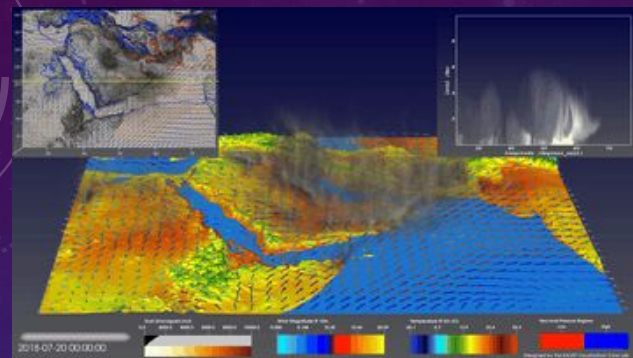
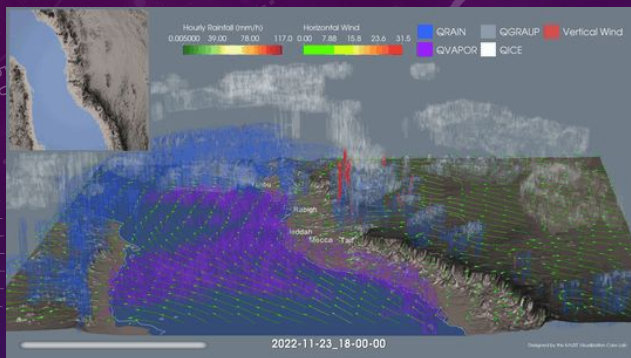
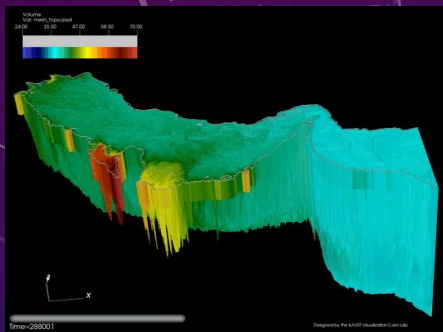




جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology



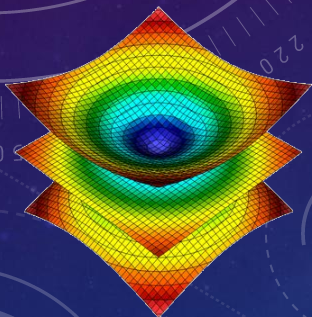
Scientific Visualization 101

Visit: An Introductory Hands-On Course

KAUST Visualization Core Lab

Dr. James Kress

October 14, 2025



KAUST
VISUALIZATION
CORE LAB

Dr. James Kress

Scientific Visualization 101: Visit



Resources

KVL Contact Information

- KVL Website:
wiki.vis.kaust.edu.sa
- General Inquiries:
help@vis.kaust.edu.sa

User Resources

- Visit Downloads:
<https://visit-dav.github.io/visit-website/releases-as-tables/#latest>
- Discussions:
<https://github.com/visit-dav/visit/discussions>
- User Guide:
<https://visit-sphinx-github-user-manual.readthedocs.io/en/develop/>
- Wiki
<http://www.visitusers.org>

Download Visit now while we go over basic concepts so you are ready for the hands-on portions

The KVL Team



Dr. Sohaib Ghani
(LEAD STAFF SCIENTIST)

- VISUAL ANALYTICS
- INFORMATION VIS
- STATISTICAL ANALYSIS



Dr. James Kress
HPC SCIVIS

- VISUALIZATION SOFTWARE
- HPC INSITU VISUALIZATION
- DISTRIBUTED VISUALIZATION



Dr. Ronell Sicat
SCIVIS, AR/VR

- SCIENTIFIC VISUALIZATION
- SEGMENTATION & 3D ANALYSIS
- AR/VR DEVELOPMENT



Dr. Didier Barradas
Data Scientist

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING



Dr. Abdelghafour Halimi
Data Scientist

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING

Core Services

Training and
Workshops

Data Visualization & Data
Science Workflows

Facilities
Support

Scientific
Visualization
Workshop
Series

Data
Science
Workshop
Series

AI Tools
and
Techniques
Workshop
Series

HPC
Visualization

Image
Segmentation &
3D Analysis

AR/VR

Large Scale
AI & Data
Science

AR/VR Hub

Tiled
Display
Walls

Visualization Laboratory Wiki

Search docs

Welcome to the KVL

Welcome to the KAUST Visualization Core Lab (KVL)

Who We Are

Core Services

Mission

Contact Us

Location

Recent Highlights

Video Overview

People

Training Events

Facilities

Highlights

KVL Documentation

Frequently Asked Questions

Visualization Tools User Guides

VR Tools User Guides

Data Science Tools User Guides

Facility User Guides

Docs » start

Welcome to the KAUST Visualization Core Lab (KVL)



Who We Are

The KAUST Visualization Core Laboratory is a state-of-the-art facility within the Core Labs that offers students, faculty, researchers, and university collaborators a unique opportunity to utilize one-of-a-kind visualization, interaction, and computational resources for the exploration and analysis of scientific data.



Core Services

Our mission is to support the data visualization and data science needs of KAUST researchers and In-Kingdom entities. To that end we have a varied range of expertise across the team. Contact us with your questions, project requests, or collaboration requests that fall within our service areas:

- 2D/3D Visualization Facilities**
 - We provide a unique set of **visualization** and **meeting** facilities on campus.
 - Contact us for inquiries or use your KAUST credentials to **create a booking**.
- Data Visualization and Data Science Workflows**
 - We support KAUST users with **visualization workflows**, **VR workflows**, and **data science/machine learning**.
 - Contact us for **additional information**, to **submit a general request**, or **request a collaboration**.
- Training and Workshops**
 - We have a wide variety of trainings available on our [YouTube Channel](#) as well as select trainings performed **in-person** each semester.



Mission

To support the needs of KAUST researchers and In-Kingdom entities by:

- Developing and maintaining an effective and efficient environment for data exploration and analysis
- Providing advanced visualization and data analysis services
- Providing training on state-of-the-art visualization hardware and software for scientific discovery
- Developing new capabilities to remain at the cutting edge of visualization and data science



Contact Us

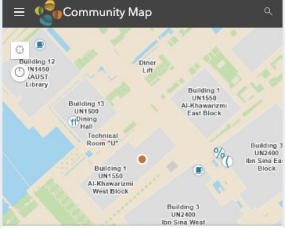
help@vis.kaust.edu.sa
KVL YouTube Channel
KVL Twitter
Core Labs Website
KVL Core Labs Main Website



Location

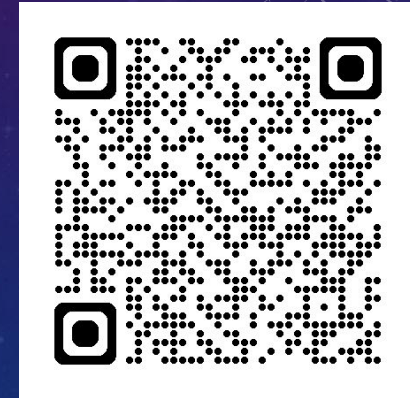
Our main showcase facility is located @:
Building 1 (seaside), Level 2, Showcase

Community Map



KAUST Visualization Core Lab

Zoom to Email Map Direction



<https://wiki.vis.kaust.edu.sa>

Dr. James Kress

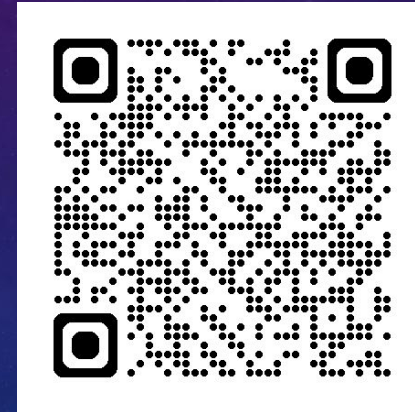
Scientific Visualization 101: Visit

5

KVL Training Events

--- Available In-Person and Online ---

- Scientific Visualization Workshop Series
 - ParaView, VisIt, Avizo/Amira
- Data Science Workshop Series
 - Shell, Conda, Python, Git, and more
- Hands-on AI Tools and Techniques Workshop Series
 - Intro to Machine Learning/Deep Learning, Visualization for Data Science



<https://www.youtube.com/@kaustvislab>

Data Visualization and Science Workflows

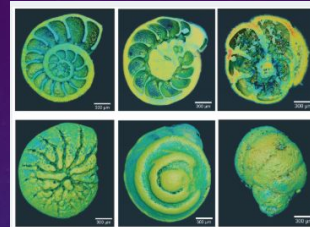


KVL Collaborates in areas such as:

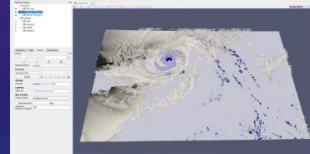
- HPC Visualization
- Scientific and Information Visualization
- AR/VR
- Image Segmentation and 3D Analysis
- Large-scale AI and Data Science

Send us an email if you have a collaborative project that can benefit from our expertise:

help@vis.kaust.edu.sa



Micro-CT and Holographic Visualization of Late Cretaceous Benthic Foraminifera in Saudi Arabia



KVL and Kitware Blog Collaboration

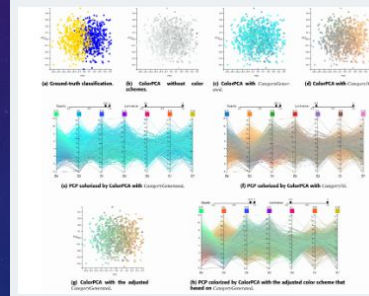


KVL Releases Open Source Software to Visualize Supercomputing Simulations

Scientific Visualization 101: Visit



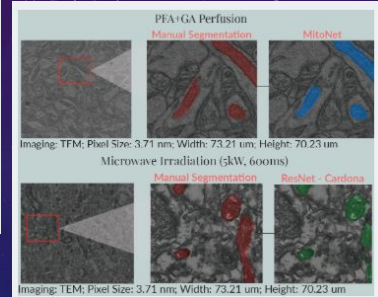
Mobile AR Visualization of Giant Red Sea Coral



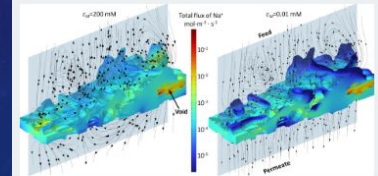
ColorPCA: Scalable Colored Dimensionality Reduction for Unlabeled High-Dimensional Data



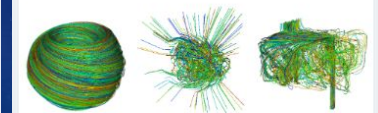
KVL Co-Organized Visualization Workshop



Segmentation and 3D Reconstruction of Glycogen and Mitochondria in Microwave-fixed Brain EM



3D Modeling of Composite Membranes from TEM



Analyzing Particle Advection Performance

Workshop Goals

- Hands-on learning with VisIt
 - Introductory course
 - Slides / demonstrations
- Why VisIt @ KAUST
 - Open source, scalable, multi-platform visualization application with users worldwide
 - Available on all major computation resources at KAUST
 - VisIt on Ibex and Shaheen
 - Support for distributed computations to process very large data sets
 - VisIt has been proven on up to 27 billion element meshes

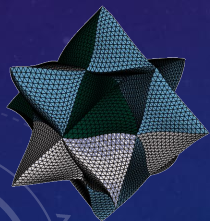
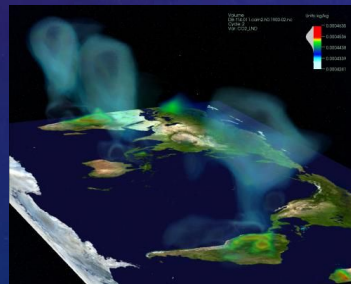
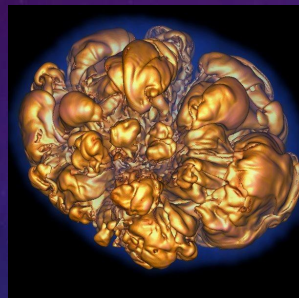
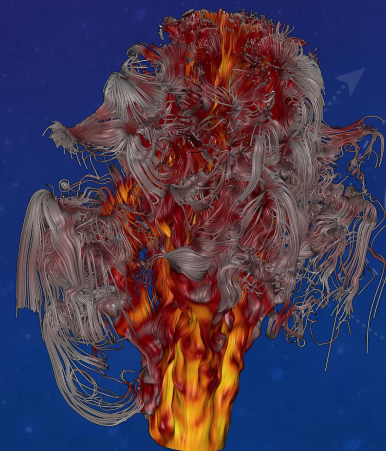
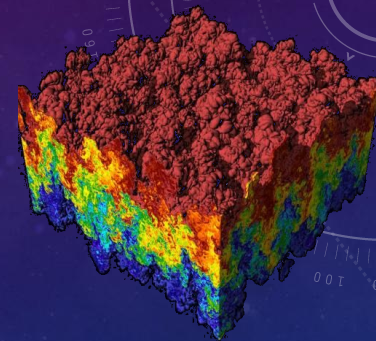
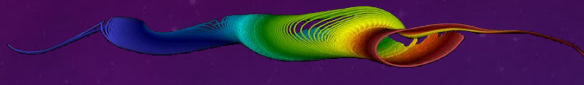


VisIt Basics

What is VisIt and What can It Do?

What is VisIt?

- Open-source application for analysis and visualization of mesh-based data
- Infrastructure for parallel post-processing that scales from laptops to HPC clusters
- Built-in in situ capabilities



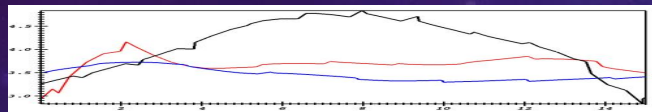
VisIt Supports a Wide Range of Use Cases



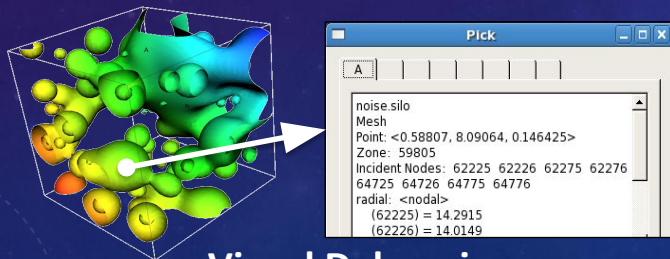
Data Exploration



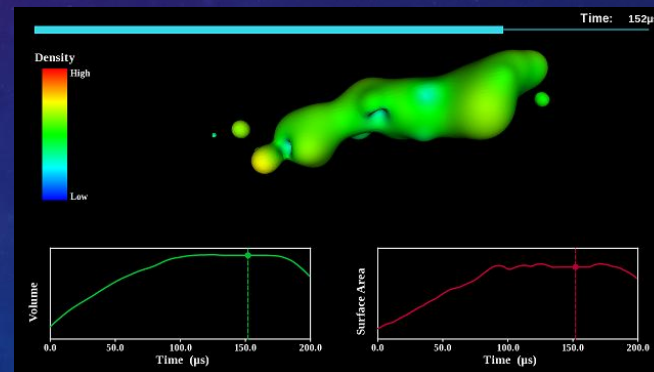
Comparative Analysis



Quantitative Analysis

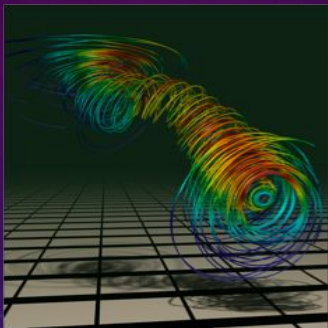


Visual Debugging

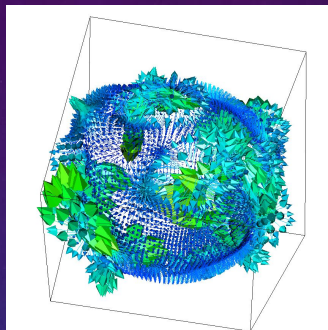


Presentation Graphics

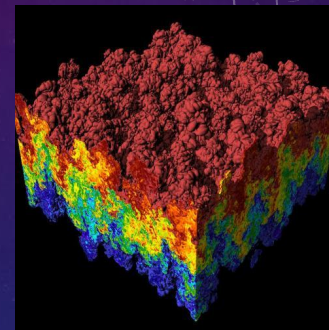
VisIt Supports a Wide Range of Plotting Types



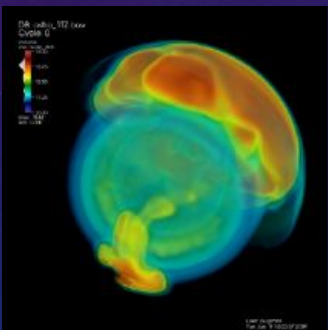
Streamlines / Pathlines



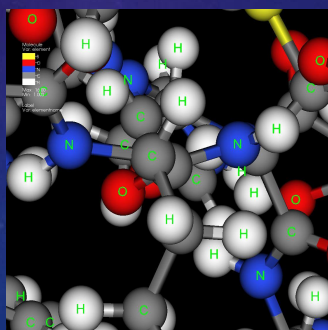
Vector / Tensor Glyphs



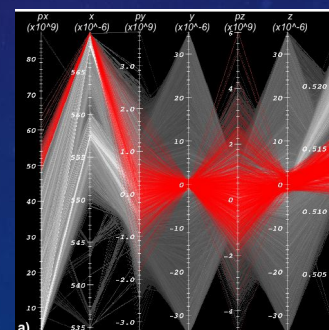
Pseudocolor Rendering



Volume Rendering



Molecular Visualization



Parallel Coordinates

How Do I Obtain VisIt?

- Use an existing build:
 - For your Laptop or Workstation:
 - Binaries for Windows, OSX, and Linux (RHEL + Ubuntu):
(<https://visit-dav.github.io/visit-website/releases-as-tables/#latest>)
 - KVL team manages builds on Ibex and Shaheen
- Build VisIt yourself:
 - “build_visit” is a script that automates the process of building VisIt and its third-party dependencies. (docs: https://visit-sphinx-github-user-manual.readthedocs.io/en/develop/building_visit/index.html)

How Do I Get My Data Into VisIt?

VisIt supports more than 110 file formats

- VTK, Silo, Xdmf, PVTk
- The PlainText database reader can read simple text files (CSV, etc)
 - https://visit-sphinx-github-user-manual.readthedocs.io/en/develop/data_into_visit/PlainTextFormat.html
- visit_writer utility: code to write VTK files from your sim code
 - https://visit-sphinx-github-user-manual.readthedocs.io/en/develop/data_into_visit/VTKFormat.html
- Support for Mesh-based data in Conduit Blueprint:
 - http://llnl-conduit.readthedocs.io/en/latest/blueprint_mesh.html

Read the docs: https://visit-sphinx-github-user-manual.readthedocs.io/en/develop/data_into_visit/index.html



Visualization Techniques

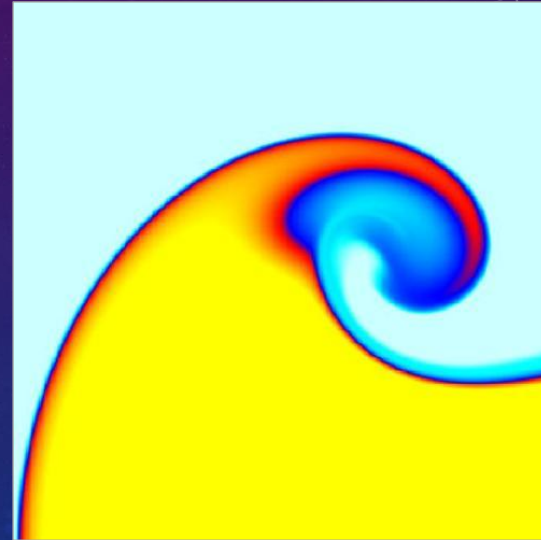
For Mesh Based Simulations

Pseudocolor Rendering

– Maps Scalar Fields to a Range of Colors



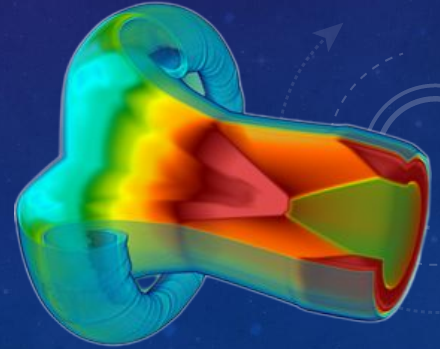
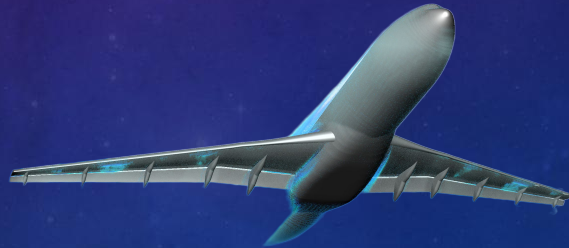
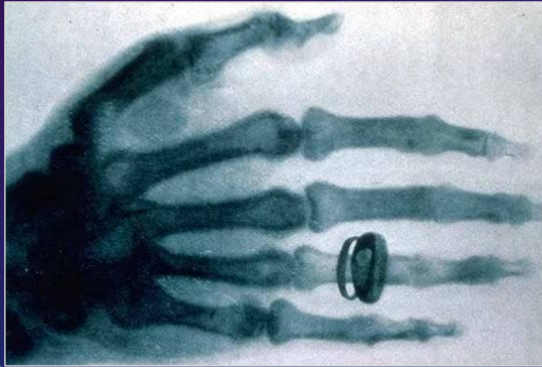
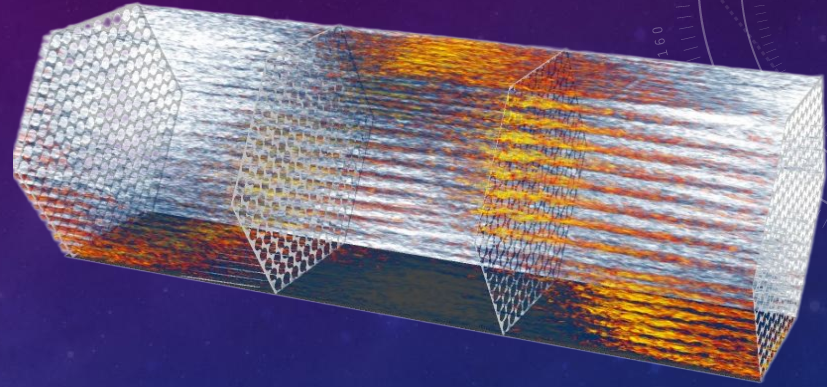
Pseudocolor Rendering of Elevation



Pseudocolor Rendering of Density

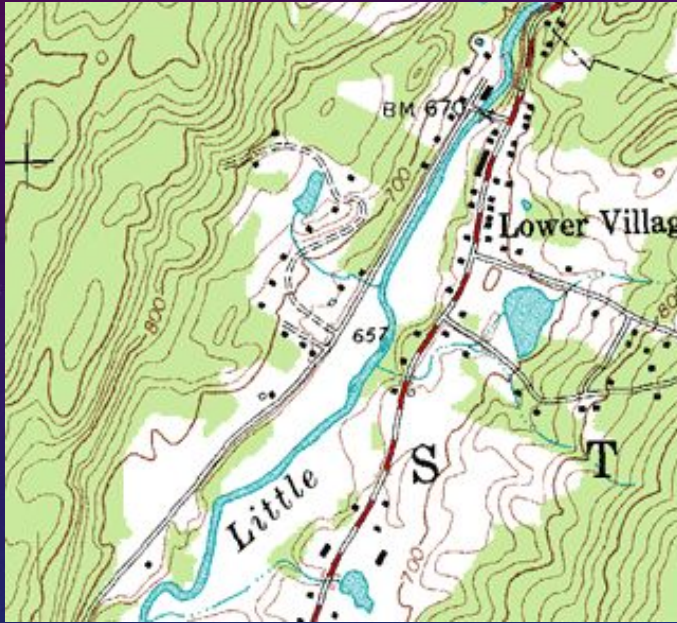
Volume Rendering

- Cast Rays and Applies Transfer Functions



Isosurfacing (Contouring)

- Extracts Surfaces of that Represent Level Sets



2D Contour (Elevation)



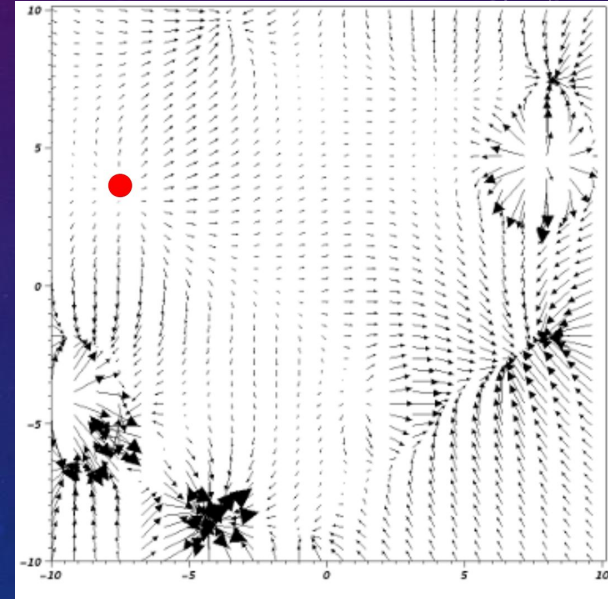
3D Contour (Pressure)

Particle advection

– Foundation of Several Flow Vis Techniques

- $S(t)$ = position of particle at time t
- $S(t_0) = p_0$
 - t_0 : initial time
 - p_0 : initial position
- $S'(t) = v(t, S(t))$
 - $v(t, p)$: velocity at time ' t ' and position ' p '
 - $S'(t)$: derivative of the integral curve at time ' t '

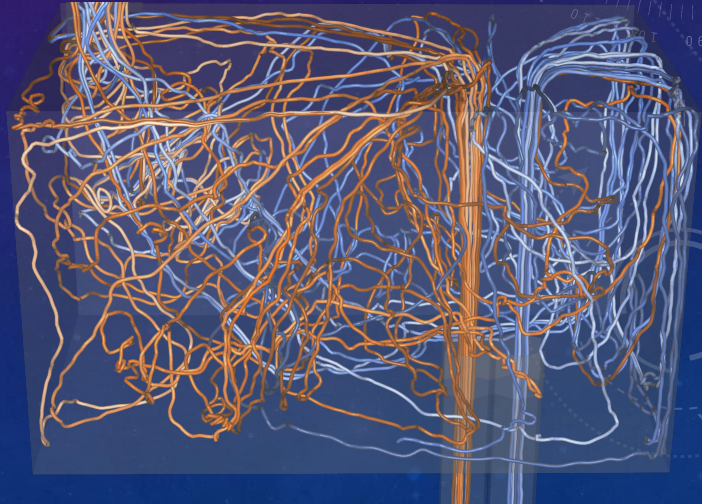
This is just an ordinary differential equation



Streamline and Pathline

– Built on Particle Advection

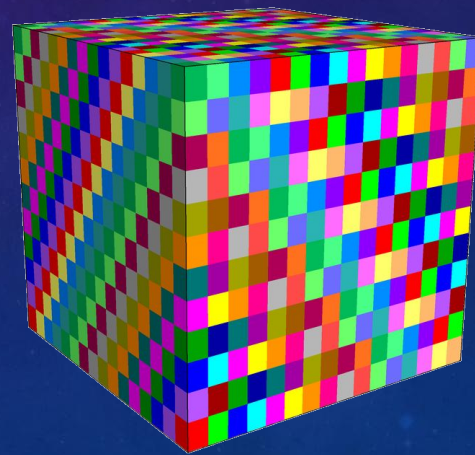
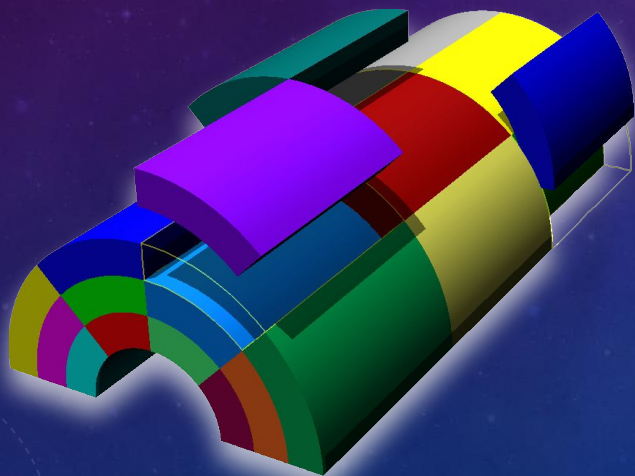
- Streamlines:
Instantaneous paths
- Pathlines:
Time dependent paths



Domain Decomposed Meshes

– Enable scalable parallel visualizations

- Simulation meshes may be composed of smaller mesh “blocks” or “domains”
- Domains are partitioned across MPI tasks for processing





VisIt Interface Tour

VisIt GUI

Pulldown Menu

Plot Window

Active Window Selector

Data Sources

Time Slider

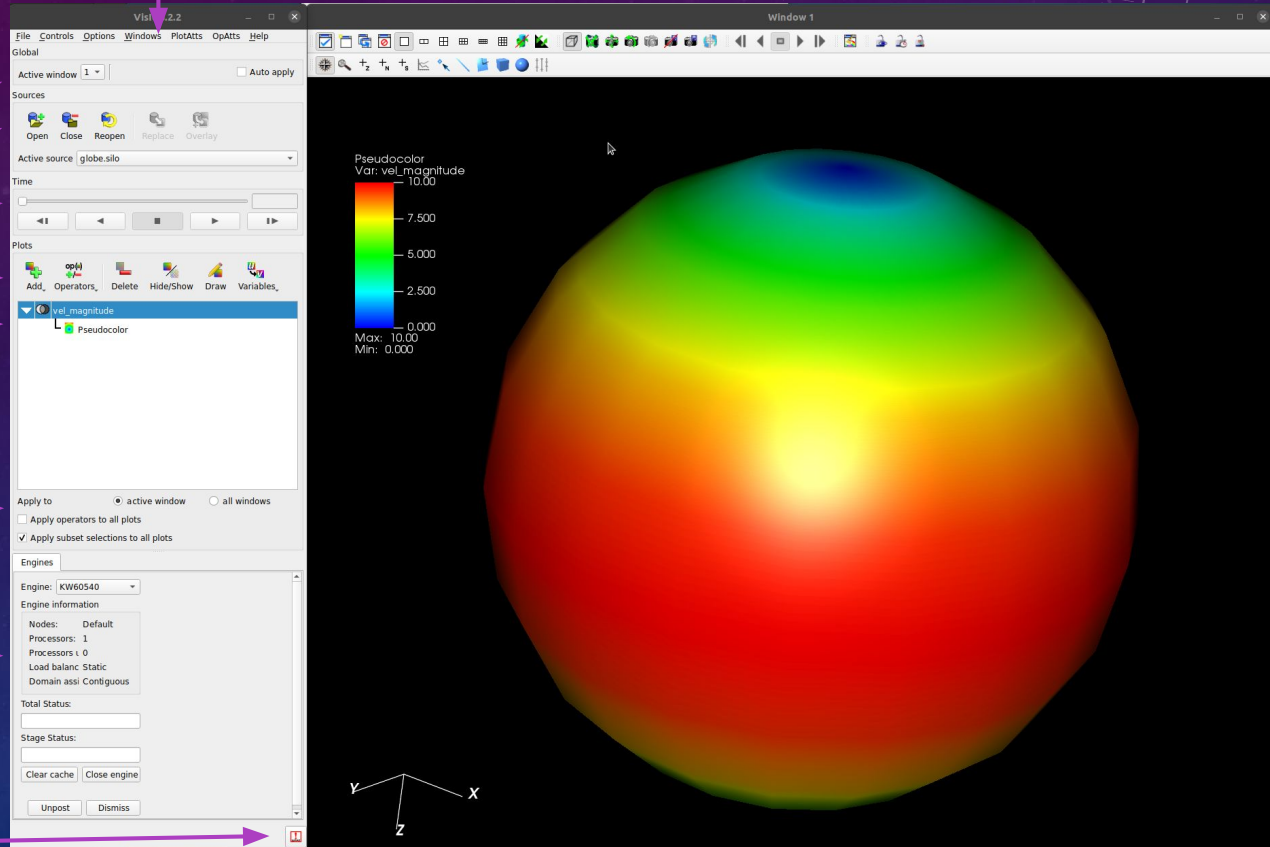
Plots & Operators

Pipeline Browser

Apply To

Notepad

Output Indicator





Hands–On Session 1

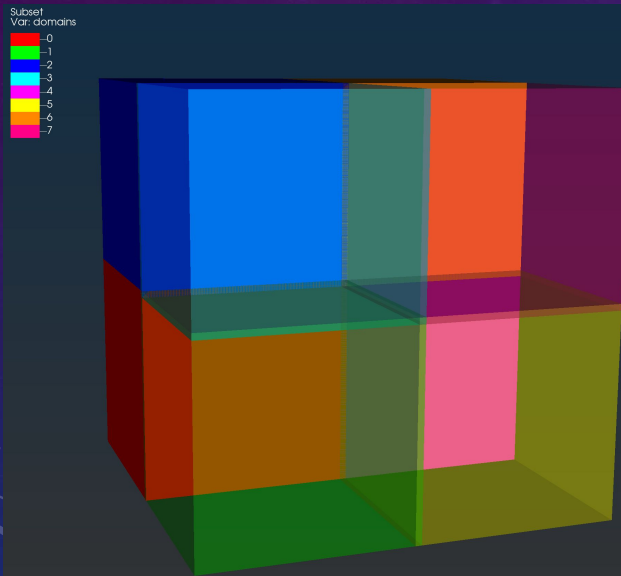
GUI Tour

First Data Set

- Gray-Scott Data Set

- grayScott_step-*.pvti - Parallel VTK Image File

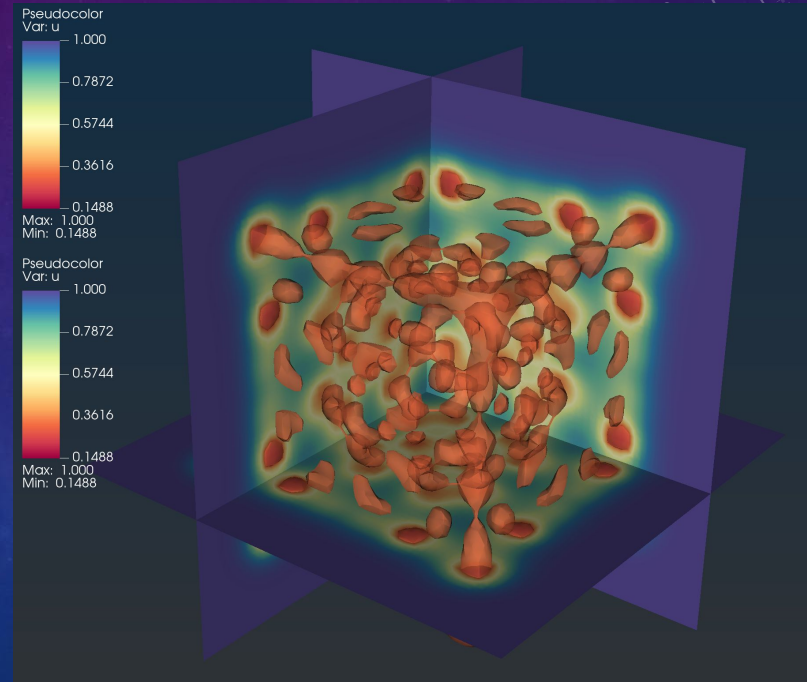
- Multi Time Step / Multi Block Files



Creation of our data

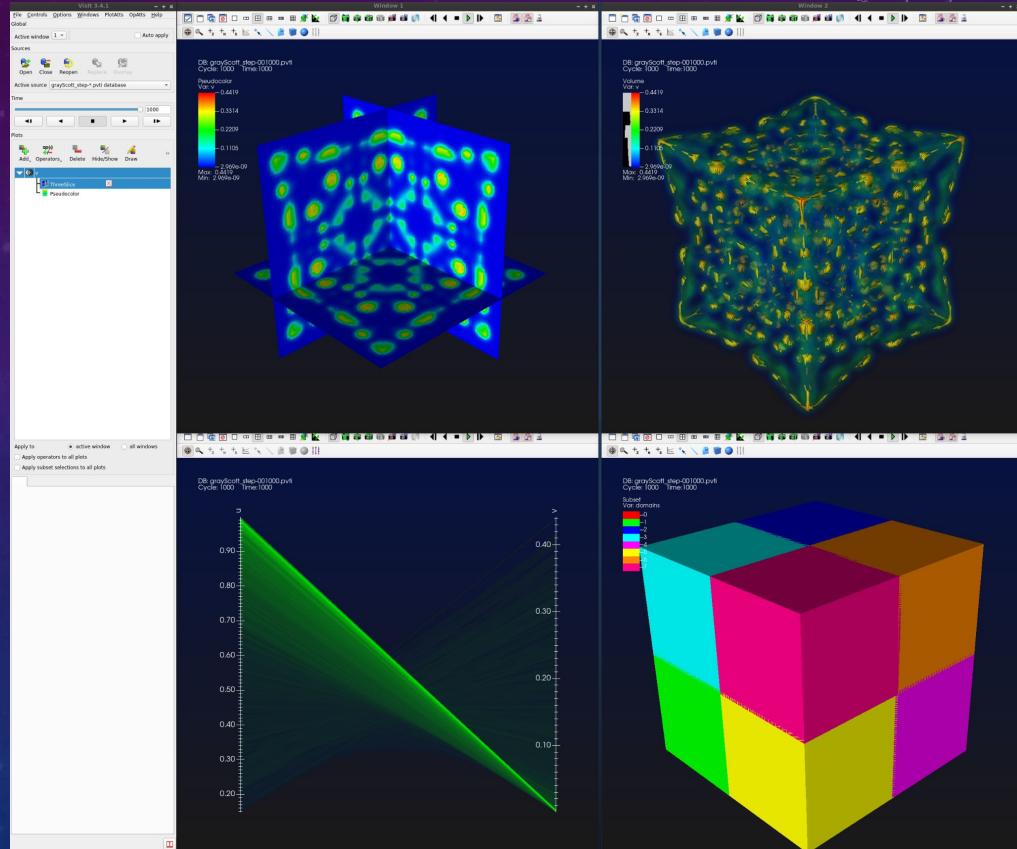
Miniapp simulation data: [Gray-Scott Miniapp](#)

- This is a 3D 7-point stencil code to simulate the Gray-Scott reaction diffusion model.
 - A Reaction-diffusion system is a system in which a dynamical system is attached to a diffusion equation, and it creates various patterns. This is an equation that simulates the chemical reaction between the chemicals 'U' and 'V'. 'U' is called the activator and 'V' is called the repressor.



VisIt GUI Tour

- Opening files / file types
- View file info
- Navigating views
- Multiple views
- Window tools
- Add plot / add operator
- Change plot / operator attributes
- Selectively applying operators
- Link views





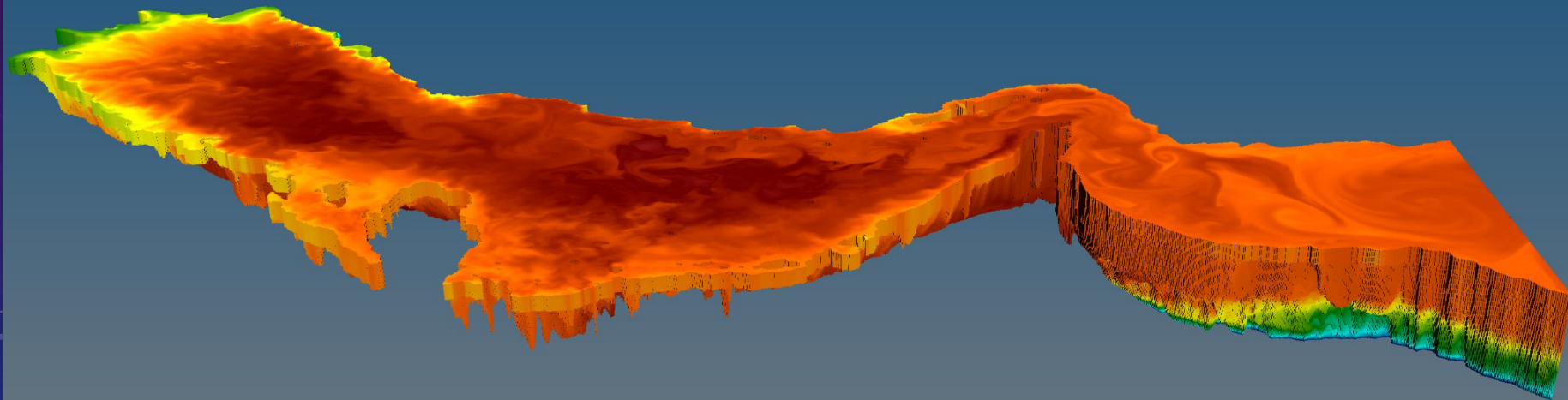
Hands–On Session 2

Basic Plots / Slices / Contours

Second Data Set

- Arabian Gulf Data Set
 - Arabian_gulf.vtu – VTK binary XML format

Location of our data





Hands–On Session 3

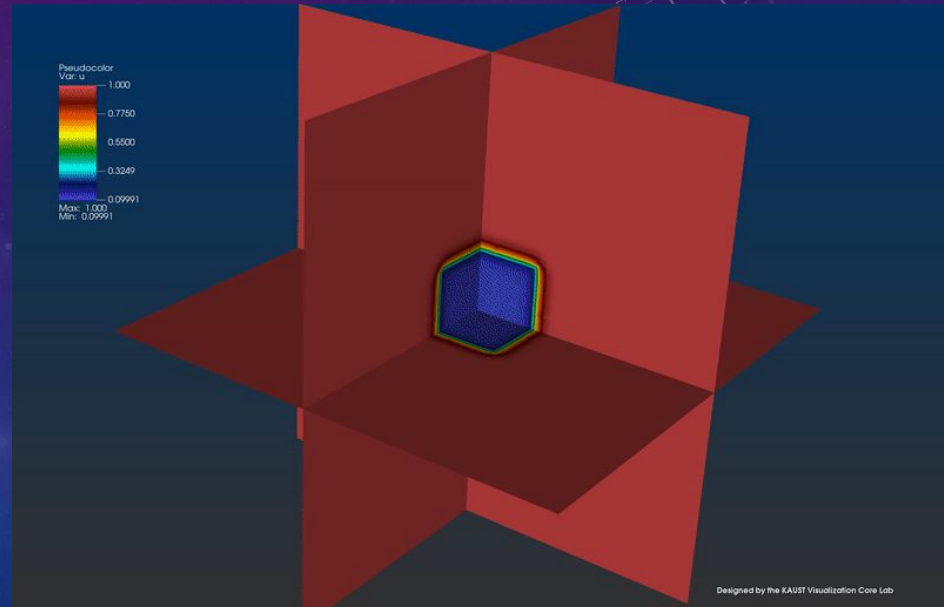
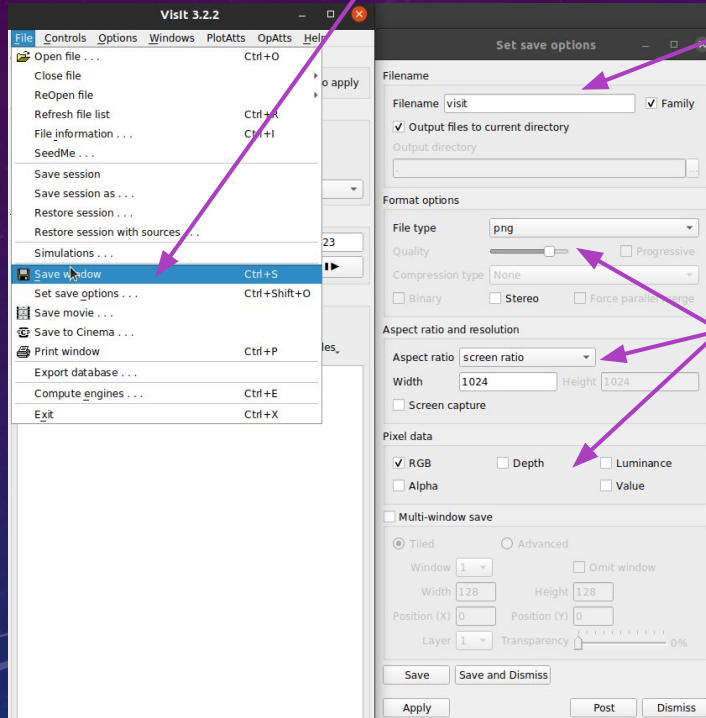
Screenshots / Movies / Animations / Custom Expressions / Queries / Saving Visit State

Screenshots / Movies

Save Window / Save Options

Filename & Directory

Save Options



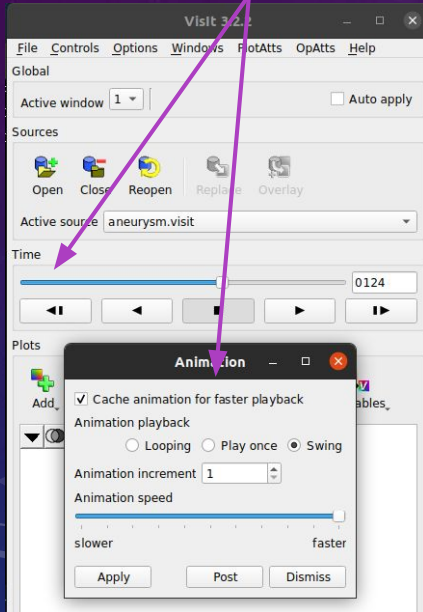
Animation / Keyframing



Resulting Movies

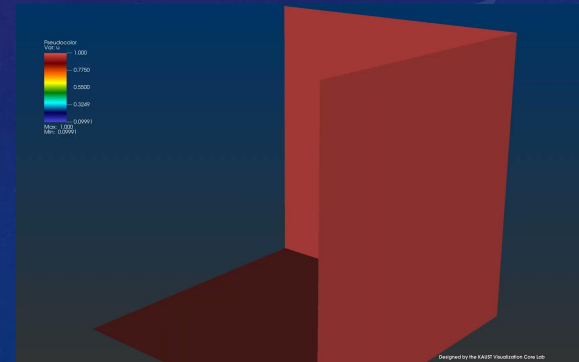
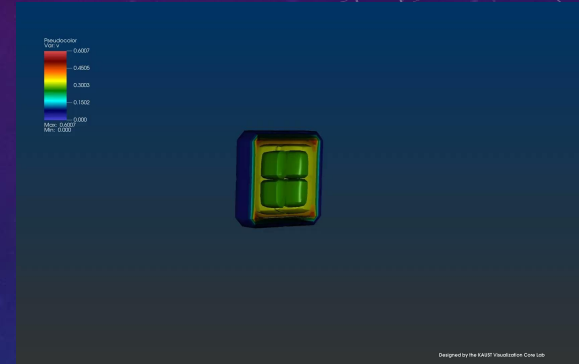
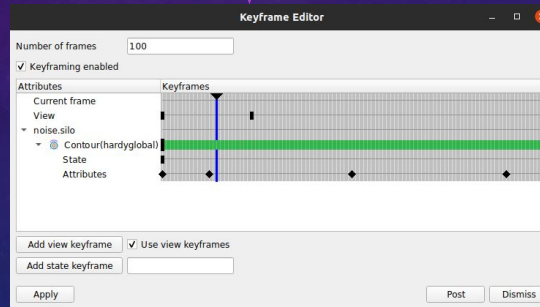
Viewing Animations

Animation Time Slider



Keyframing

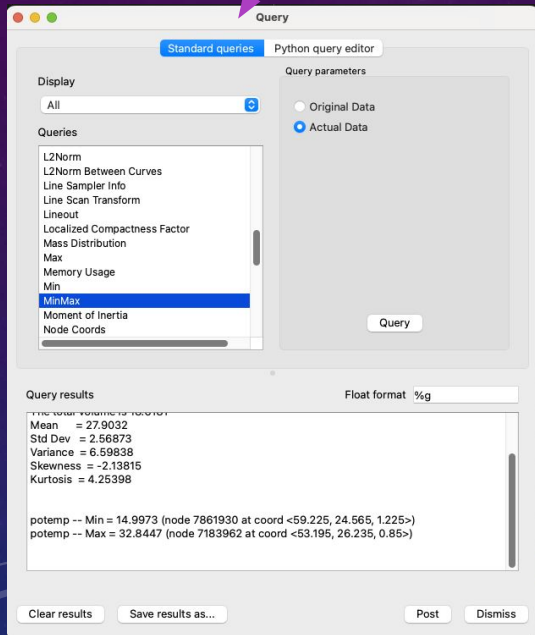
Keyframe editor



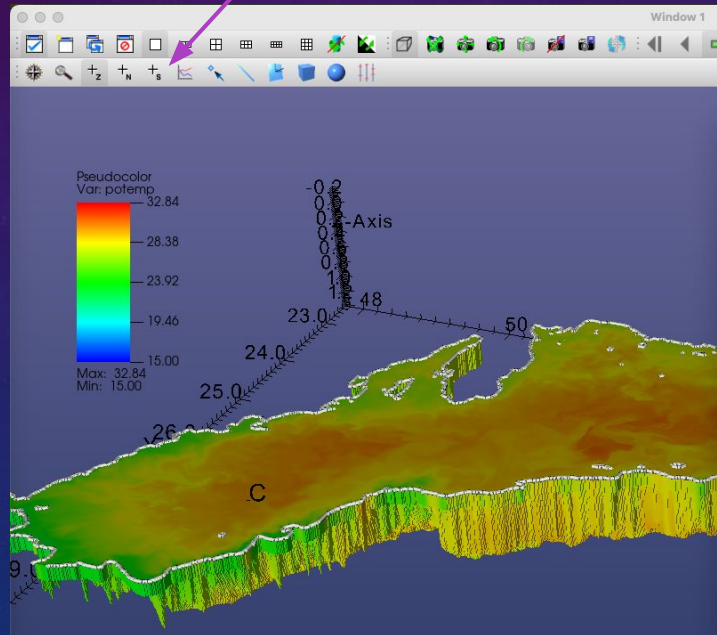
Queries / Pick



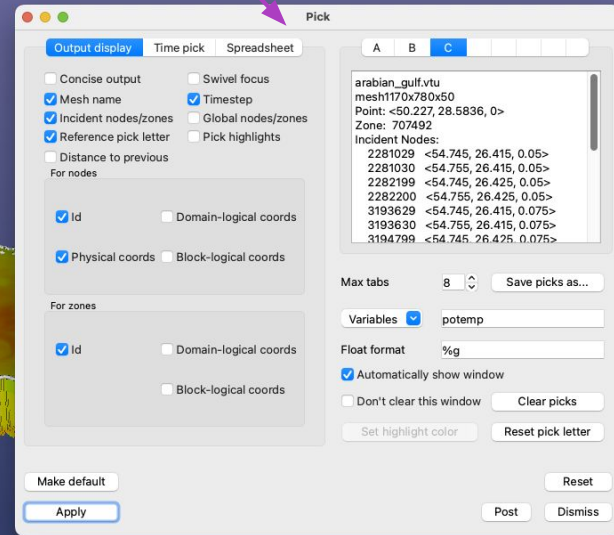
Query Window



Pick Options



Output Window



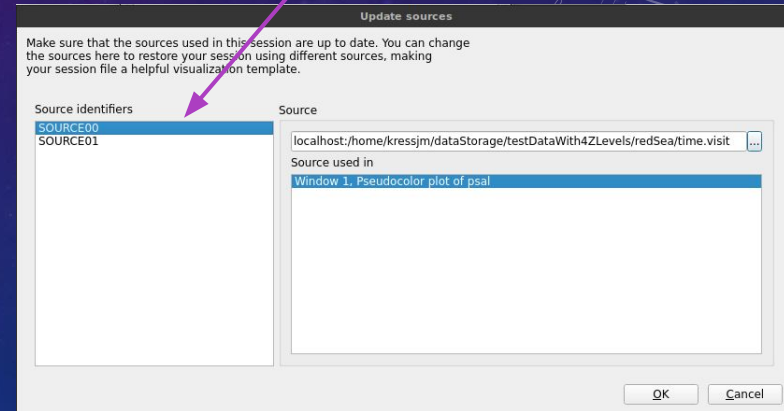
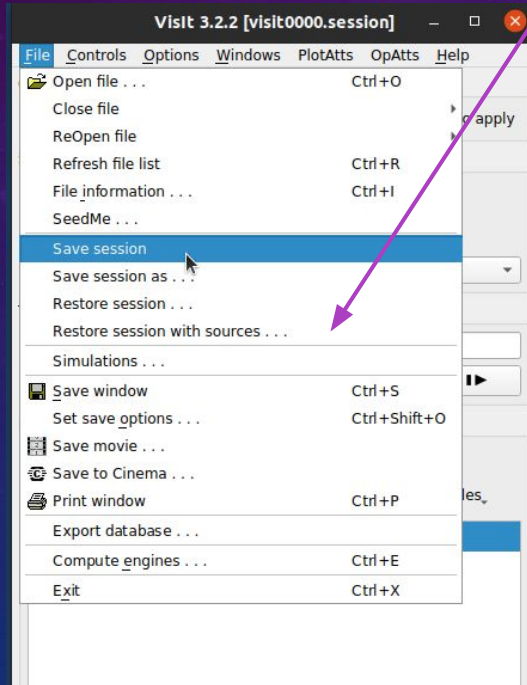
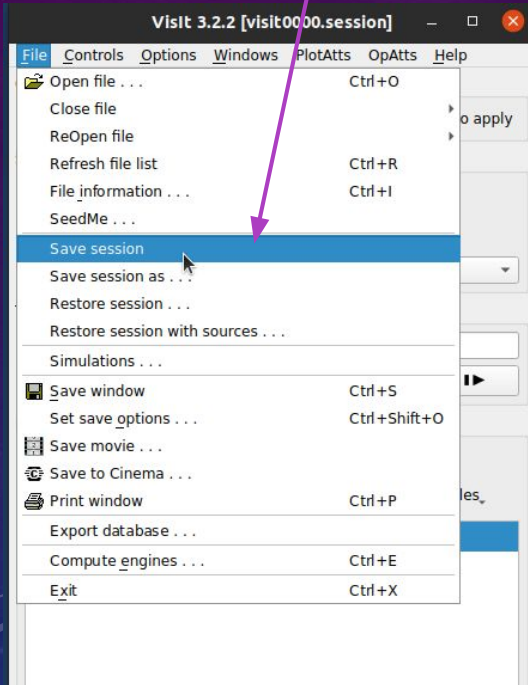
Save Session / Restore Session w/Sources



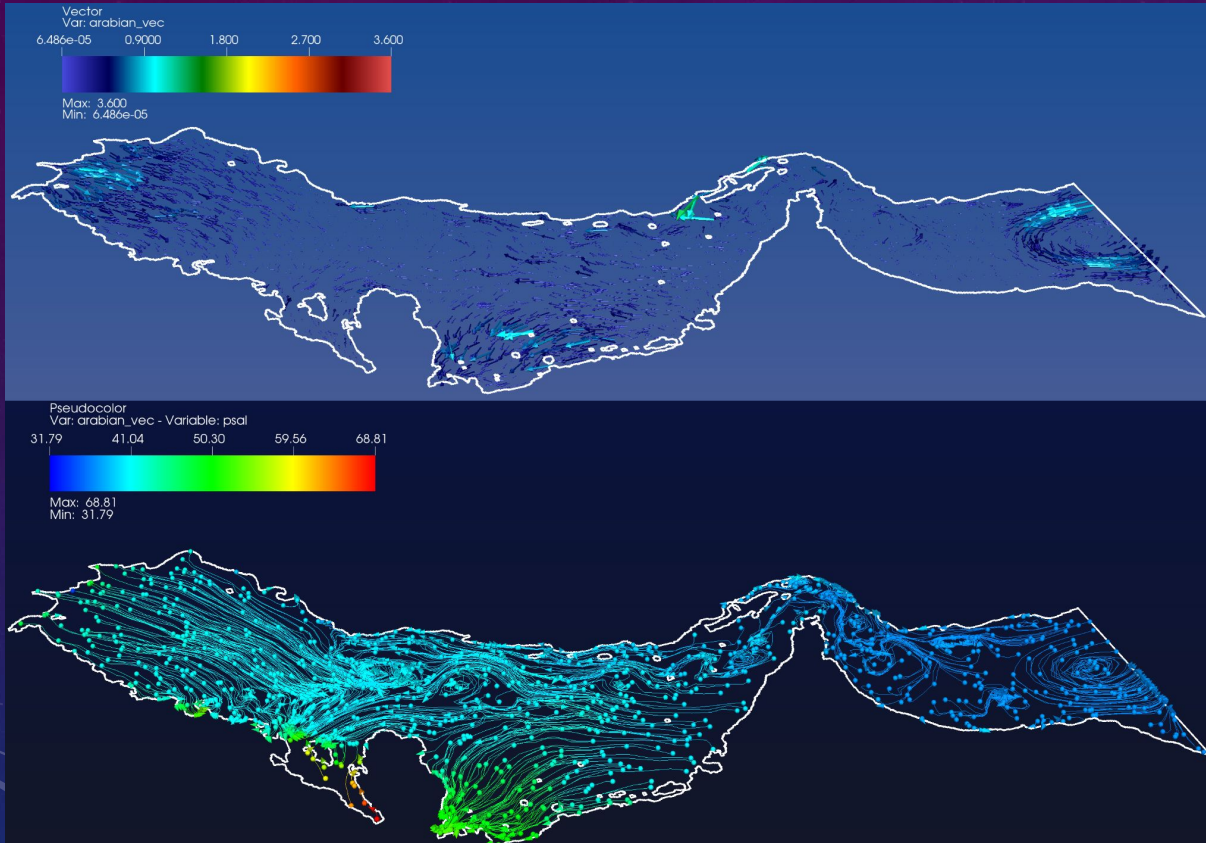
Save Session Dialogue

Restore Session with Sources

See each source and what plot uses each source



Vector Plots / Streamlines



Create a vector expression, then:

1. Create vector plot
 - a. Transform coordinates in z-direction
2. Create integral curve plot
 - a. Slice in z-direction
 - b. Project data to 2D
 - c. Integral curve
 - d. Elevate data back to 3D



VisIt Wrap-up

Best Practices / Scaling-up Workflows

Visualization Best Practices



جامعة الملك عبد الله
لعلوم والتقنية
King Abdulaziz University of
Science and Technology

KAUST
Supercomputing
Laboratory

Quickstart System Architecture **Software ecosystem** Policy Data Management Training Blogs Contact Us

🏠 > Software ecosystem > Visualization > Visualizatio...

Section Navigation

- Software environment
- Job Scheduling
- Profiling and Debugging tools
- Science Platforms
- Visualization**
 - Visualization Best Practices**
 - ParaView @ KAUST
 - VisIt @ KAUST
 - In Situ @ KAUST

Visualization Best Practices

- 1. If your data is small/manageable**
 - Do your visualizations on your laptop or desktop
- 2. If your data is medium/large**
 - Do interactive visualization on Ibox
 - Run ParaView or VisIt on your local machine and connect directly to Ibox to load/process/visualize
 - [Using ParaView Interactively](#)
 - [Using VisIt Interactively](#)
- 3. If your data is large/huge and you have a defined workflow**
 - Do batch visualization on Shaheen
 - [Batch Processing with ParaView](#)
 - [Batch Processing with VisIt](#)
- 4. If you have repeatable repetitive tasks**
 - Do scripted or batch visualization

Reach out

Contact the KAUST Visualization Core Lab for visualization advice, help, collaboration, and consulting:

- [KVL Wiki](#)
- KVL email: help@vis.kaust.edu.sa

Previous [Visualization](#) Next [ParaView @ KAUST](#)

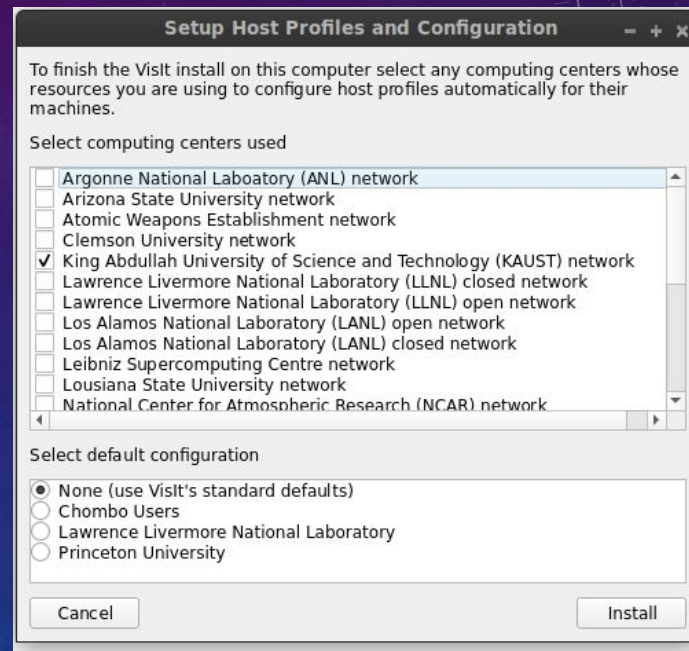
docs.hpc.kaust.edu.sa

Accessing KAUST HPC Resources

- Must have an active/valid user account
- Load the KAUST profile
- Connect & Visualize

For instructions see:

- https://docs.hpc.kaust.edu.sa/soft_env/visualization/visit_overview.html





Thanks!

Contacts:

james.kress@kaust.edu.sa

help@vis.kaust.edu