 2008



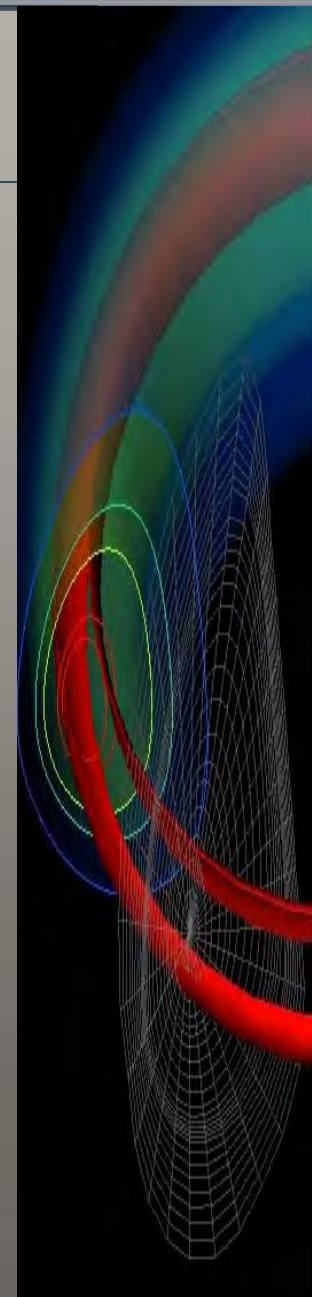
VACET Team

- Lawrence Berkeley National Laboratory
 - Bethel, Weber, Prabhat.
- Lawrence Livermore National Laboratory
 - Childs, Whitlock, Bonnell, Laney.
- Oak Ridge National Laboratory
 - Ahern, Meredith, Ostrouchov, Pugmire.
- University of Utah
 - Johnson, Hansen, Silva, Pascucci.
- University of California, Davis
 - Joy, Hamann.



VACET Motivation

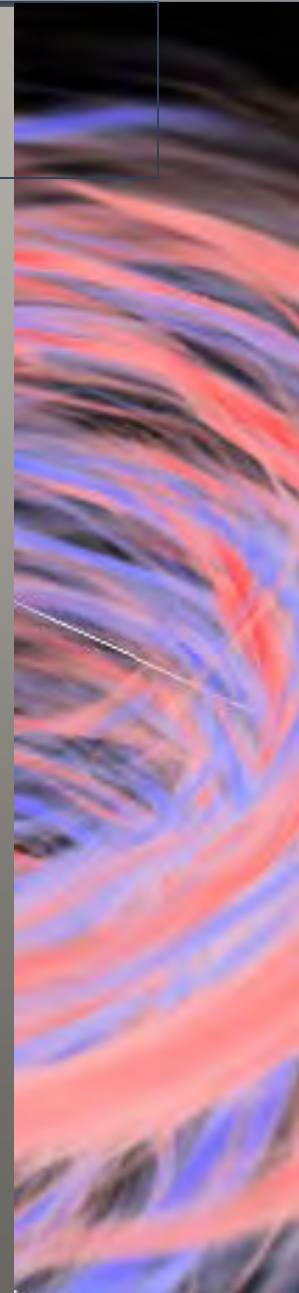
- Visual Data Analysis: plays a central role in the scientific discovery process.
- SciDAC (and other) science efforts have unmet data understanding needs.
 - Domain-specific challenges
 - Large, complex data
 - Emerging computational platforms
 - Training, consulting/partnering, support.





Large Data Visualization Issues

- Existing, traditional algorithms don't work.
 - HPC Challenges
 - Human cognition challenges.
- We listen to our science stakeholders. They want:
 - To see and analyze relevant and scientifically interesting data.
 - To compute and see relationships between fields.
 - Perform these operations on very large data.
 - And on HPC platforms.
 - Want production-quality software, expert help (“fishing instruction”).





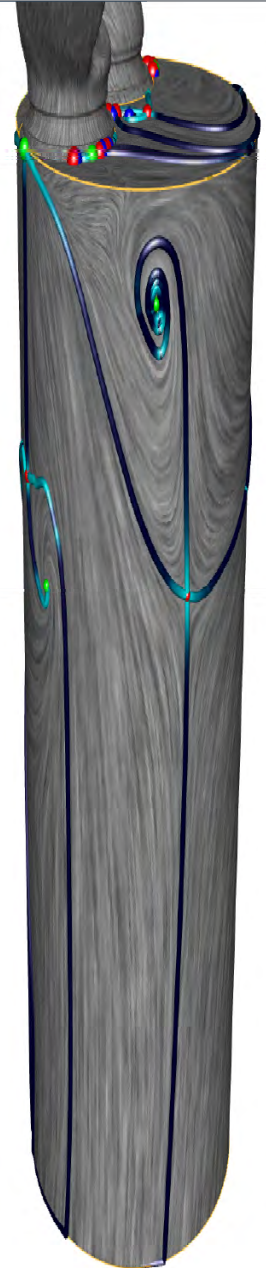
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VACET Mission Statement

- Meet the Data Understanding Challenge
 - Adapt, extend, create when necessary, and deploy visualization and data understanding technology for SciDAC2 and other DOE science stakeholders.
 - Accelerate scientific knowledge discovery.
- Production-Quality and –Capable Software
 - Provide production-quality visualization and analytics software infrastructure for use at DOE's open computing facilities.

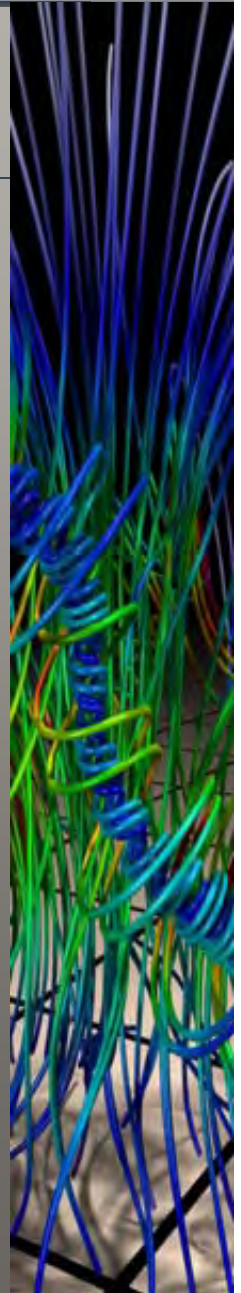
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Accomplishments

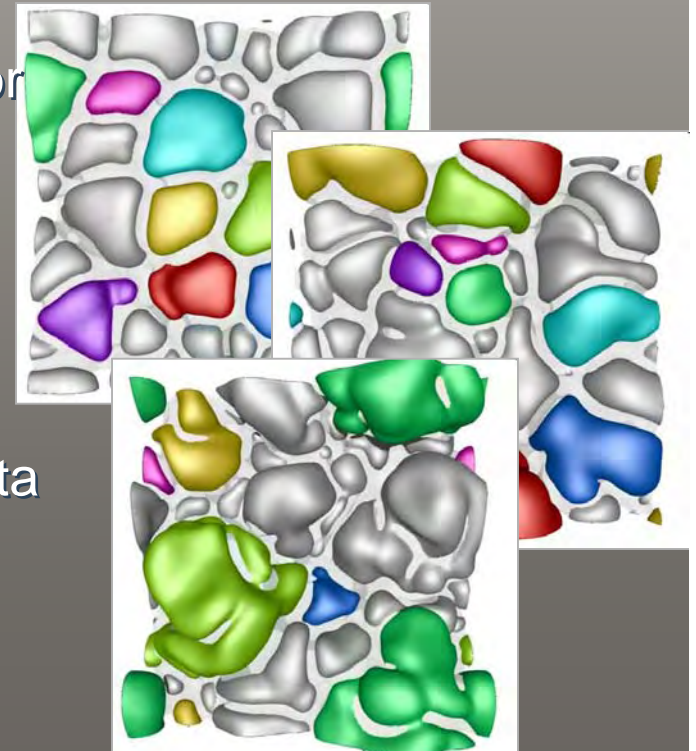
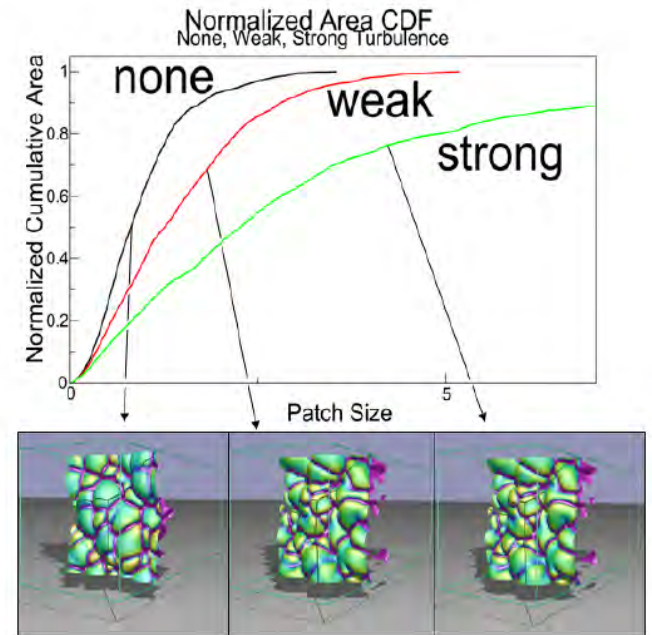
- Successfully brought multiple “products to market”
 - Science applications adopt VACET technology as community-wide visual data analysis s/w infrastructure.
 - Stakeholders are voting with their feet.
- Award-winning research
 - Dozens of peer-reviewed field-leading journal articles
 - Numerous Best-Paper awards
- High (and positive) visibility within the SciDAC and visualization communities.
- Realizing vision of a successful SciDAC Center





Combustion, Part 1

- PI: John Bell (LBNL), SciDAC Community Astrophysics Consortium Partnership, Incite Awardee.
- Accomplishments:
 - New topological analysis techniques for studying relationship between parameters and their effect.
 - Joint publications with stakeholder.
- Science Impact:
 - First-ever quantitative analysis large, time-varying combustion simulation data to study influence of turbulence on size/shape of combustion regions in lean, premixed hydrogen flames.



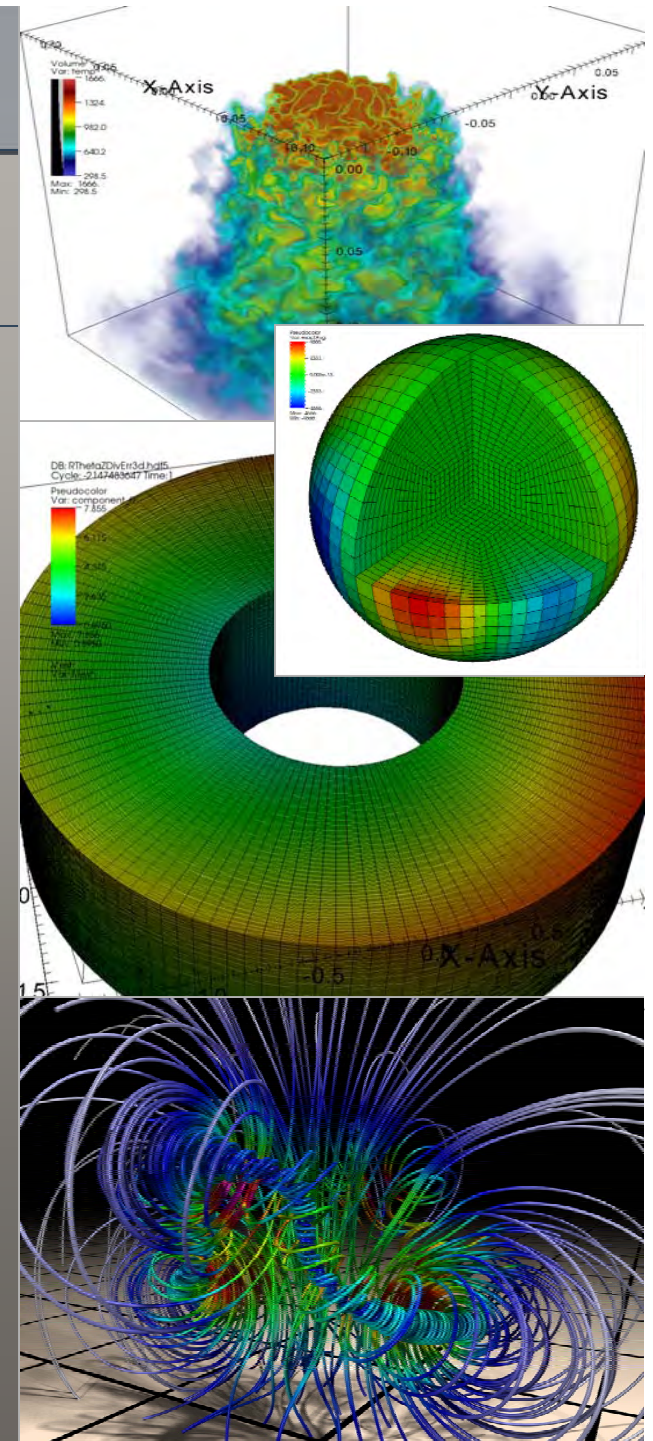


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Mathematics

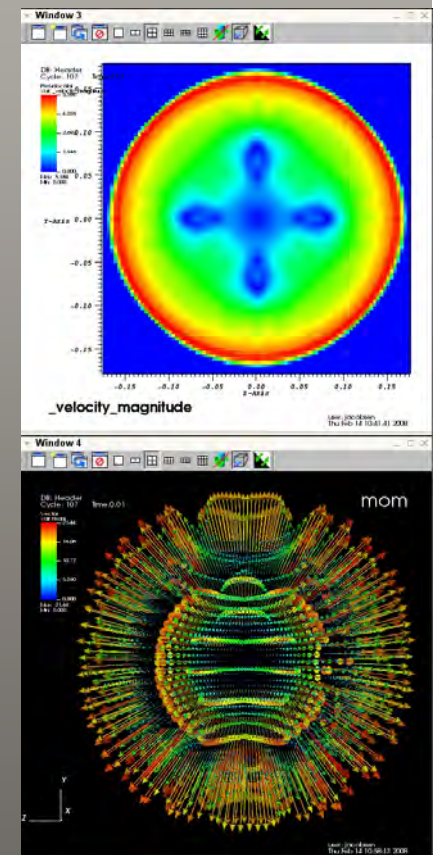
- PI: Phil Colella (LBNL), SciDAC Applied Partial Differential Equations Center
- Accomplishment(s)
 - Software engineering to “bring product to market”. Performance improvements, interface enhancements, file readers, visual data exploration techniques.
- Science Impact
 - Direct cost savings: APDEC no longer uses its own resources (e.g., FTEs) to develop, maintain, and support AMR visualization software.
 - Ability to perform AMR visualization on large, time-varying data, and using parallel platforms.
 - Benefits propagate to all APDEC stakeholders.

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Astrophysics

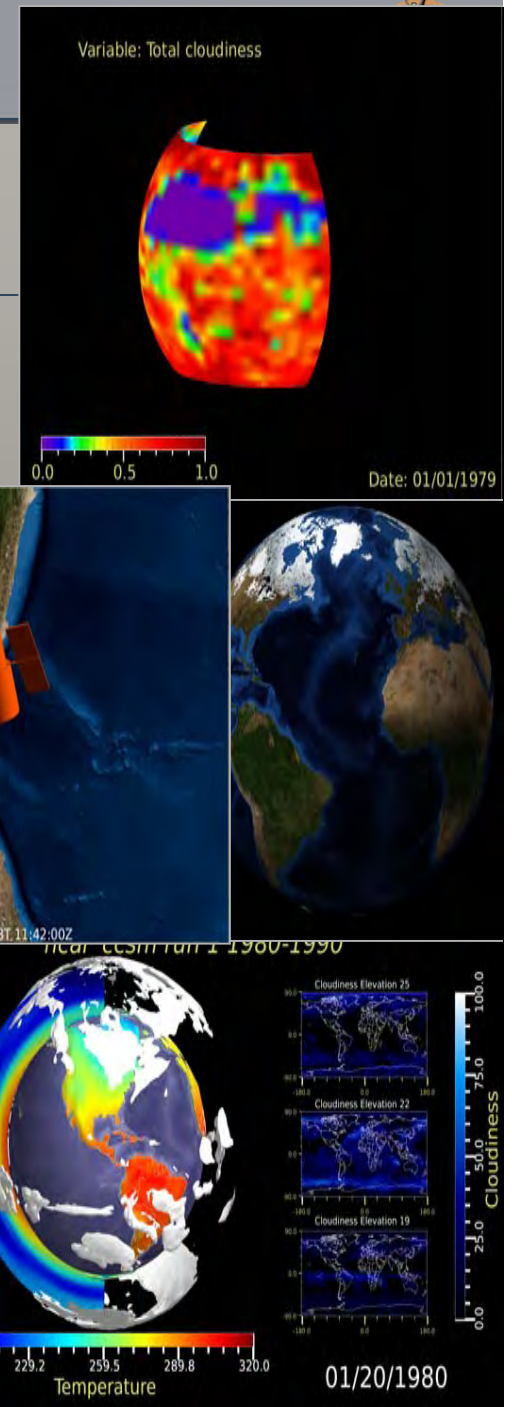
- PI: Stan Woosley (UCSC), John Bell (LBNL), Adam Burrows (Princeton). SciDAC Community Astrophysics Consortium
- Accomplishment
 - Provide production-quality AMR visualization software, including tutorials and support, to CAC code teams.
- Science Impact
 - Reduced complexity, increase in scientific productivity. A single community-wide visual data analysis application, which addresses needs of SN modeling and spectral analysis, helps eliminate the need to learn and use multiple visual data analysis applications.





Climate, Part 1

- PI: Dean Williams (LLNL), SciDAC Earth Systems Grid.
 - Other beneficiaries:
 - Community Climate System Model Consortium, Phil Jones (LANL), John Drake (ORNL)
- Accomplishments
 - Software engineering to transition research prototype into production code within a climate community standard visual data analysis system (VCDAT).
- Science Impacts
 - New capability: 3D, temporal visual data analysis is now part of a familiar application, offers new dimensions for understanding climate data.

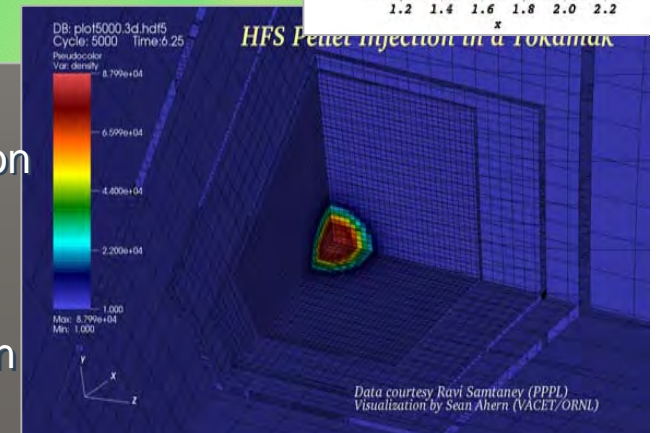
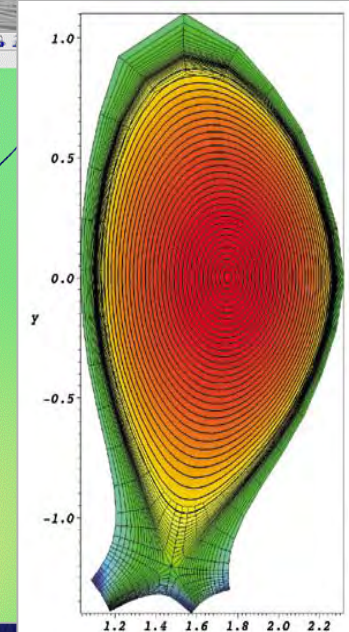
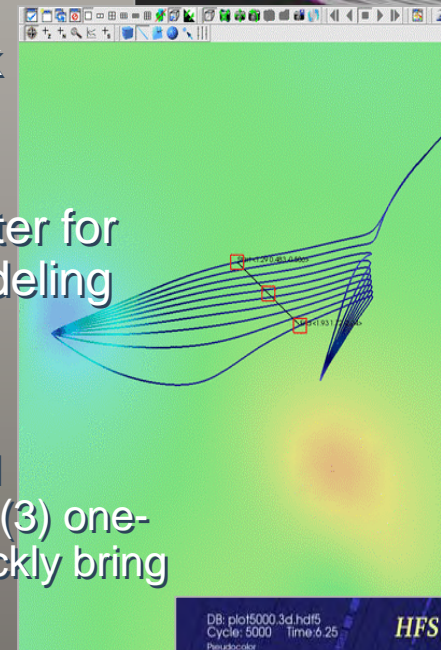
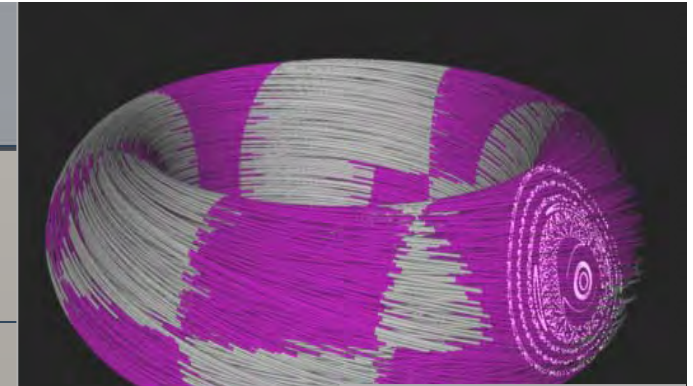




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Fusion, Part 1

- PI's/Projects
 - J. Cary (Tech-X), SciDAC Framework Application for Core-Edge Transport Simulations
 - Ravi Semtaney (PPPL), SciDAC Center for Extended Magnetohydrodynamic Modeling
- Accomplishment(s)
 - Leverage VACET investment in (1) AMR visualization software and (2) fundamental visualization s/w infrastructure, along with (3) one-on-one work with user communities to quickly bring “product to market.”
- Science Impact
 - New capability: production quality AMR visualization software infrastructure.
 - Cost savings: community-wide, production-quality visual data analysis software infrastructure helps scientists focus on science rather than visualization s/w development.

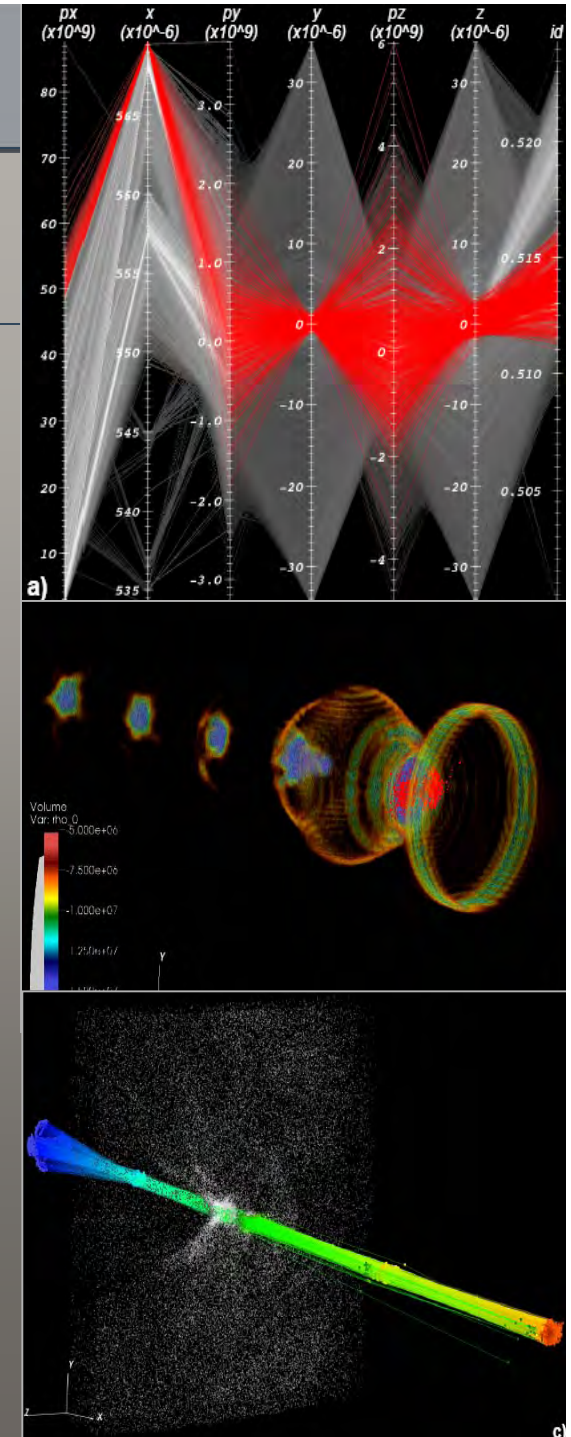




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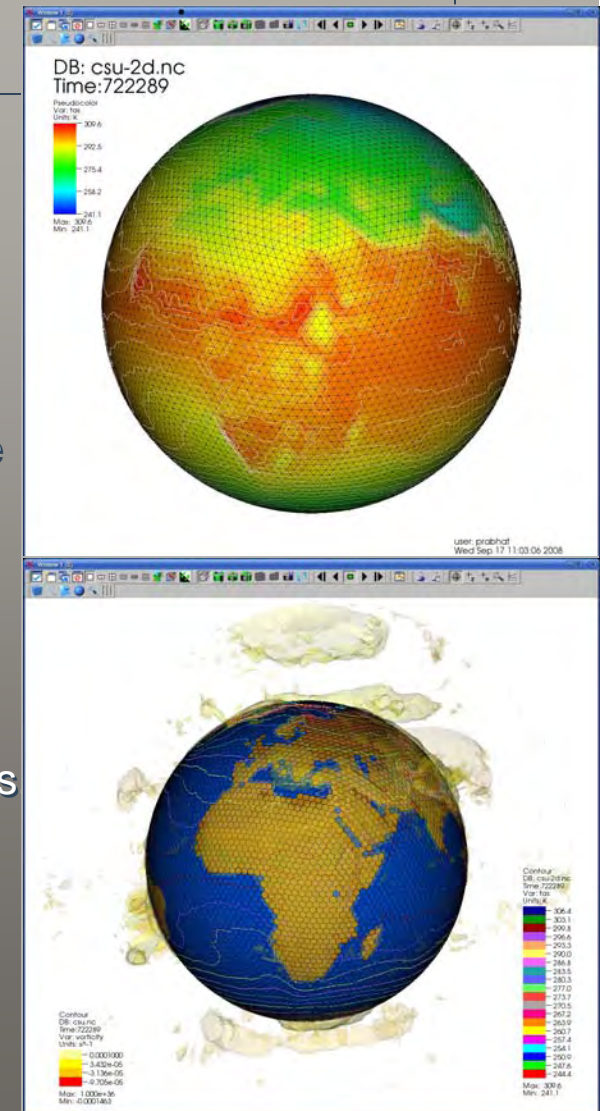
Accelerator Modeling

- PI: C. Geddes (LBNL), part of SciDAC COMPASS project, Incite awardee.
- Accomplishment:
 - Algorithms and production-quality s/w infrastructure to perform interactive visual data analysis (identify, track, analyze beam particles) in multi-TB simulation data.
- Science Impact:
 - Replace serial process that took hours with one that takes seconds.
 - New capability: rapid data exploration and analysis.
- Collaborators:
 - SciDAC SDM Center (FastBit)
 - Tech-X (Accelerator scientists)



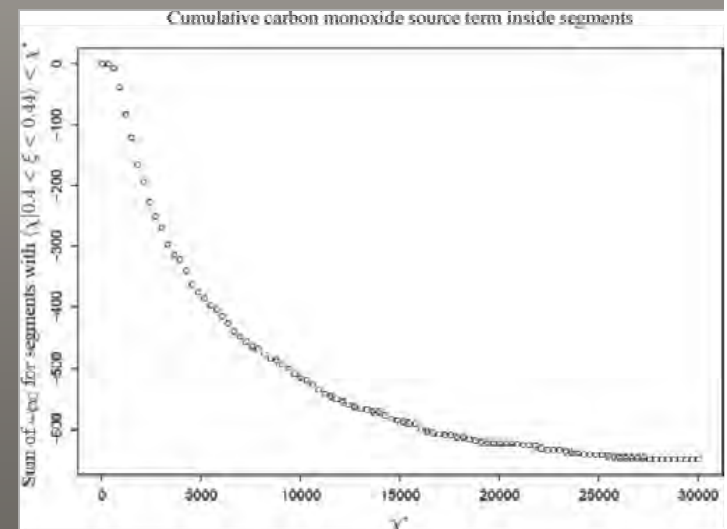
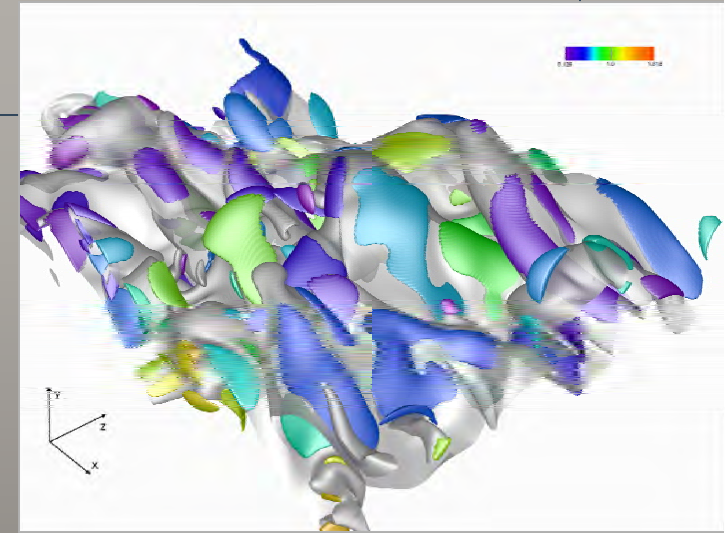
Climate, Part 2

- PI: Dave Randall (CSU). SciDAC Application: Role of Clouds in Global Climate
- Accomplishments
 - Debug and optimize parallel I/O to meet performance objectives.
 - New visualization infrastructure for icosahedral grid.
- Science Impact
 - Enable effective use of INCITE allocation at NERSC
 - Critical s/w infrastructure to enable visualization and analysis of ensemble runs of new global cloud models
- Other Collaborators:
 - NERSC Center staff
 - Karen Schuchardt (PNNL)



Combustion, Part 2

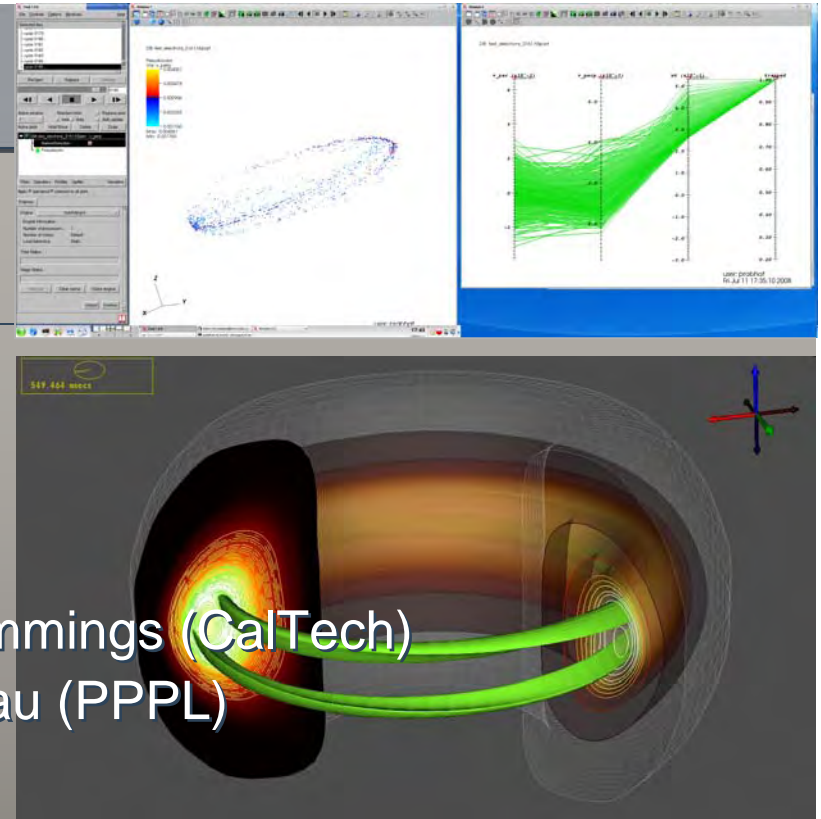
- PI: Jacqueline Chen (SNL-CA), Incite awardee.
- Accomplishment(s)
 - Algorithms for feature segmentation, tracking, and analysis.
 - Co-authors on multiple papers.
- Science Impact(s)
 - New capability: first-ever ability to see relationship between simulation parameters (e.g., level of turbulence) and scalar dissipation rate.





Fusion, Part 2

- Fusion Partnership
- PI's:
 - Stephane Ethier (PPPL)
 - Seung-Hoe Ku (NTU), Julian Cummings (CalTech)
 - Scott Krger (Tech-X), Josh Breslau (PPPL)
 - Bill Nevins (LLNL)
 - Don Bachelor (ORNL)
- Objective/Approach
 - These diverse groups have many common needs. Our team is developing/deploying new capabilities to meet these needs in production quality visual data analysis s/w.
- Impact
 - Enable new science insights in large, complex data.





Outreach

- Tutorials
 - SciDAC 2008.
 - VisIt, VisTrails
 - Siggraph 2008
 - VisTrails
 - SciDAC 2007
 - VisIt, SCIRun.
 - PPPL, September 2008.
 - CScADS Workshop, Summer 2008.
- Workshops
 - Participation in IUSV-sponsored workshops.



Outreach

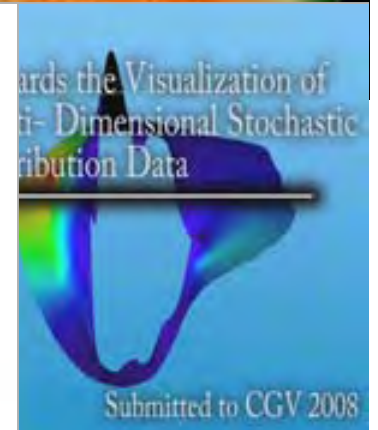
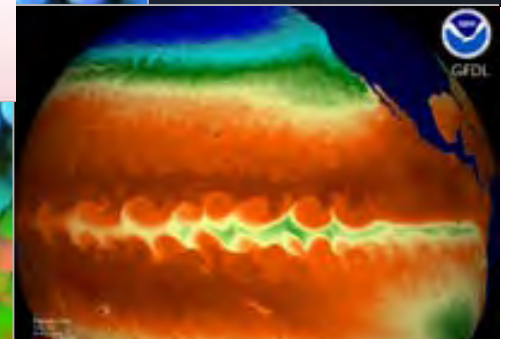
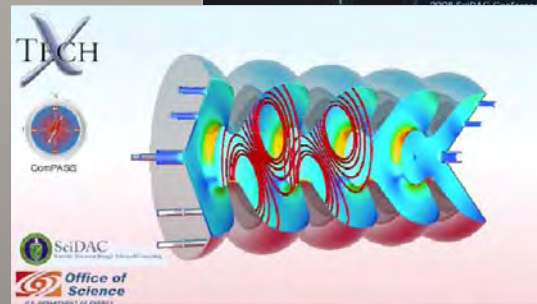
- Congressman J. Matheson (Utah) visits VACET AHM to learn about SciDAC and the crucial role played by visualization in scientific knowledge discovery.





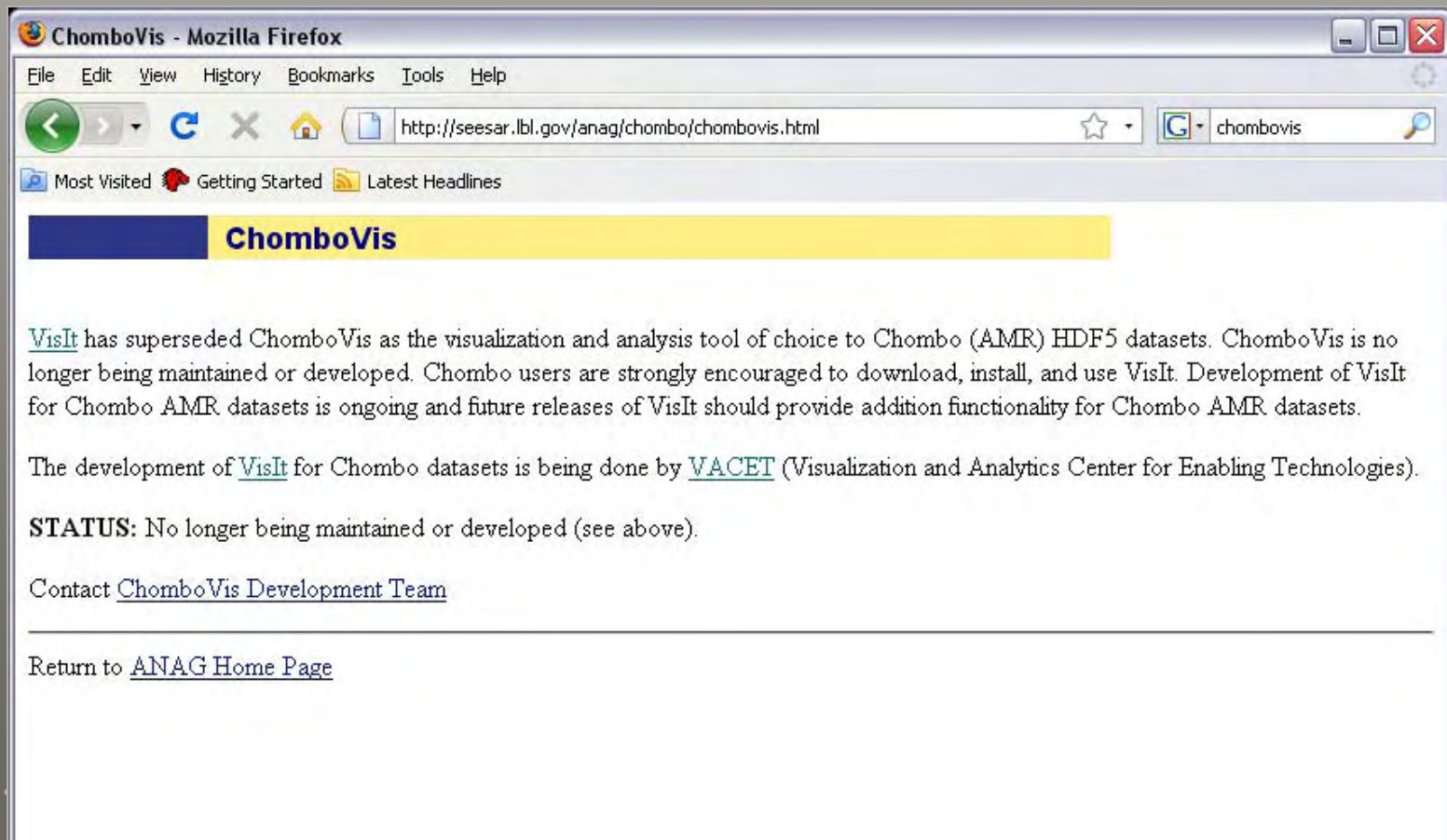
Awards – SciDAC 2008

- SciDAC 2008 “Viz Night”
 - Three “People’s Choice” Awards
 - One Honorable Mention
 - Stakeholder(s) win People’s Choice Awards using VACET s/w:
 - Tech-X: Accelerator
 - LLNL: NIF



Stakeholders Vote with their Feet

- ADPEC adopts VisIt for production-quality AMR visualization





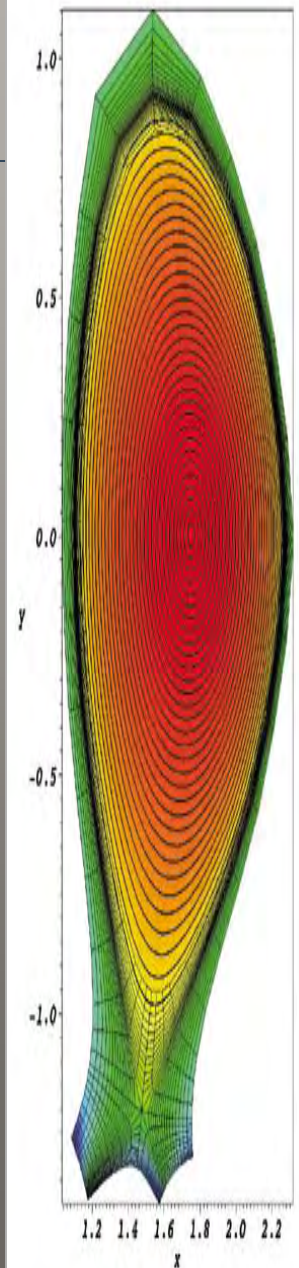
Stakeholders Vote with their Feet

- John Bell (LBNL) at the Spring 2008 Community Astrophysics Consortium Meeting:
 - “You’d have to be crazy to use anything other than VisIt for AMR visualization”
 - Adopted by the CAC for use across the project
 - Bell’s is the primary SN modeling code
 - Spectral analysis groups also moving to VisIt.



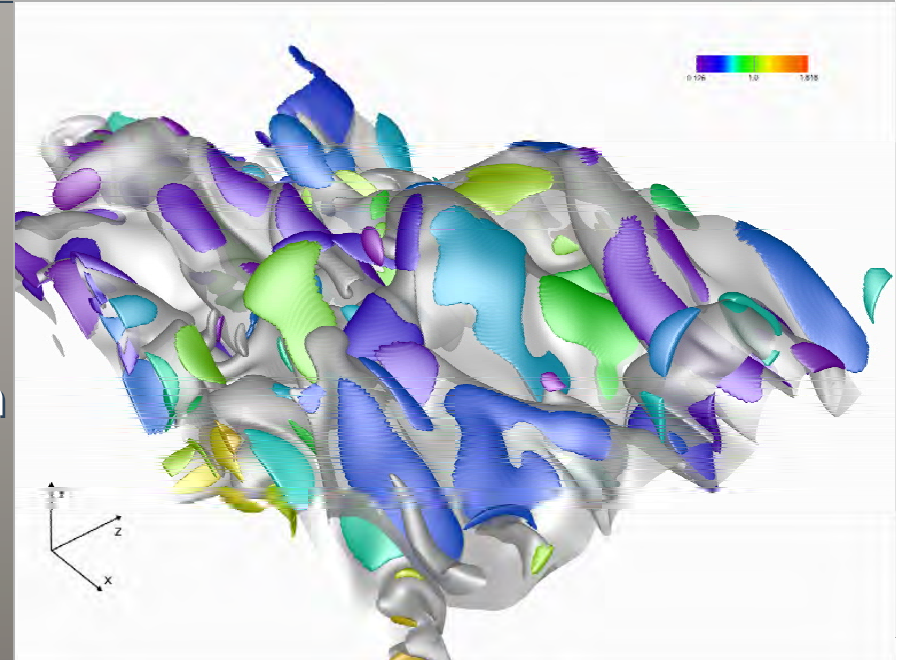
Stakeholders Vote with their Feet

- John Cary (Tech-X)
 - Making concerted effort to migrate FACETS and numerous other Tech-X efforts to VisIt.
 - Generated an animation using VisIt that won an award at SciDAC 2008.
 - Contributing to VisIt in the form of file loaders (VORPAL loader).
 - Using VisIt-generated visuals in day-to-day science activities and for special events (e.g., upcoming review).



Stakeholders Vote with their Feet

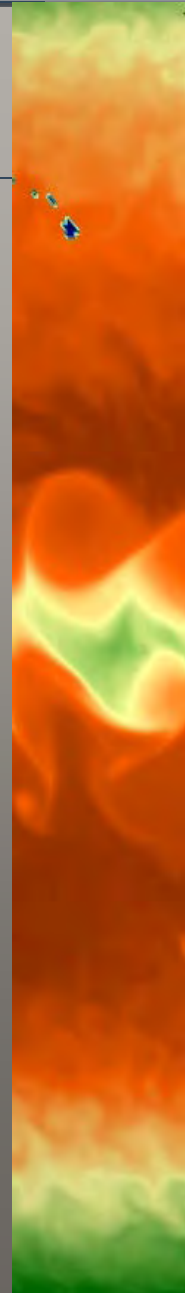
- Jacqueline Chen (SNL-CA)
 - In her SciDAC 2008 presentation: “For the first time, I can see ...”
 - She hires a post-doc from VACET to work exclusively on continuing this project.
- Bronson Messer (ORNL) (Working with Tony Mezzacappa)
 - All visuals in his SciDAC 2008 presentation done using VACET technology.





Exascale Issues

- Lots of data.
 - Where will it be stored?
 - Parallel I/O.
- Data models and formats.
 - “Babel” effect will result in increase in cost, decrease in efficiency.
- Existing visualization and analysis architectures won’t scale.
- Usability: Existing visualization approaches vulnerable to “visual cognition” test.





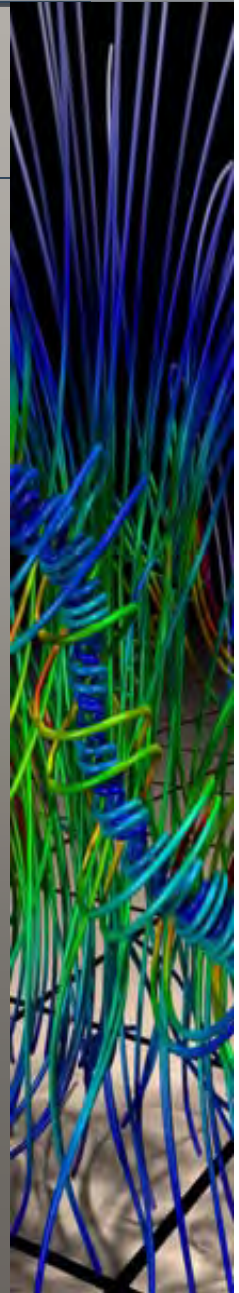
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VACET Summary

- Producing positive scientific impact across many disciplines.
- Strong scientific community support.
- Award-winning research.
- Wildly successful, exemplary performance as a CET.

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The End

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