Scientific Visualization 101
ParaView: An Introductory Hands-On Workshop

Thomas Theußl

Visualization Scientist

KAUST Visualization Core Lab

1 October 2024

Getting Started

- Install ParaView (preferably v5.13)
  - Download: https://www.paraview.org/download
- Workshop Materials
  - Visualization Lab Wiki: https://wiki.vis.kaust.edu.sa
  - Training Page: https://wiki.vis.kaust.edu.sa/training
  - Download data sets and slides:
    https://wiki.vis.kaust.edu.sa/training/scivis/2024/paraviewfall
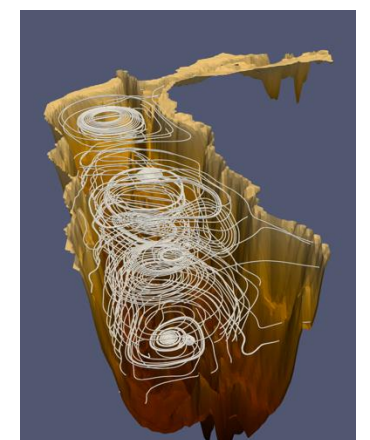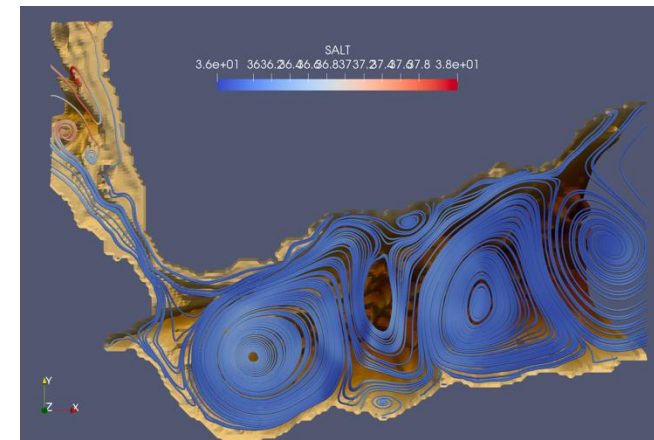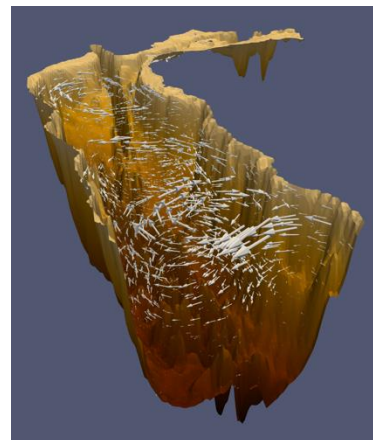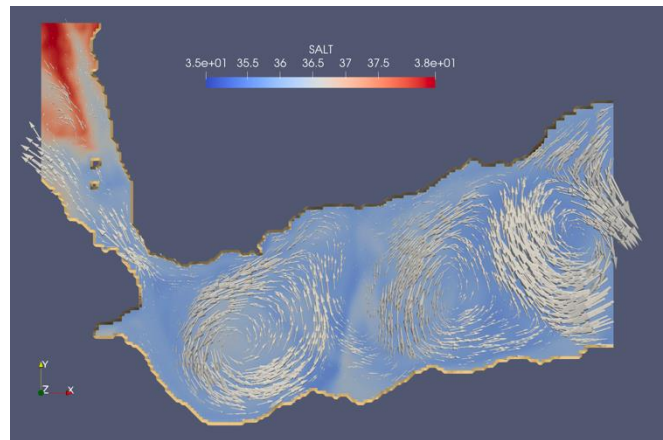
Introduction / Motivation

Hands on exercises in ParaView on some basic visualization techniques

- Scalar field visualization: colormaps, slicing, contouring
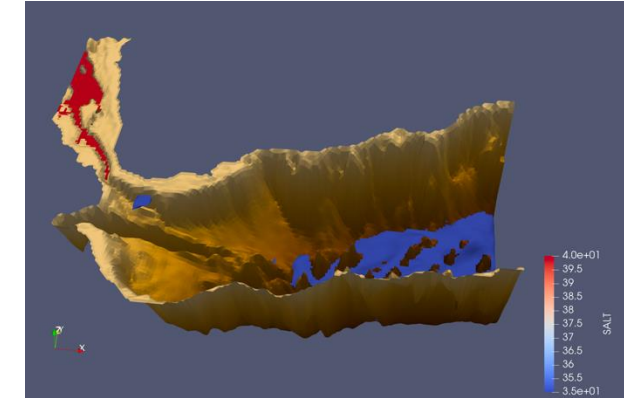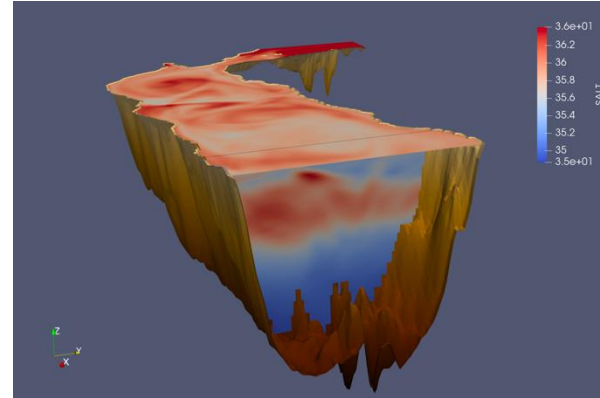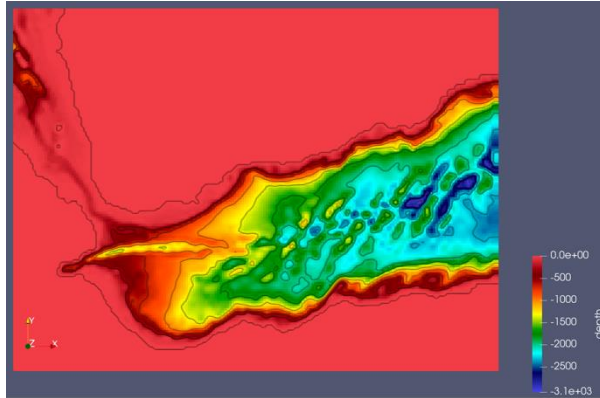
- Vector field visualization: arrow plots, streamlines

About the Data

https://kaust-vislab.github.io/SciVis2020/

The data set consists of the bathymetry of the Red Sea and an ensemble (50 members) of time-dependent 3D flow and scalar fields on a regular grid (500x500x50, 60 time steps) covering one month of simulation time to study eddies in the Red Sea and the Gulf of Aden.

The size of the ensemble data in uncompressed NetCDF format is 1.5 TB (64 GB compressed).

We will use a small portion of it in this workshop (download from the workshop web page https://wiki.vis.kaust.edu.sa/training/scivis/2024/paraviewfall
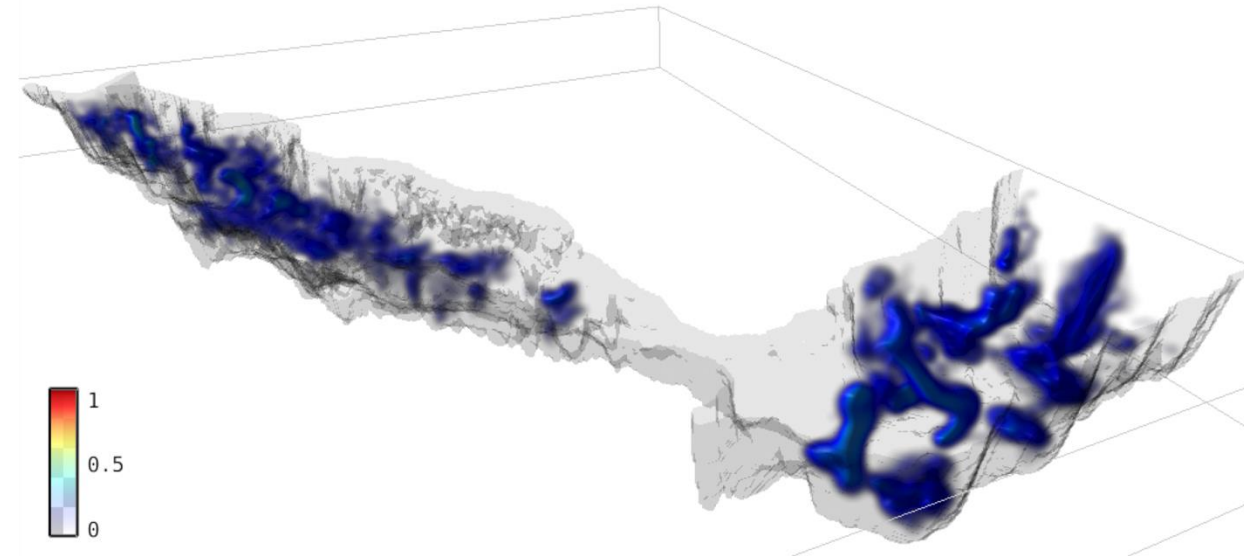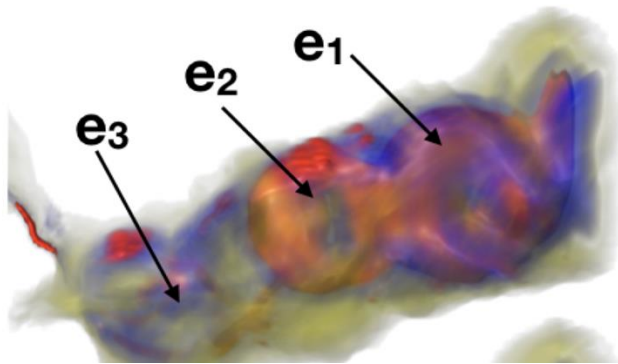
Visualization Core Lab

Overview of Facilities & Services
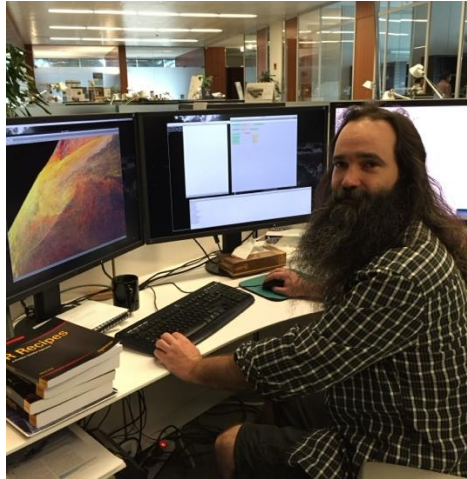
The Team

Dr. Sohaib Ghani
(LEAD STAFF SCIENTIST)

- VISUAL ANALYTICS
- INFORMATION VIS
- STATISTICAL ANALYSIS

Thomas Theussl
SCIVIS

- SCIENTIFIC VISUALIZATION
- LARGE DATA ANALYSIS
- DISTRIBUTED VISUALIZATION

Dr. James Kress
HPC SCIVIS

- VISUALIZATION SOFTWARE
- HPC INSITU VISUALIZATION
- DISTRIBUTED VISUALIZATION

Dr. Ronell Sicat
VR/AR

- SCIENTIFIC VISUALIZATION
- VR DEVELOPMENT
- 3D RECONSTRUCTION

Dr. Didier Barradas
Data Scientist

- DATA SCIENCE
- MACHINE LEARNING
- DEEP LEARNING

Dr. Abdelghafour Halimi
Data Scientist

- Data Science
- Machine Learning
- Deep Learning

KVL Core Services

- 2D/3D Visualization Facilities
  - We provide a unique set of visualization facilities on campus

- Data Visualization and Data Science Workflows
  - We support KAUST users and collaborators with visualization workflows, VR workflows, and data science/machine learning
  - Contact us for additional information or to submit a request

- Training and Workshops
  - We have a wide variety of trainings available on our YouTube Channel, as well as select trainings performed in-person/live online each semester
  - https://www.youtube.com/@kaustvislab
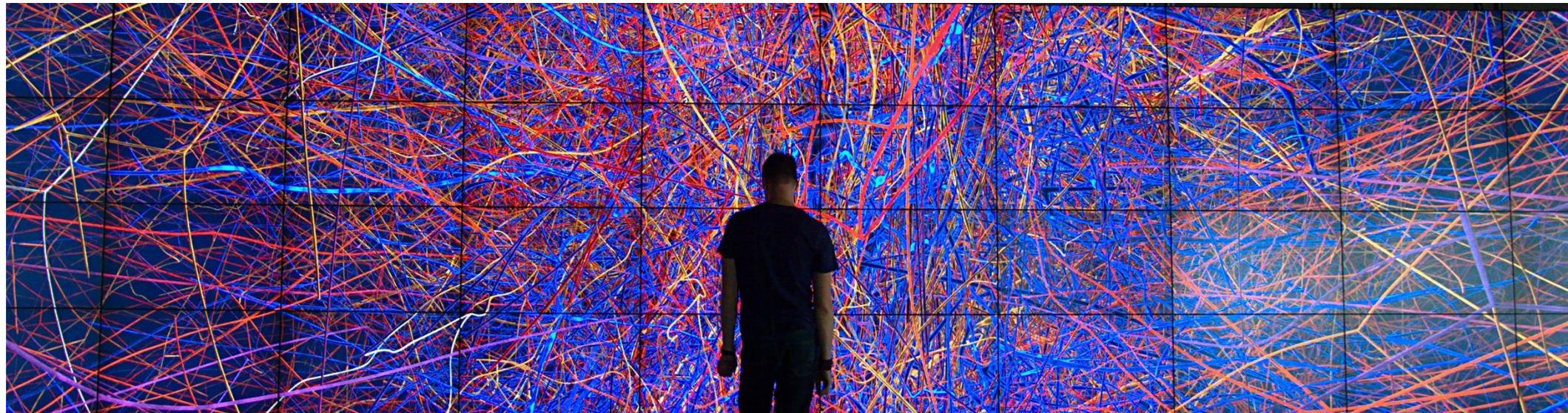
KVL Facilities

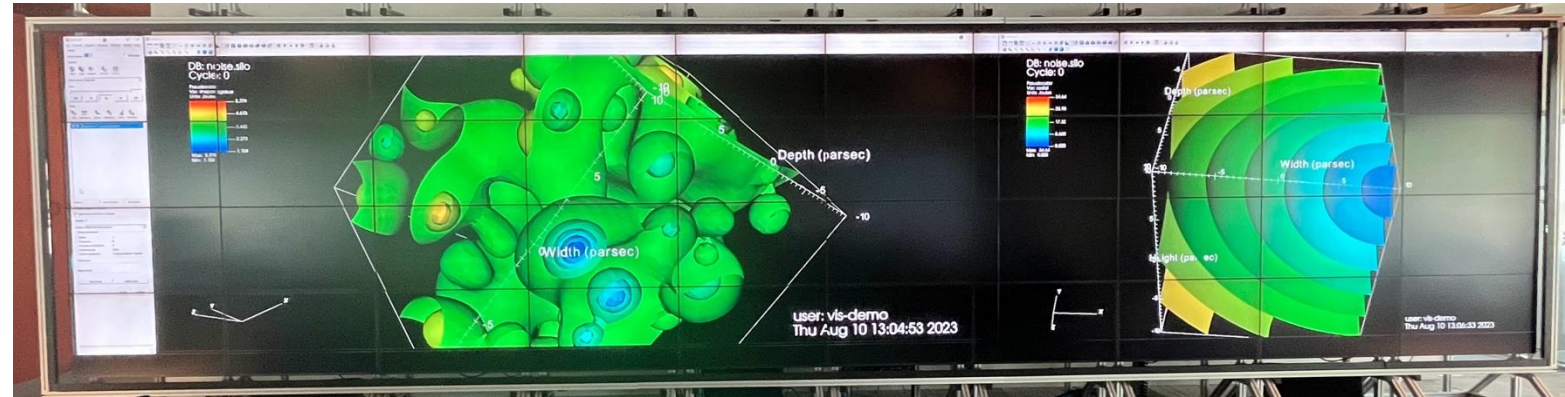

HMD's

Segmentation Tablets

CUBES VR

ZONE 1/2 DISPLAY WALLS

Z2 Visualization and Collaboration

- **ParaView & VisIt on Z2**
  - Connect to Ibex for compute or other networked storage

- **Sage3 collaboration boards**
  - Software to enable teams of collaborators to work together with data in the form of data visualizations
  - https://sage3.sagecommons.org/

Accessing KVL Facilities

- Book here (requires Portal Credentials):
  - https://wiki.vis.kaust.edu.sa/booking

Facility Booking Form

Once you click **Send Request** you can refresh this page to see your booking appear in the **bookings calendar**. All bookings are provisional until approved by KVL.

Vis Lab Home Booking Hosts 188 Logged in as kressjm

Logged in as kressjm. ×

Request a booking

| Purpose | Description of booking |

Reservation Maintenance   Cornea MPR Vis Cubes Vive Zone 1 Zone 2 Zone 5

Every 0 weeks Full day Start 2023-07-27 11:36 End 2023-07-27 11:36 Send Request

Upcoming Training Events

Scientific Visualization Workshop Series Fall 2024

Date	Training Event
September 17, 2024	Scientific Visualization 101: VisIt ~ An Introductory Hands-On Workshop
October 1, 2024	Scientific Visualization 101: ParaView
October 8, 2024	Scientific Visualization 101: Introduction to Image Segmentation and 3D Analysis

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Date	Training Event
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Hands-on AI Tools and Techniques Workshop Series

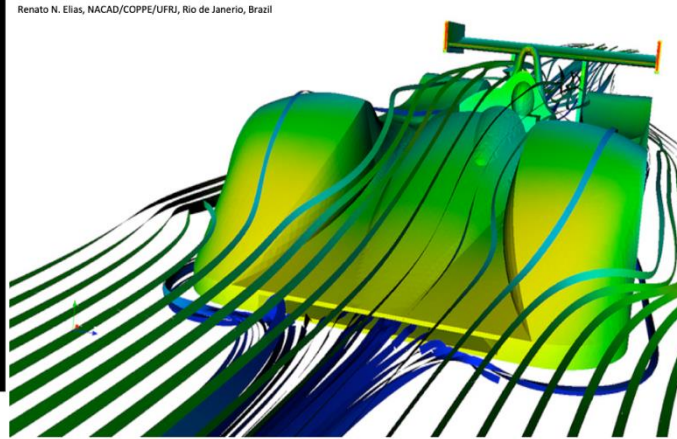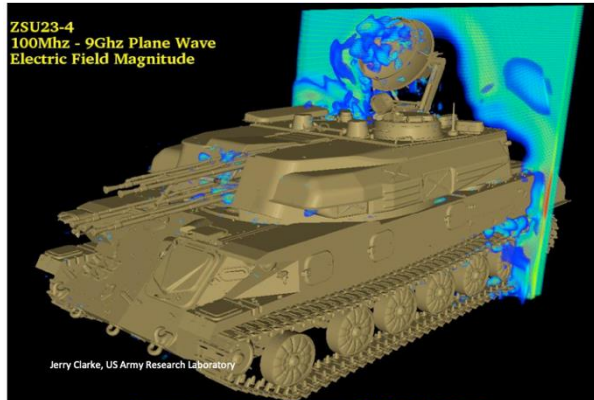| Date	Training Event
Thursday October 10, 2024	Introduction to Machine Learning
Sunday October 20, 2024	Introduction to Deep Learning
Wednesday October 23, 2024	Introduction to Data Visualization & Docker

Workshops Goals and Agenda

Workshop Goals

- Hands-on learning with ParaView
  - Introductory course
  - Slides / demonstrations
- What is ParaView ?
  - Opensource, scalable, multi-platform visualization application
  - Support for distributed computations to process large datasets
  - Commercial maintenance and support (Kitware Inc.)
- Why Paraview @KAUST
  - Available on all major computational resources at KAUST
  - Paraview on Ibex and Shaheen
  - Paraview @ KAUST Visualization Laboratory

What is ParaView?
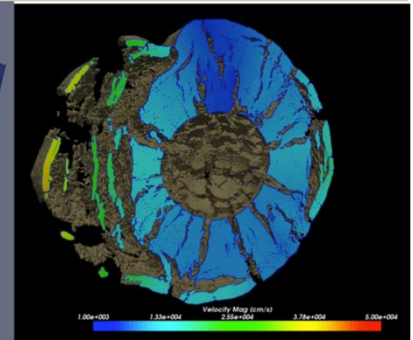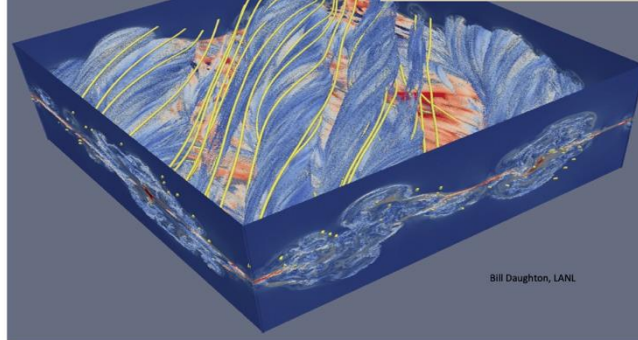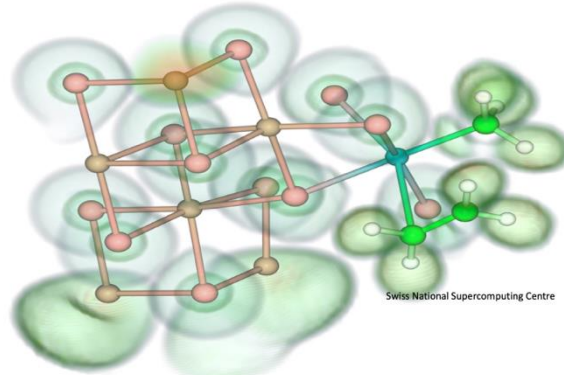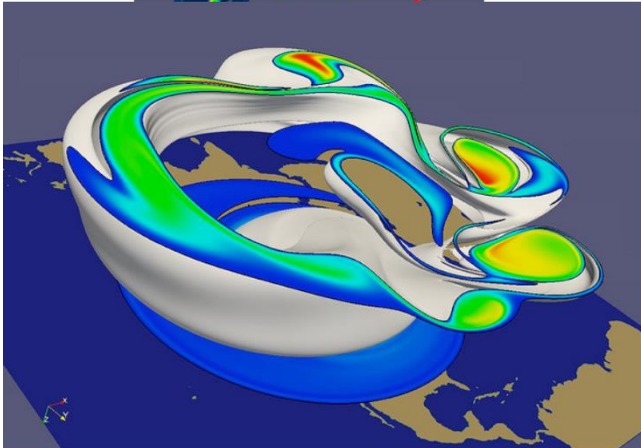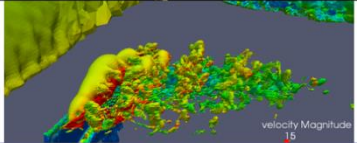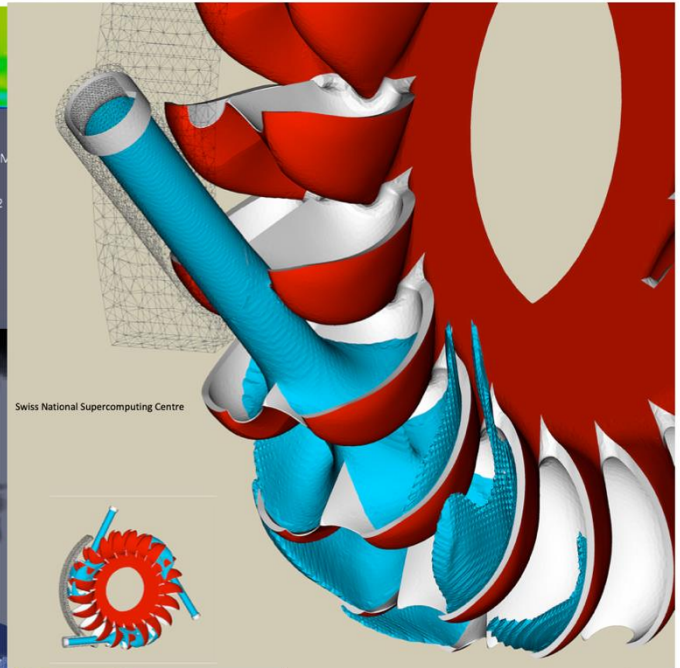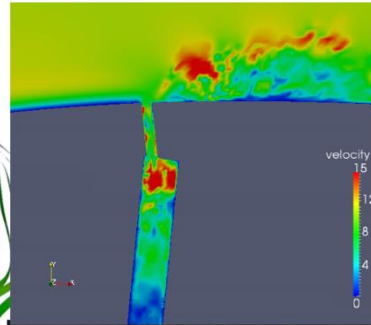
Source: Paraview Tutorial Slides

ParaView Architecture

ParaView Client	pvpython	ParaWeb	Catalyst	Custom App
UI (Qt Widgets, Python Wrappings)				
ParaView Server				
VTK				
OpenGL	MPI	IceT		Etc.
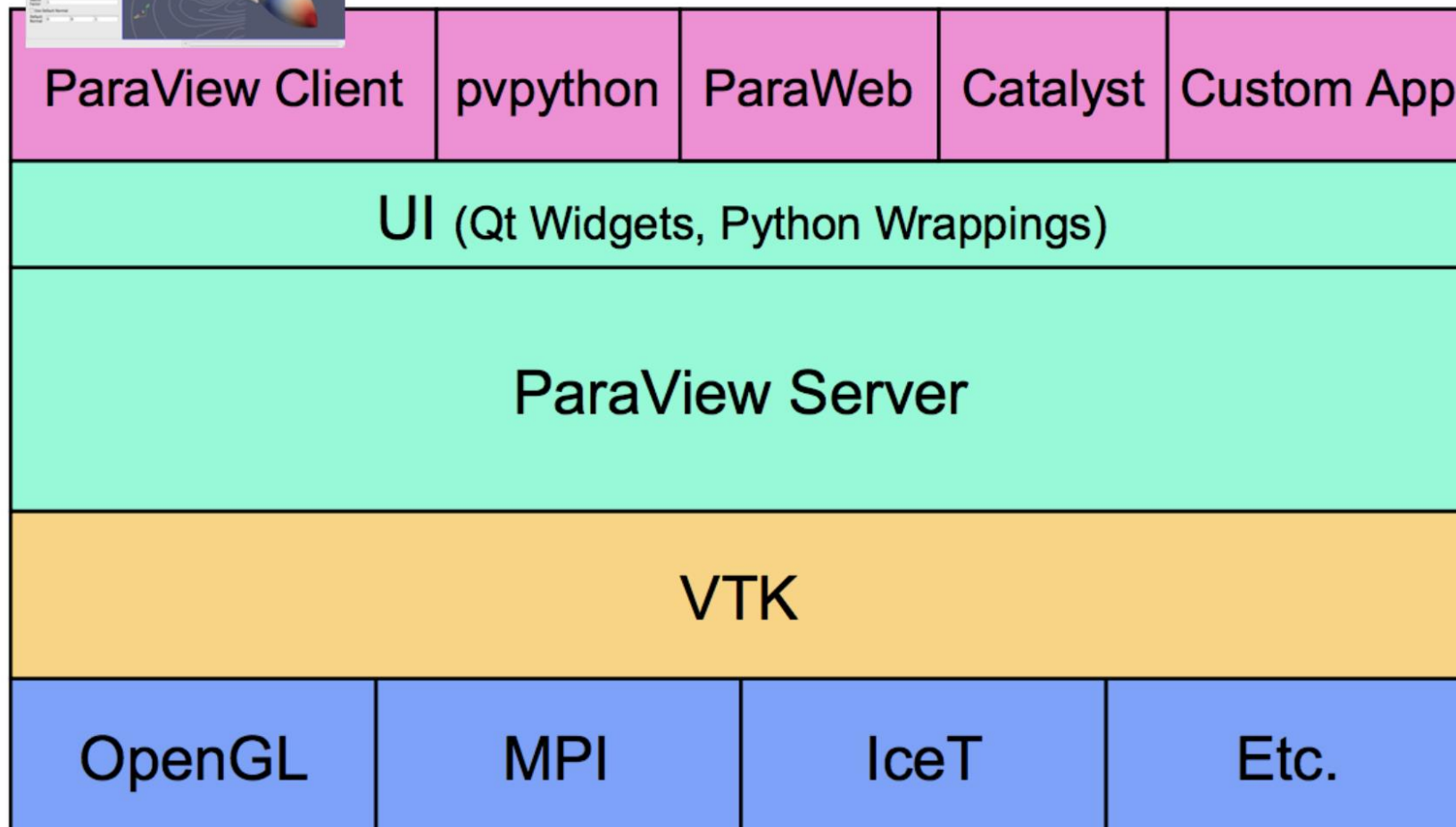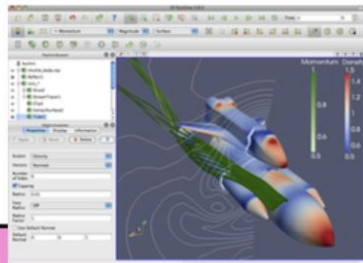
Today's Agenda

Time	Topic	Speaker
~15 min	Introduction	Thomas Theußl
~45 min	Scientific Visualization: Scalar Fields	Thomas Theußl
~45 min	Scientific Visualization: Vector Fields	Thomas Theußl
~15 min	The ParaView GUI and Features	Thomas Theußl
on demand	Q&A / Discussion	all

Introduction / Motivation

Hands on exercises in ParaView on some basic visualization techniques

- Scalar field visualization: colormaps, slicing, contouring
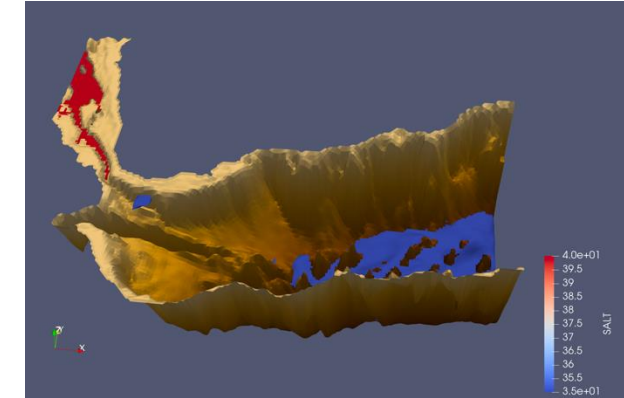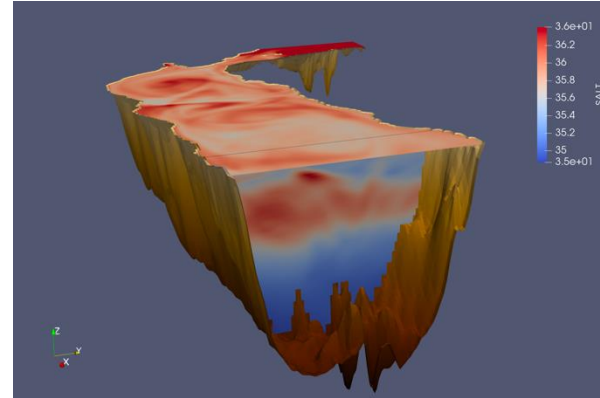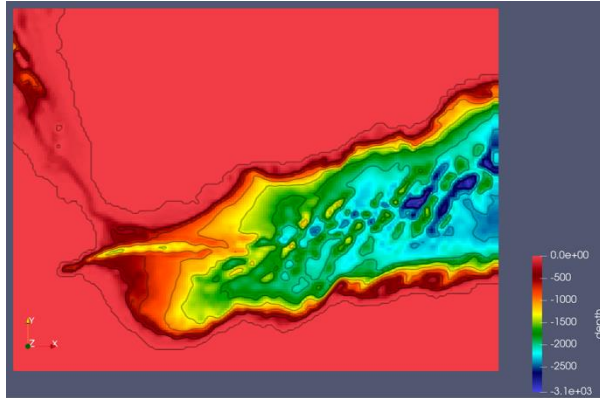
- Vector field visualization: arrow plots, streamlines
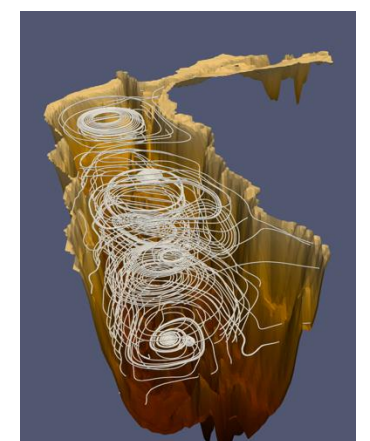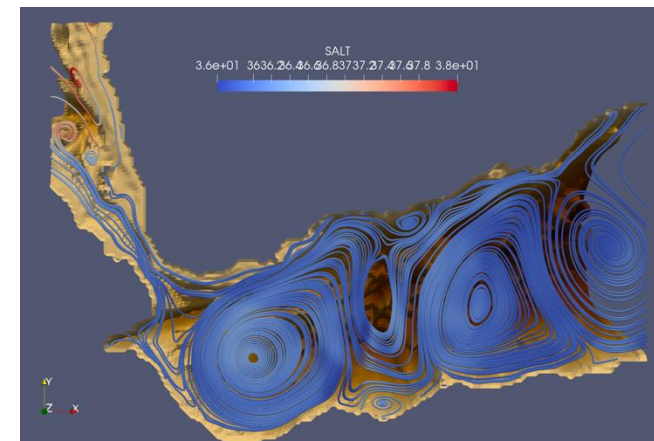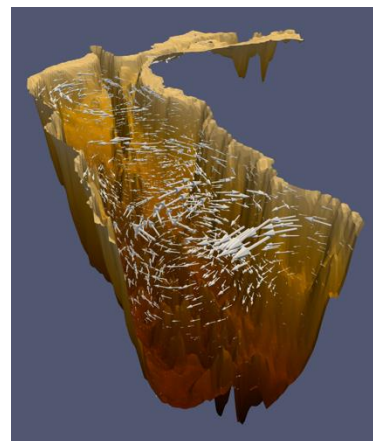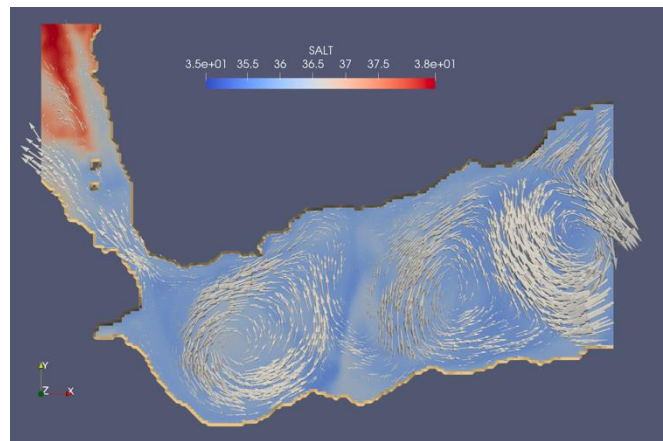
Basic Interaction
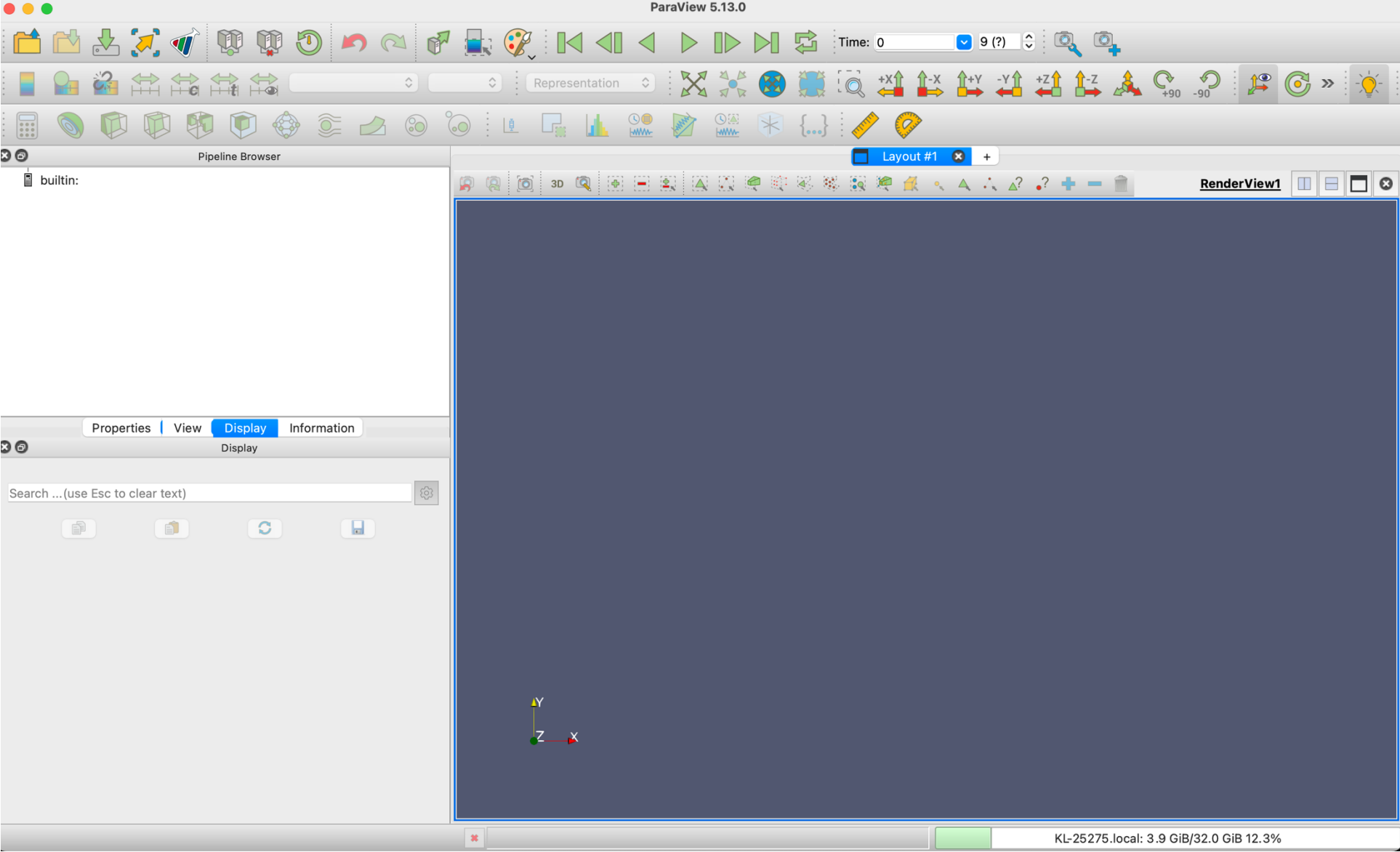
Scalar Field Visualization

Scalar Fields

- 1D scalar field: $\Omega \subset R \rightarrow R$
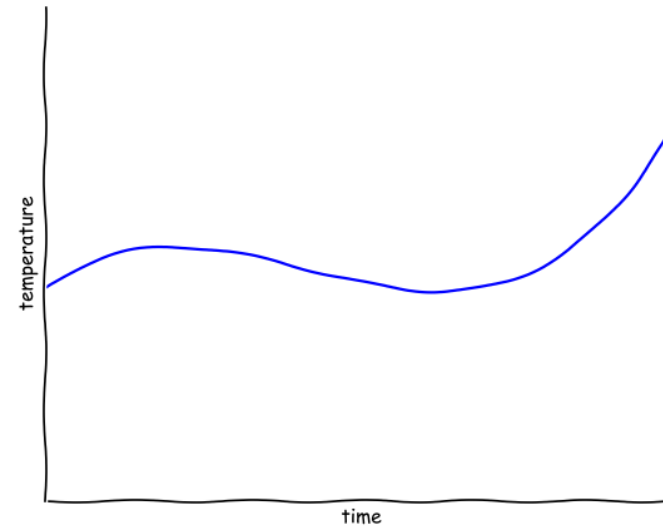
- 2D scalar field: $\Omega \subset R^2 \rightarrow R$
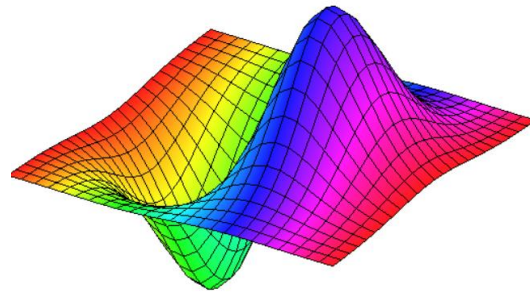
- 3D scalar field: $\Omega \subset R^3 \rightarrow R$ i.e., salinity or temperature in the Gulf of Aden
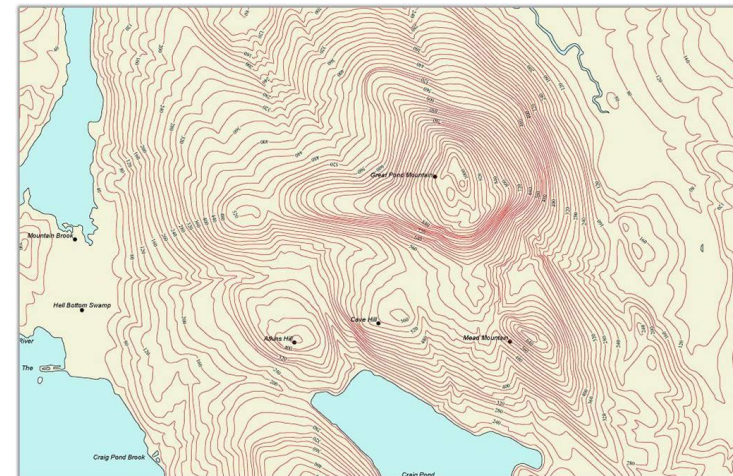
source: wikipedia

Colormaps

In the Display tab:
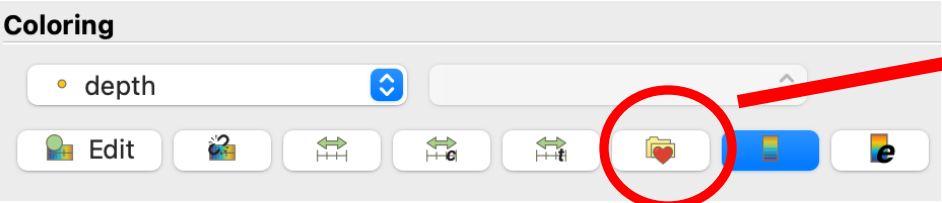
Choose preset
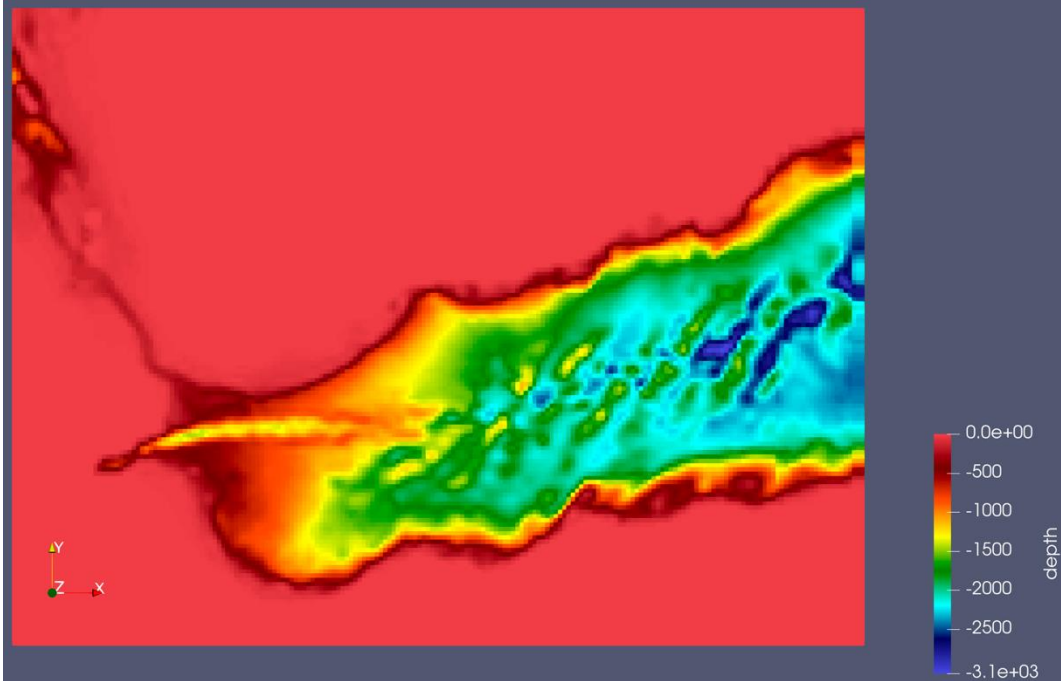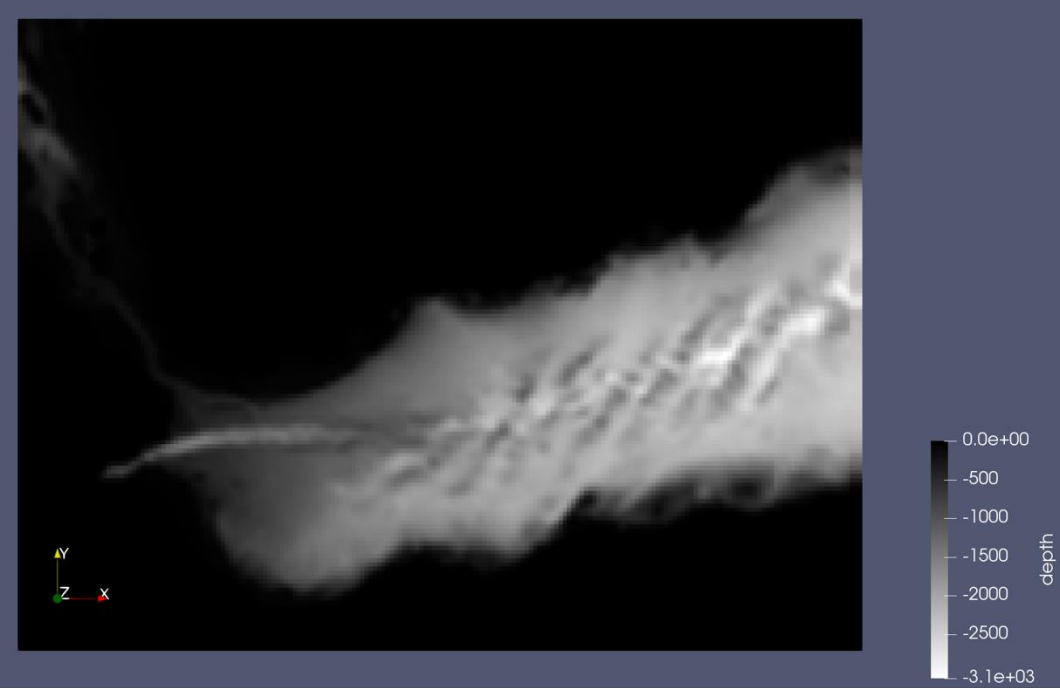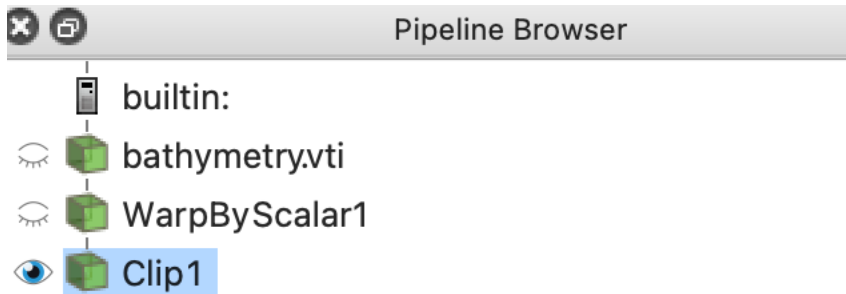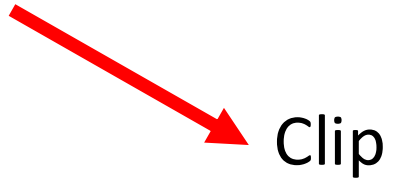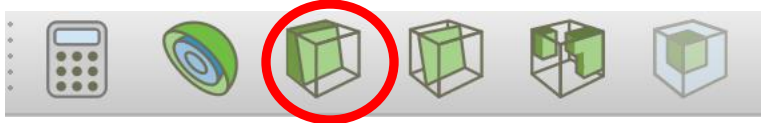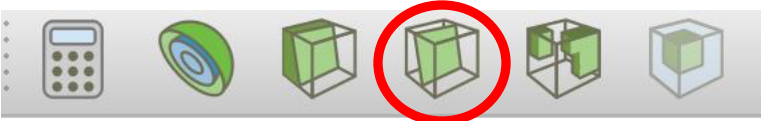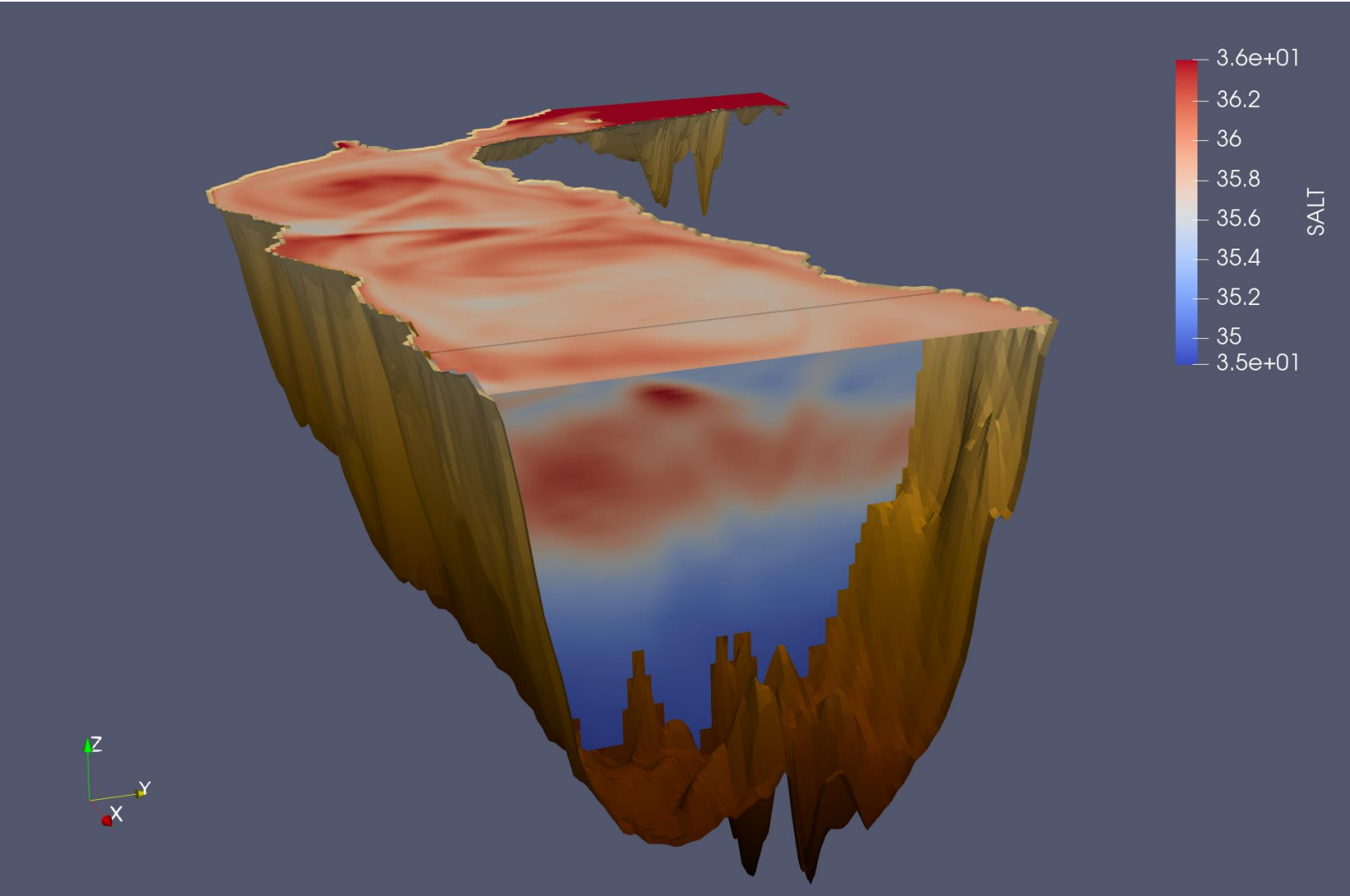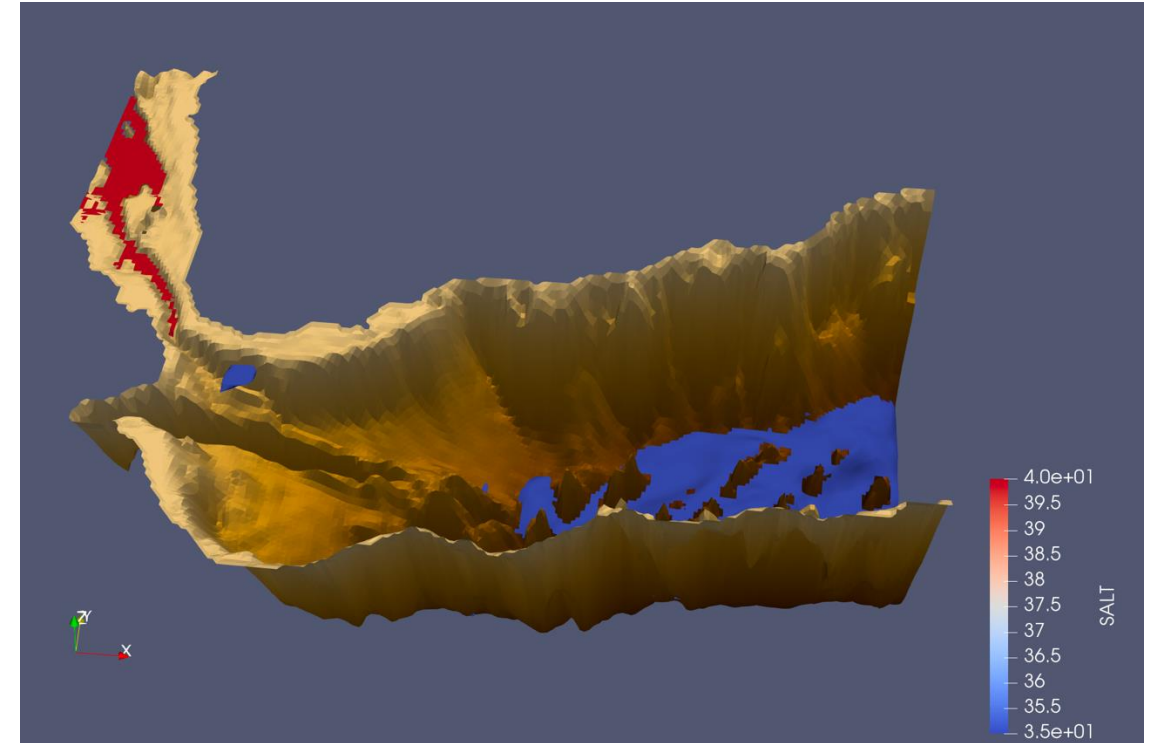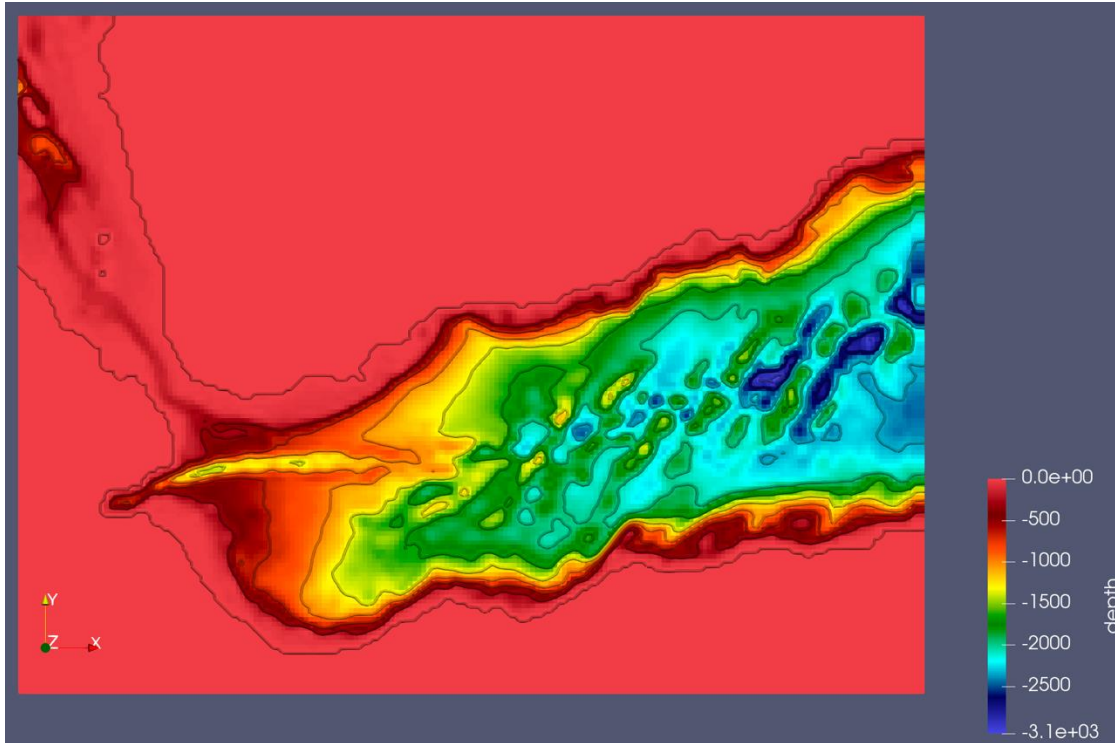
• Contouring in 2D
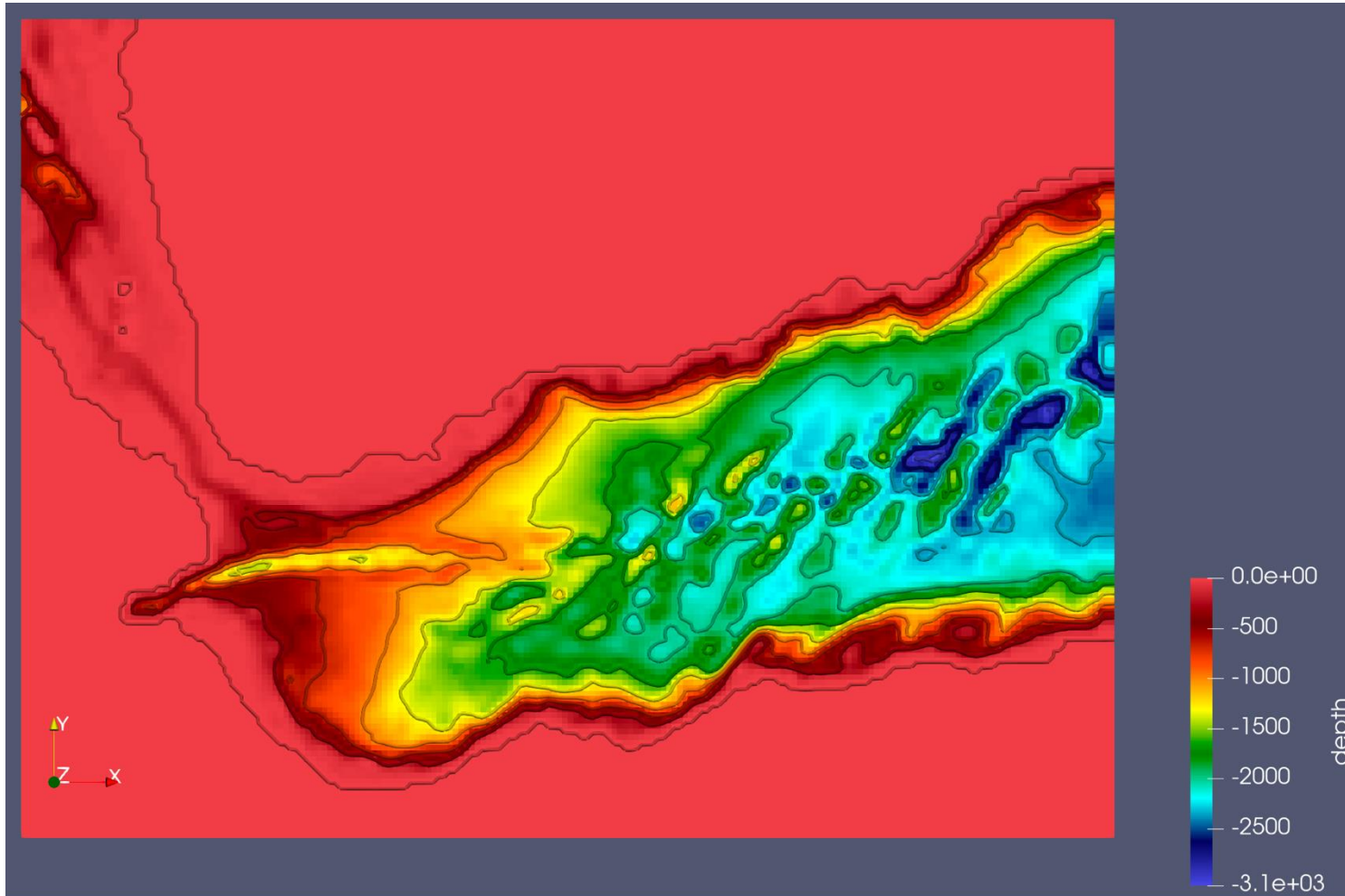
Height Field

- Filters->Alphabetical->Warp By Scalar
- Set 'Scale Factor' (I use 0.00125 here)
- Click Apply
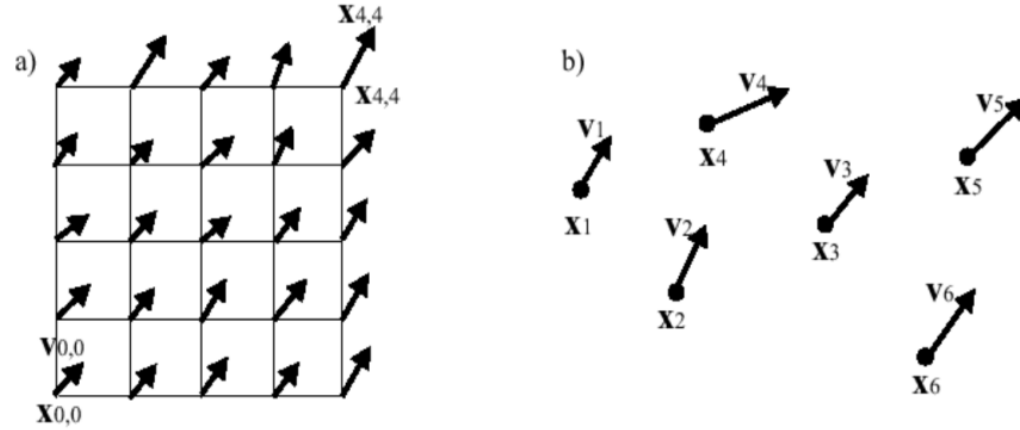

Clip
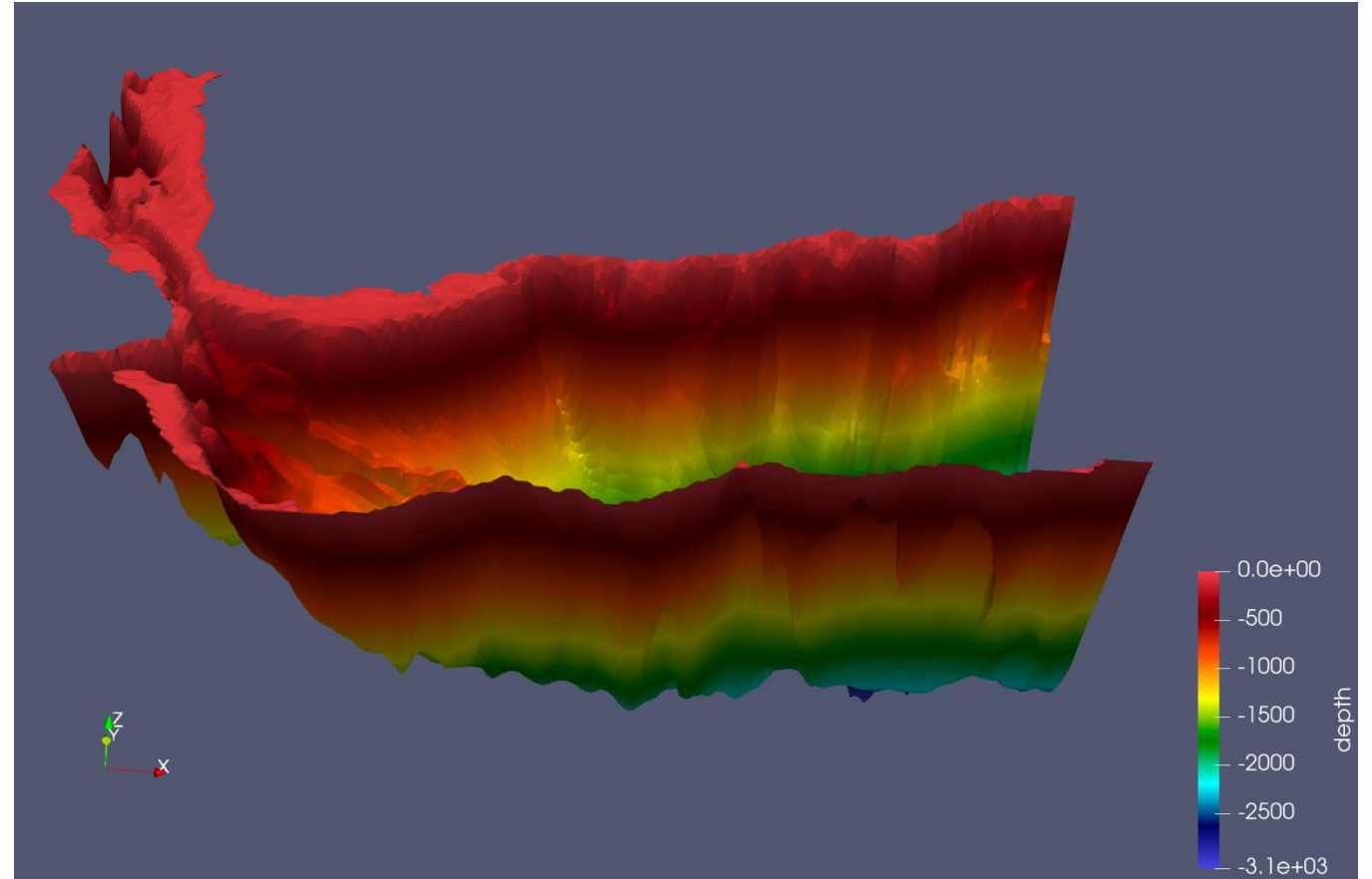
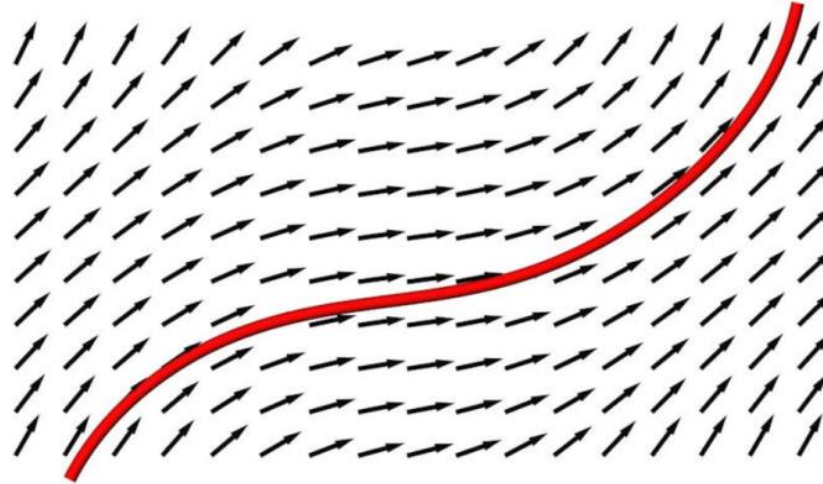# Slicing

• Contouring in 2D and 3D

Vector Field Visualization
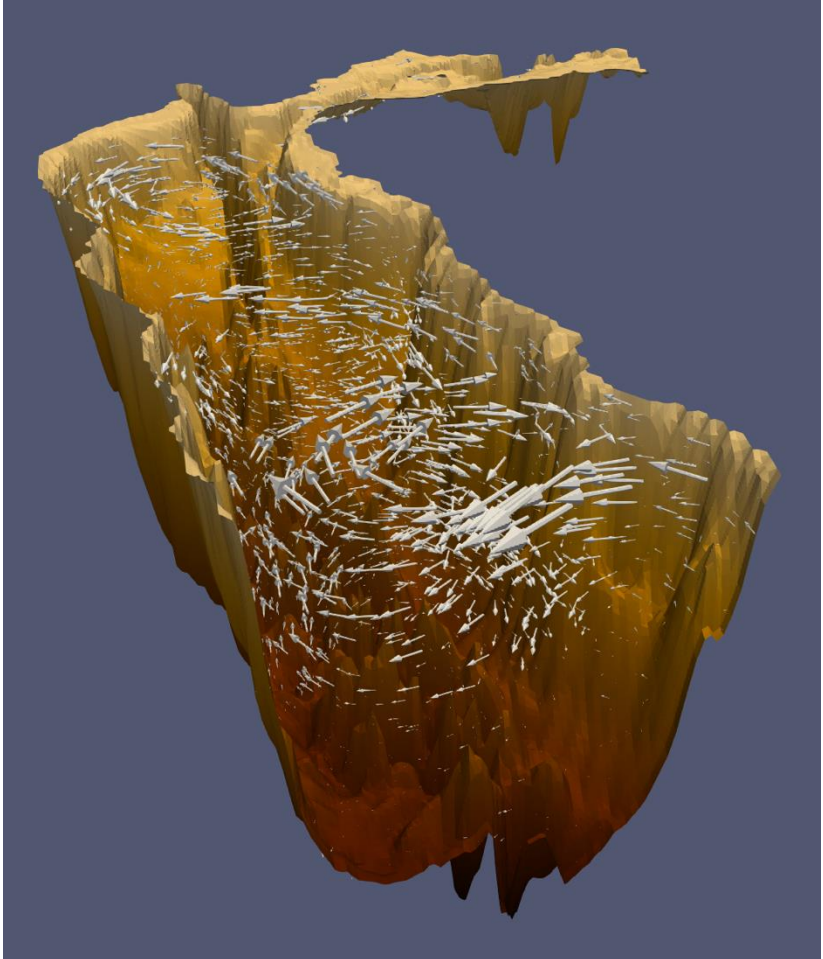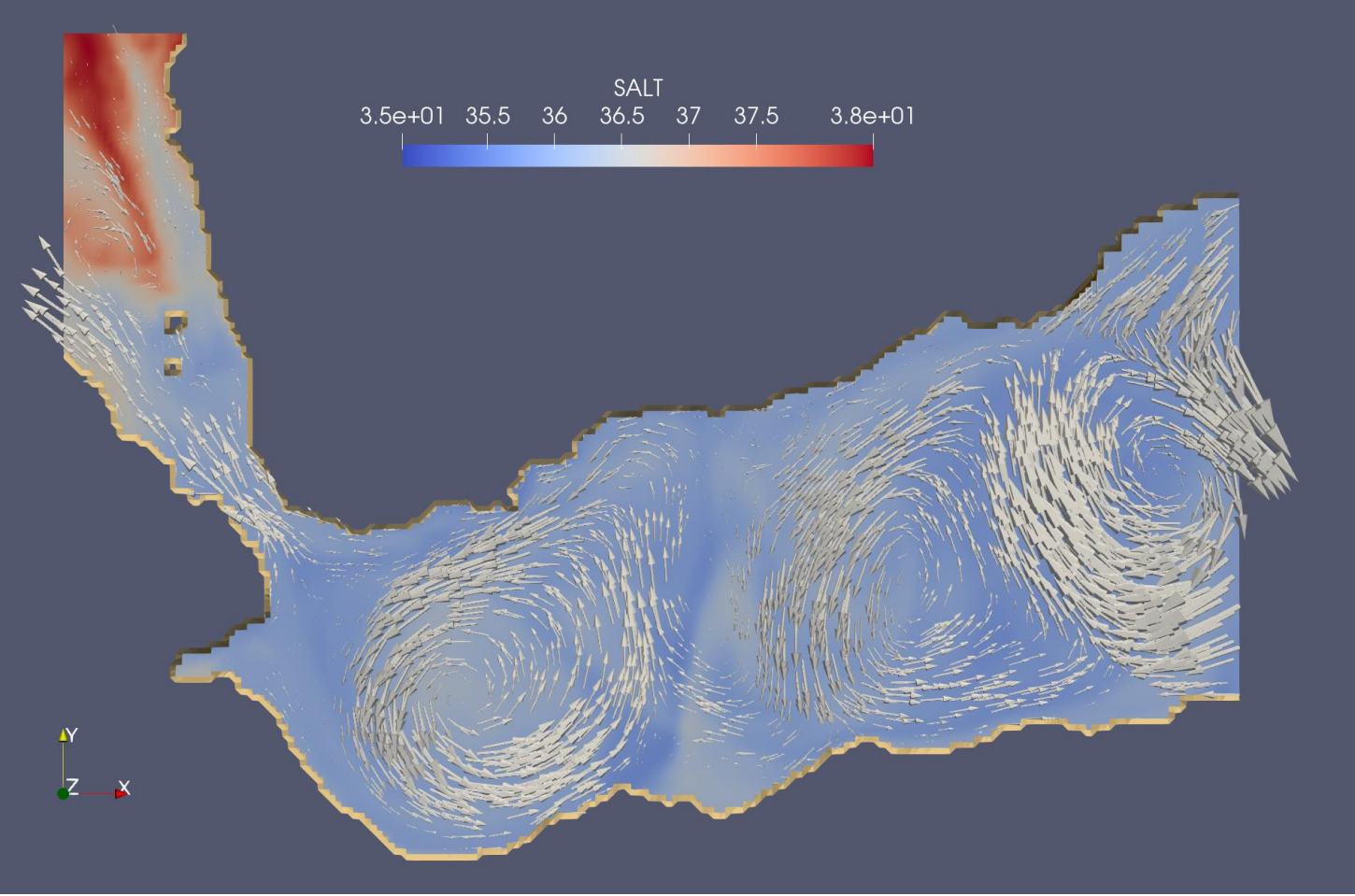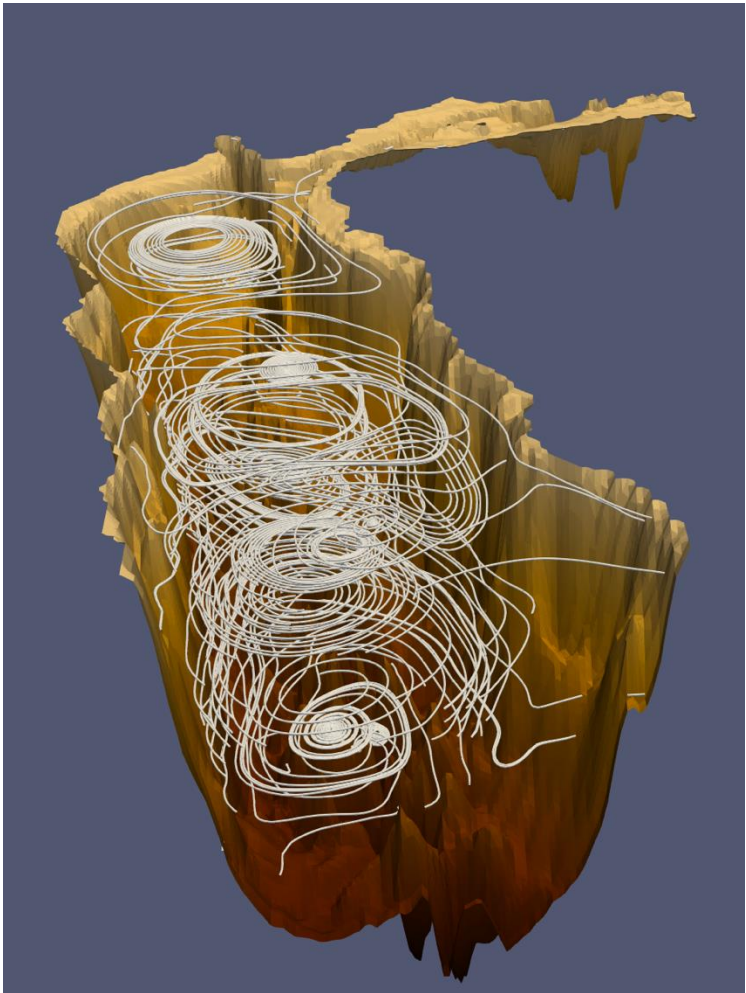
Vector Field Visualization Techniques
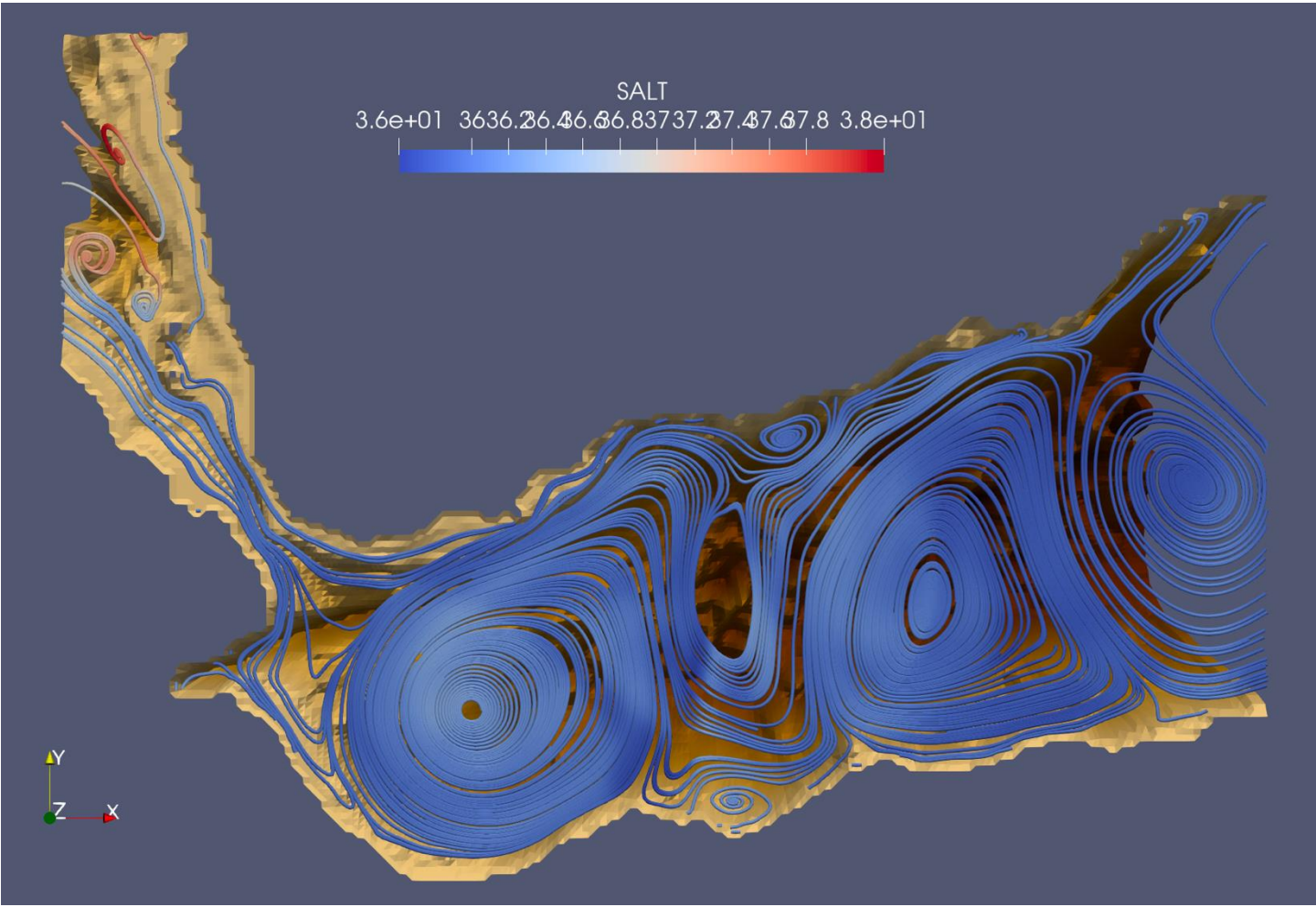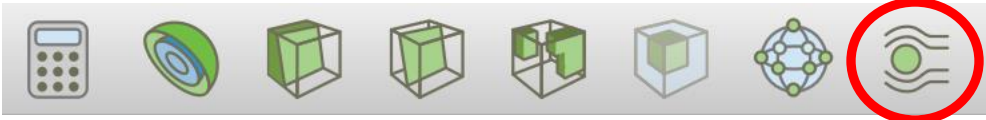
- Arrow plots

- Streamlines

Arrow Plots

Streamlines

The ParaView GUI and Features
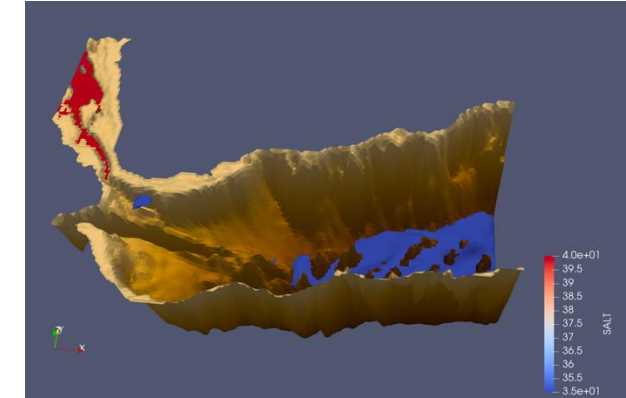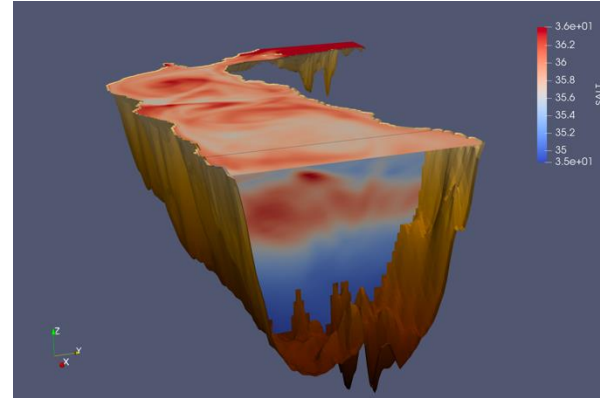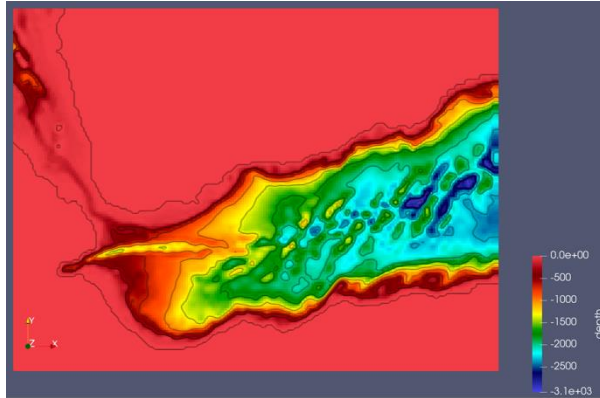
The ParaView GUI and Features

- Screenshots

- Saving and loading states

- Multiple linked views

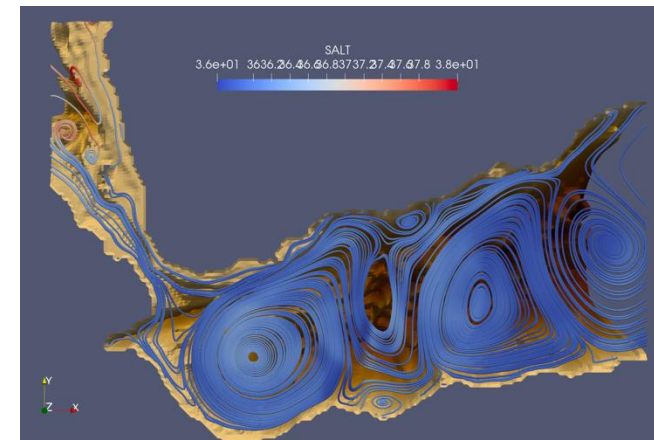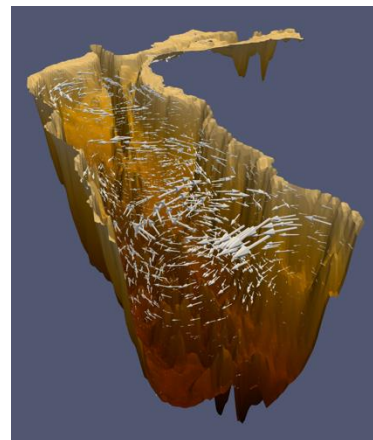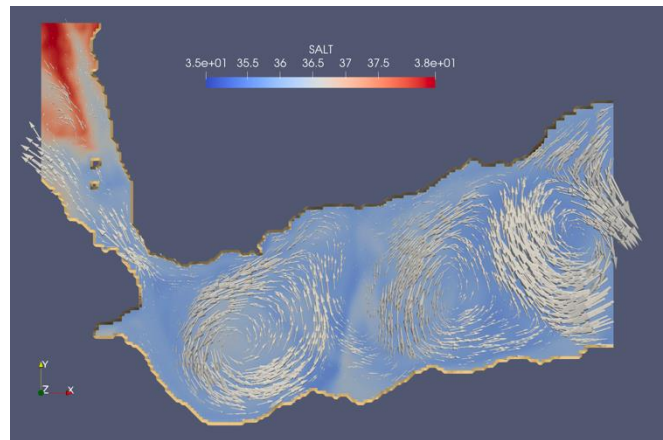- …

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