MOHID

Visualizer

User Manual

Interactive visualization tool for MOHID HDF5 model outputs

Software Manual
Related to the MOHID Model
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1. Introduction

1.1 Overview

MOHID Visualizer is an interactive desktop application for exploring and analysing outputs from MOHID model simulations. It reads HDF5 files produced by MOHID and provides a rich graphical interface for visualising scalar fields, vector fields, time series, vertical profiles, T-S diagrams, and Hovmöller diagrams. The application is built with Julia and GLMakie, providing hardware-accelerated rendering suitable for large oceanographic datasets

1.2 Target Users and Scope

This software is intended for researchers, graduate students, coastal engineers, environmental consultants and operational forecasting teams working with MOHID simulations.

The visualizer bridges numerical modelling outputs and scientific interpretation, supporting research workflows, teaching activities and institutional reporting.

1.3. System Architecture

The application integrates:

- GLMakie for interactive scientific visualization.
- HDF5 for reading MOHID model outputs.
- NCDatasets for NetCDF export.
- ArchGDAL for GeoTIFF generation.
- Tile providers for basemap integration.

The architecture supports multi-file loading with internal temporal mapping and variable pairing for vector field detection.

1.4 Installation and Deployment

1.4.1 Julia Script Version

Requires Julia installation and package dependencies. Recommended for advanced users and developers requiring extensibility.

1.4.2 Compiled Executable Version (.exe)

A standalone Windows executable that does not require Julia installation. This deployment mode simplifies distribution in academic environments and ensures operational reproducibility.

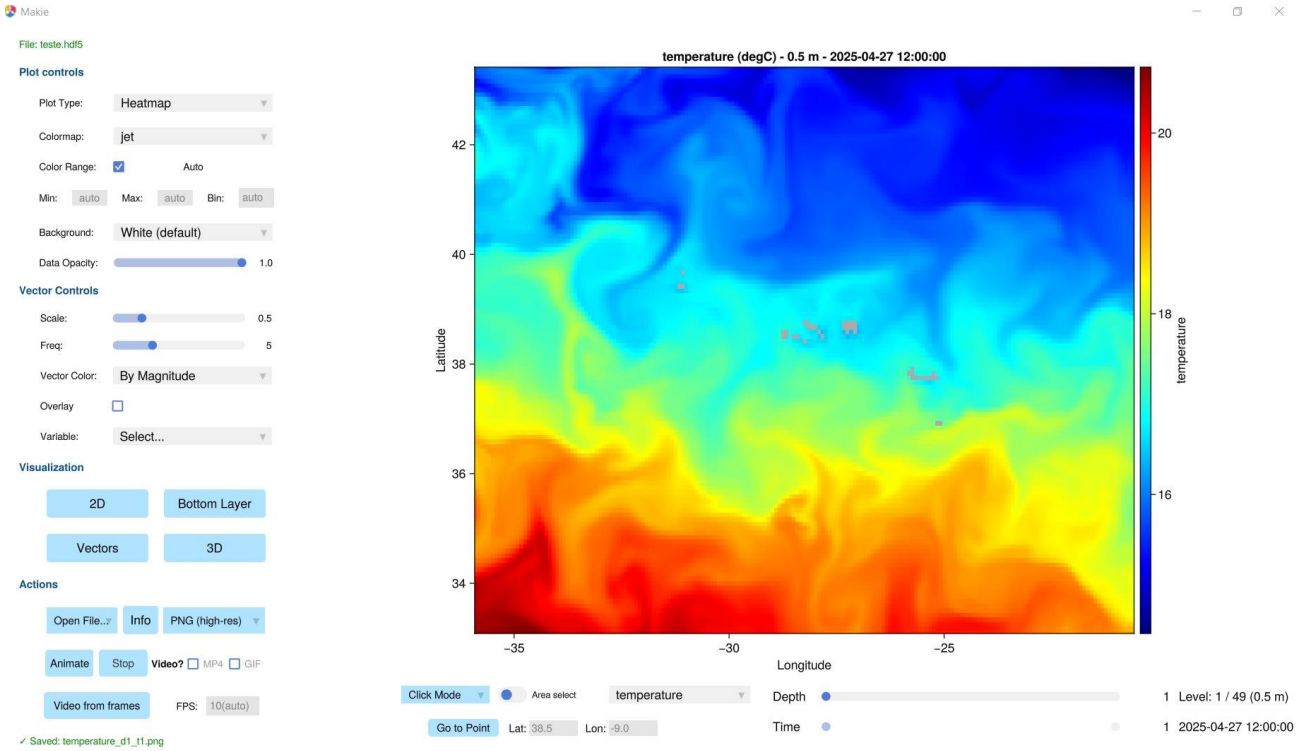

Figure 1 — MOHID Visualizer main interface showing sea surface temperature

1.5 Key Features

- 2D map visualisation of any scalar variable (temperature, salinity, velocity magnitude, etc.)
- Vector field overlays (water currents, wind) with configurable density and scale
- Time Series plots at any selected point
- Vertical Profile plots for 3D variables
- Hovmöller diagrams for depth-time analysis
- T-S (Temperature-Salinity) diagrams for water mass analysis
- Animation and MP4/GIF video export
- Multi-file support — load and merge multiple HDF5 files simultaneously
- Map tile backgrounds via Tyler (OpenStreetMap, satellite imagery, etc.)
- Export to CSV, PNG, NetCDF, and GeoTIFF

1.6 System Requirements

Component	Requirement
Operating System	Windows 10/11 (64-bit)
RAM	8 GB minimum, 16 GB recommended
Graphics	OpenGL 3.3 compatible GPU
Disk Space	~4 GB for the standalone application
Internet	Required for map tile backgrounds (optional)

2. Getting Started

2.1 Launching the Application

Double-click MohidVisualizer.exe to launch the application. A console window will appear briefly while the application initialises, followed by the main graphical interface.

✓ The first launch may take 10–20 seconds as Julia compiles the interface. Subsequent launches are faster.

2.2 Opening a File

1. Click the Open File... button in the Actions section (bottom-left panel).
2. A file picker dialog will appear. Navigate to your MOHID HDF5 file (.hdf5 or .h5).
3. Select the file and click Open.
4. The application will load the file and display the first available variable.

! *MOHID Visualizer expects HDF5 files produced by MOHID Water with the standard Results group structure.*

2.3 The Main Interface

Area	Location	Purpose
Plot controls	Left panel — top	Plot type, colourmap, colour range, background, opacity
Vector Controls	Left panel — middle	Arrow scale, frequency, colour, overlay variable
Visualization	Left panel	Switch between 2D, Bottom Layer, Vectors, 3D views
Actions	Left panel — bottom	Open files, export PNG, animate, export video
Map area	Centre	Main visualisation canvas — pan, zoom, right-click for analysis
Colour bar	Right of map	Colour scale with variable name and units
Depth slider	Bottom	Select vertical level (3D variables)
Time slider	Bottom	Navigate through time steps
Status bar	Very bottom	Operation feedback and coordinates

3. File Management

3.1 Opening and Adding Files

Action	Description
Open File...	Closes any currently loaded files and opens a new HDF5 file from scratch.
Add File... (File menu)	Adds a second or subsequent HDF5 file (same geometry). Files are merged in time or by variable.
Close File... (File menu)	When multiple files are loaded, shows a list to choose which file to remove.

3.2 Multi-File Support

MOHID Visualizer supports loading multiple HDF5 files simultaneously. This is useful for extending a time series across several output files (e.g. monthly files) or combining files that contain different variables.

The file label at the top of the interface shows how many files are loaded and the total number of time steps. For example: Files: 6 loaded (25 steps, 7 vars).

✓ Variables that exist in some files but not others are handled gracefully — the application reads each variable from whichever file contains it at each time step.

3.3 Closing a File

1. Click the File menu > Close File...
2. One window appears with the information of all open files (see Figure 2). The menu updates to show the names File1, File2, .., of all loaded files, each prefixed with ×.
3. Click the file you wish to remove.
4. The file is closed, the data is updated, and the display reloads automatically.

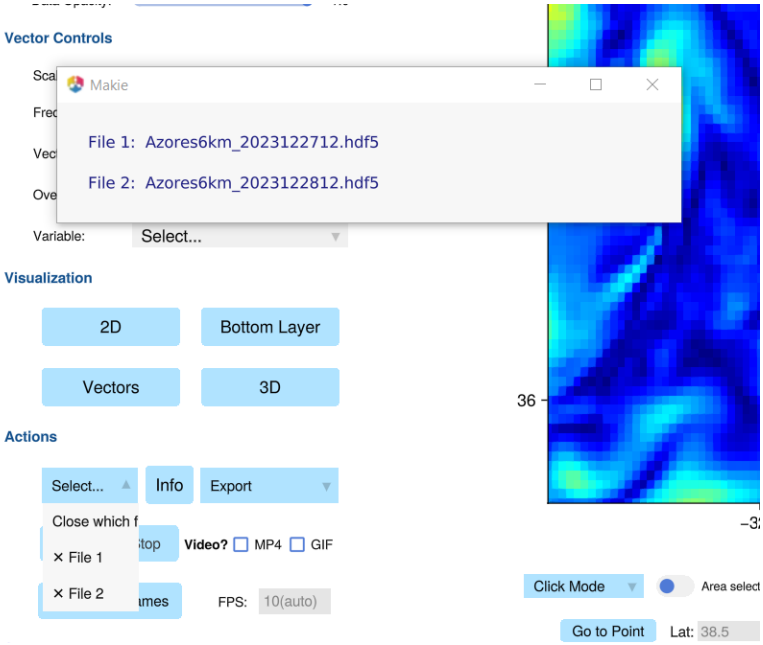

Figure 2 — "Close" file options

> **!** *You cannot close a file when only one is loaded. Use Open File... to replace it instead.*

4. Visualisation

4.1 Selecting a Variable

Use the variable dropdown at the bottom of the interface (next to the Click Mode selector) to choose which field to display. The list shows all variables across all loaded files.

4.2 Plot Type and Colourmap

Setting	Options	Description
Plot Type	Heatmap, Contour, Filled Contour	Heatmap is fastest; Contour shows isolines; Filled Contour combines both.
Colormap	jet, viridis, balance, thermal, …	Choose the colour palette. 'balance' is good for anomalies; 'thermal' for temperature.
Color Range	Auto / Manual	Auto fits the range to the current data. Manual allows custom Min/Max values.
Data Opacity	0.0 – 1.0	Controls transparency of the data layer over map tile backgrounds.

4.3 Navigating Time and Depth

Use the Time slider at the bottom-right to step through time steps. The current timestamp is shown to the right of the slider. Use the Depth slider to select the vertical level for 3D variables — the actual depth in metres is shown alongside.

4.4 Map Backgrounds

Option	Description
White (default)	Plain white background — fastest rendering, no internet required.
Black	Plain black background — useful for dark-themed presentations.
OpenStreetMap	Standard street and coastline map tiles (requires internet).
Satellite	Aerial/satellite imagery (requires internet).
Other tile providers	Additional map styles available via Tyler.jl. (see Figure 3)

! *Map tile backgrounds require an internet connection. Tiles are cached locally after the first download for offline reuse.*

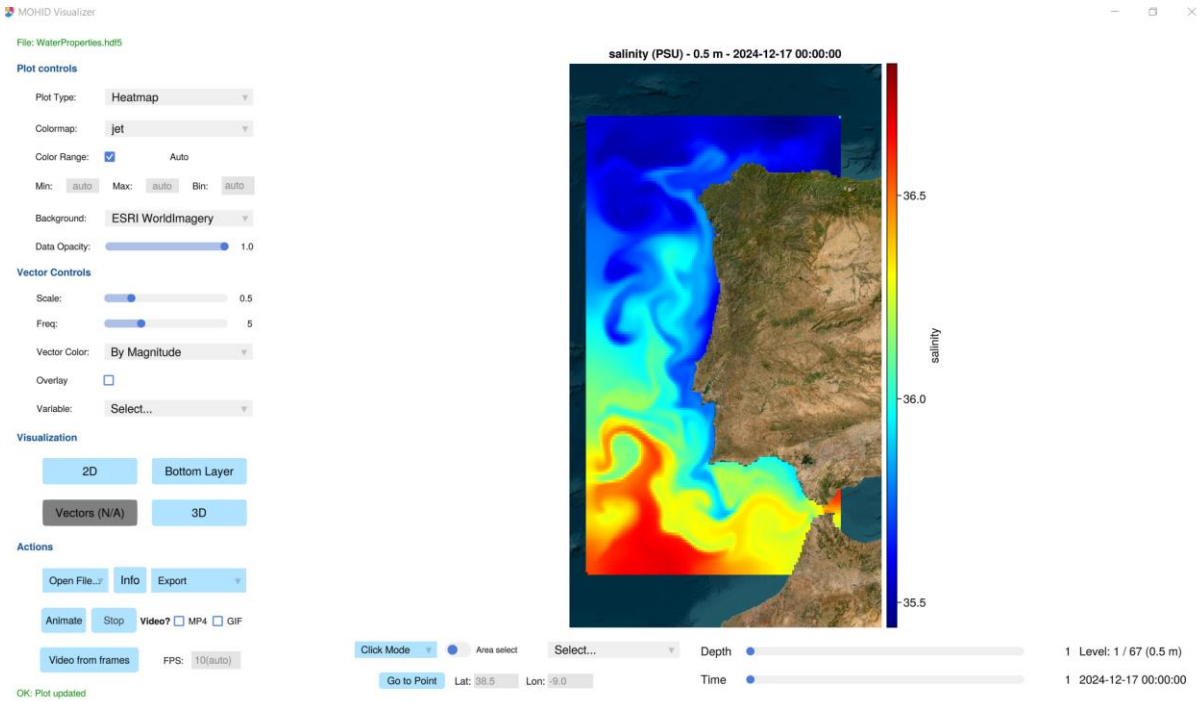

Figure 3 — Salinity at surface in PCOMS region – over ESRI Worldimagery background option

4.5 Vector Fields

When velocity or wind data is available, the Vectors button activates vector field overlays showing current direction and magnitude.

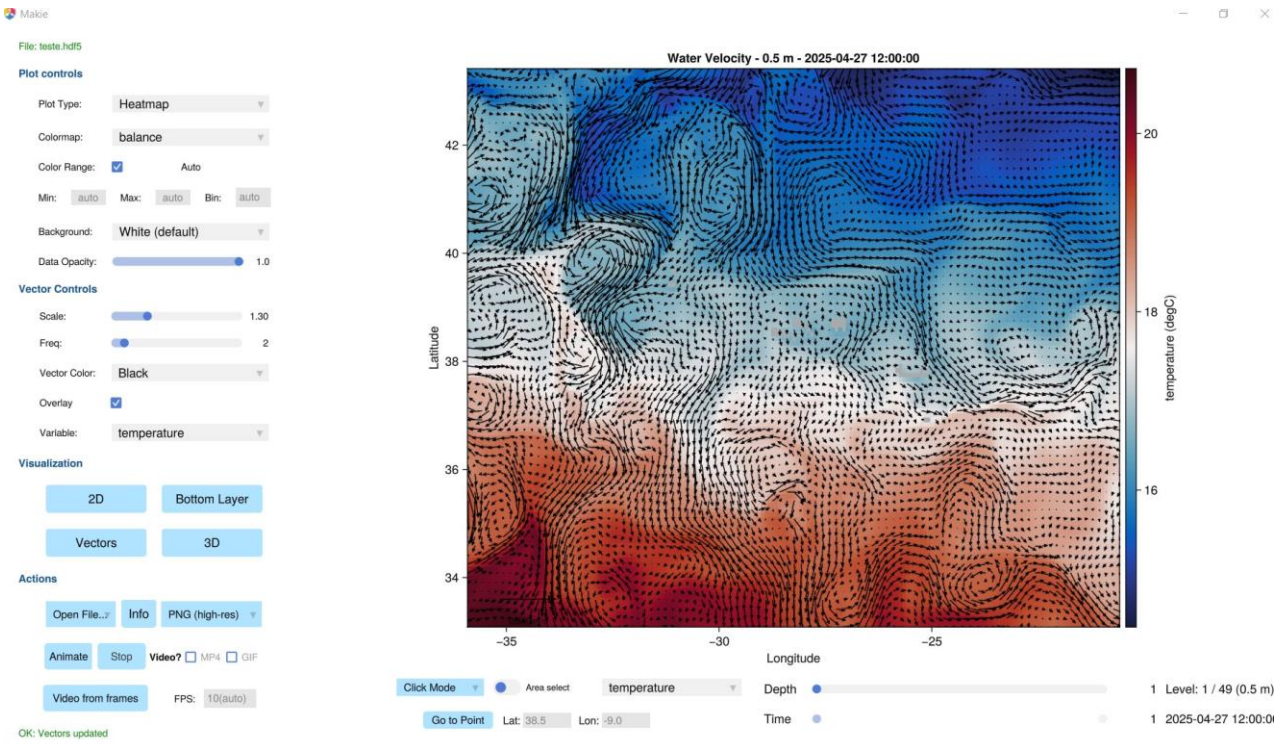

Figure 4 — Water velocity vectors overlaid on temperature (Overlay mode, black arrows)

4.5.1 Vector Controls

Control	Description
Scale	Controls arrow length relative to magnitude. Increase for longer arrows.
Freq	Arrow density — lower values show fewer, larger arrows; higher values show a denser field.
Vector Color	Colour arrows by magnitude (By Magnitude) or a fixed colour (Black, White, etc.).
Overlay	When checked, displays a scalar variable as a background behind the arrows. Choose the variable in the Variable dropdown below.

4.5.2 Custom Vector Pairs

Standard vector pairs (velocity U/V, wind velocity X/Y, etc.) are detected automatically. For non-standard variable names, create a file called **mohid_vectors.json** in the same folder as MohidVisualizer.exe:

```
{
  "vector_pairs": [
    {
      "name": "Residual Current",
      "u": "residual U",
      "v": "residual V",
      "type": "water"
    },
    {
      "name": "Tidal Current",
      "u": "tidal U",
      "v": "tidal V",
      "type": "water"
    },
    {
      "name": "Baroclinic Current",
      "u": "baroclinic U",
      "v": "baroclinic V",
      "type": "water"
    },
  ]
```

Use "type": "water" for 3D velocity fields or "type": "wind" for 2D surface wind.

5. Analysis Tools

All analysis tools are accessed by right-clicking on the map at a point of interest, or by selecting the mode from the Click Mode dropdown at the bottom of the interface.

5.1 Time Series

Shows the evolution of a variable at a single point over all time steps. The red dashed line marks the current time step; the green dotted line shows the mean.

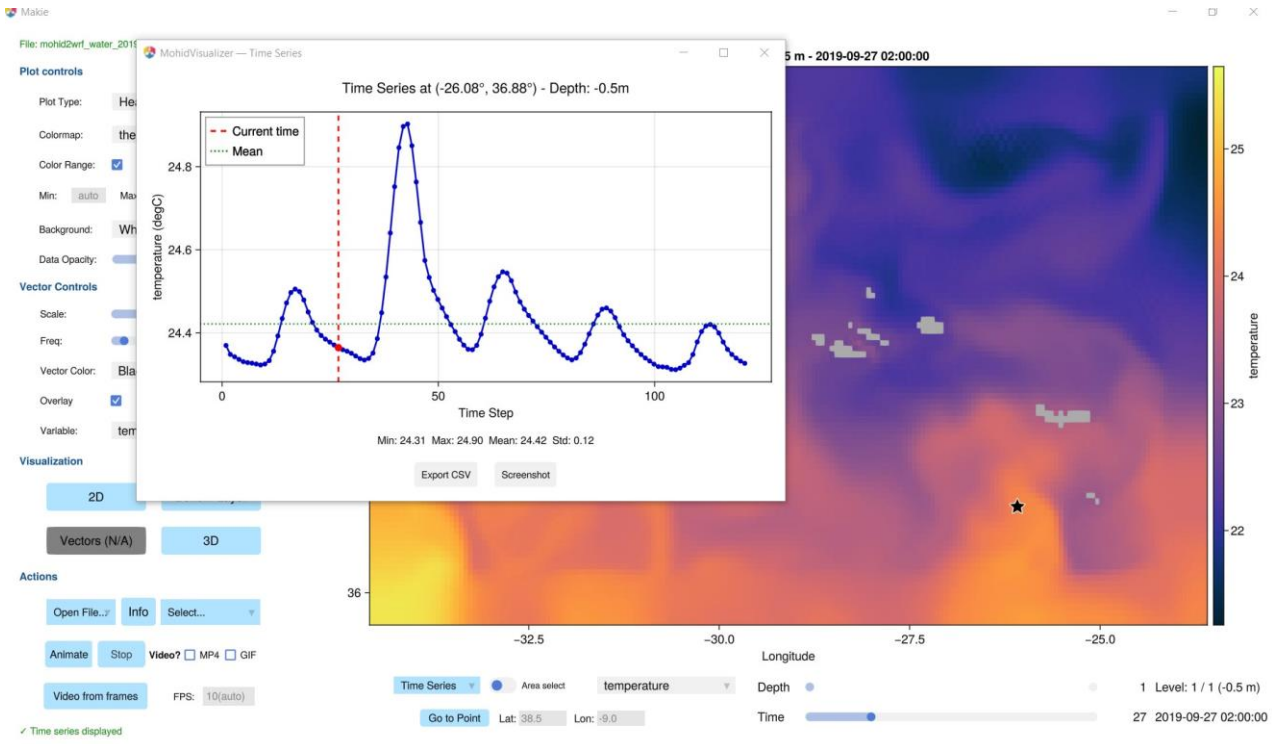

Figure 5 — Time Series window showing temperature oscillations at a selected point

1. Select Time Series from the Click Mode dropdown (or right-click > Time Series).
2. Click on the map at the location of interest.
3. The Time Series window opens with Min, Max, Mean, and Std shown below the chart.
4. Use the Time slider in the main window to update the red line position.
5. Click Export CSV to save the full time series with timestamps.

5.2 Vertical Profile

Shows the depth distribution of a variable at a chosen location and time step. Only available for 3D variables.

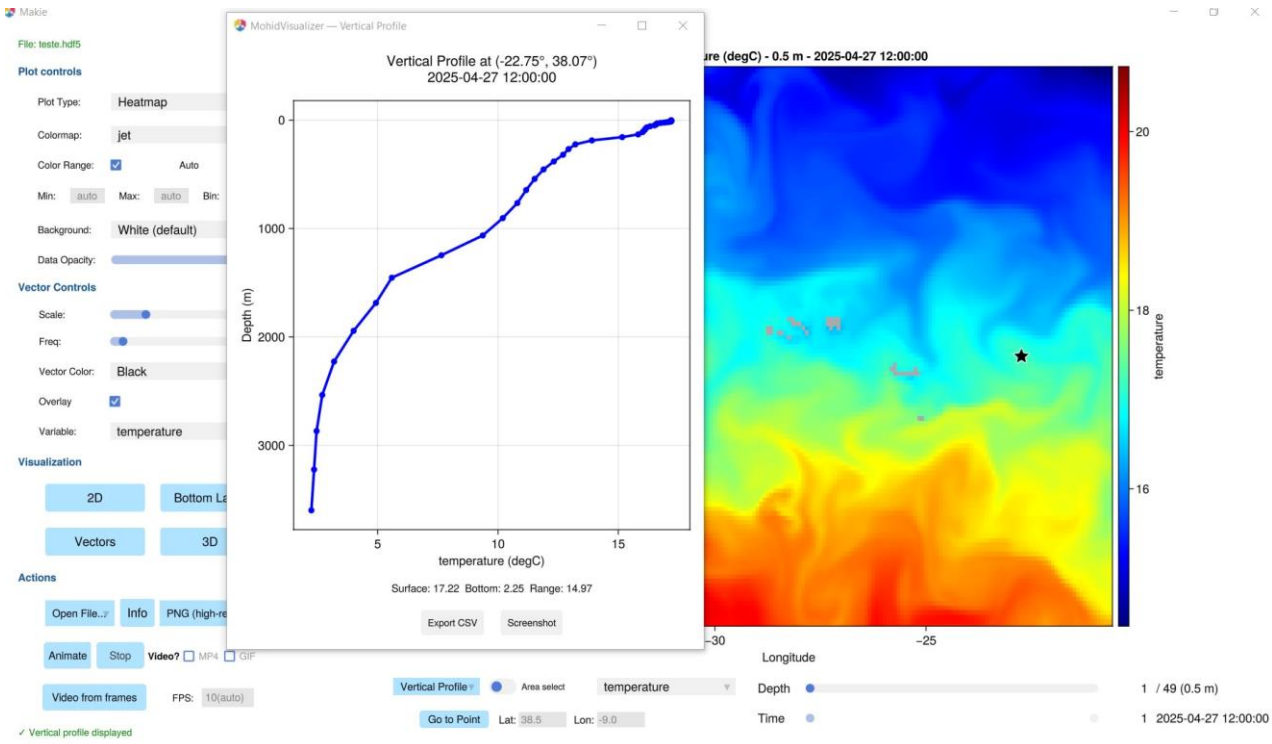

Figure 6 — Vertical Profile showing temperature decreasing from ~17°C at surface to ~2°C at depth

1. Select Vertical Profile from the Click Mode dropdown.
2. Click on the map at the location of interest (marked with a star ★).
3. The profile updates automatically when the Time slider is moved.
4. Click Export CSV to save depth and value columns.

5.3 Hovmöller Diagram

Shows a variable as a function of depth (vertical axis) and time (horizontal axis) at a fixed location. The white dashed line marks the current time step. Particularly useful for identifying thermocline depth, seasonal cycles, and mixing events.

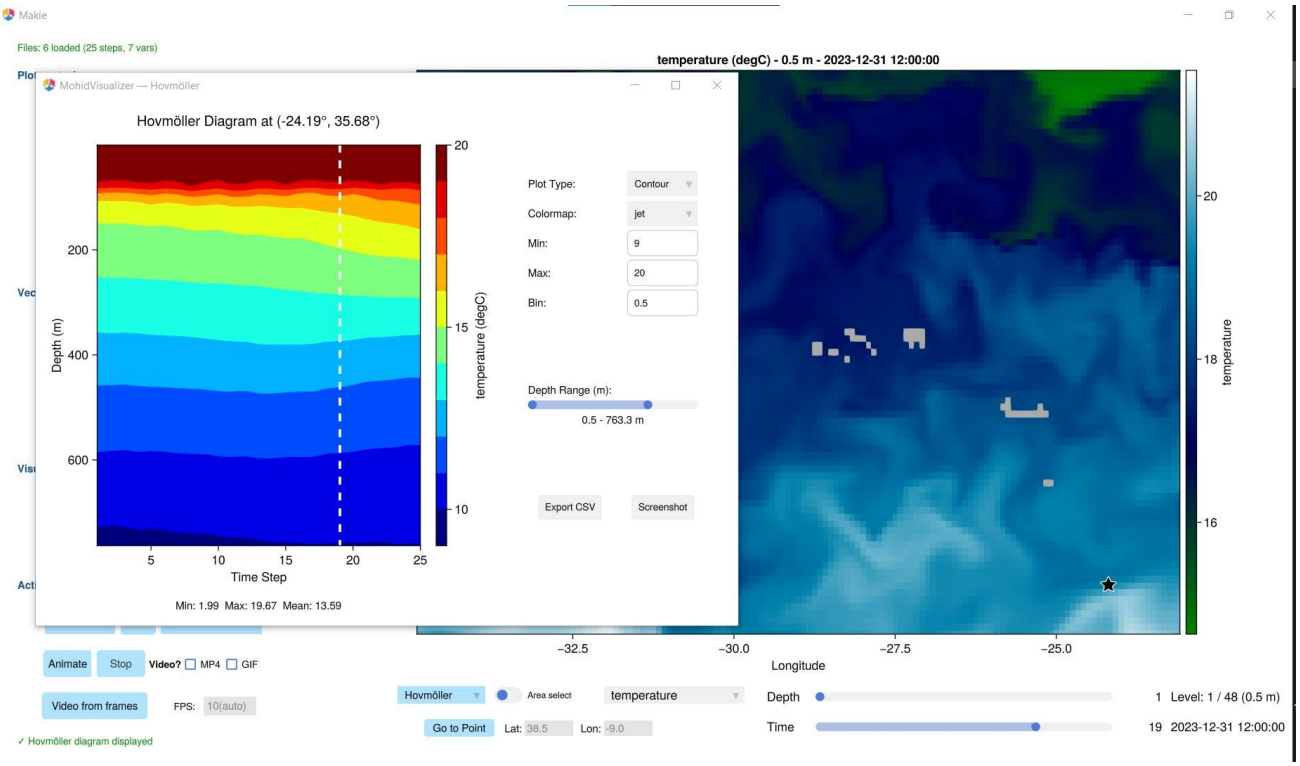

Figure 7 — Hovmöller diagram showing temperature structure across 6 loaded files (25 time steps)

1. Select Hovmöller from the Click Mode dropdown.
2. Click on the map at the location of interest.
3. Adjust Plot Type (Contour/Heatmap), Colormap, and Min/Max range as needed.
4. Use the Depth Range slider to zoom into specific depth layers.
5. Click Export CSV to save in long format (Time, Depth_m, variable).

5.4 T-S Diagram

The Temperature-Salinity diagram is a classic oceanographic tool for identifying water masses and mixing processes. Points are coloured by depth, and isopycnal lines (lines of constant density) are drawn automatically.

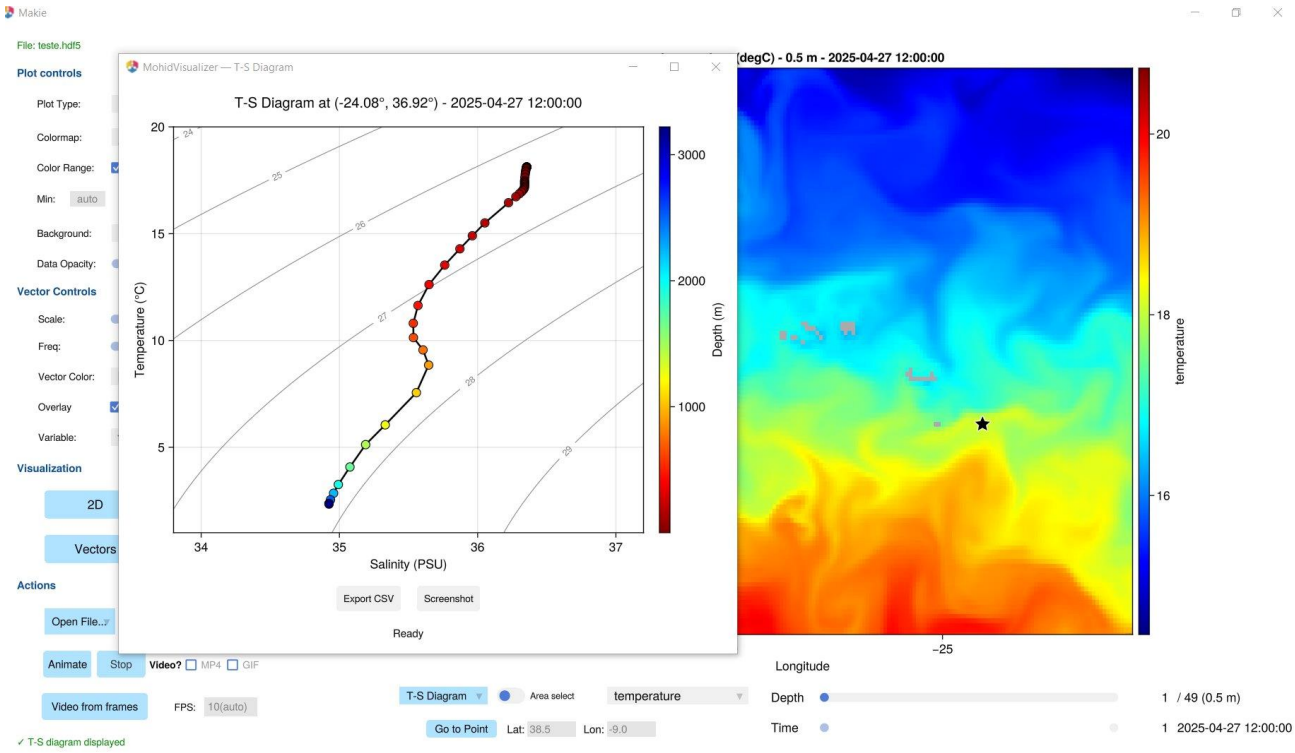

Figure 8 — T-S Diagram showing water column structure coloured by depth (surface in red, deep in blue)

1. Select T-S Diagram from the Click Mode dropdown.
2. Click a point on the map (Point mode) or drag a rectangle (Area select mode).
3. The diagram shows all depth levels at the selected location and time.
4. Click Export CSV to save temperature, salinity, and depth columns.

> **!** *T-S Diagram requires both temperature and salinity variables to be available. They can be in different loaded files.*

6. Exporting Data

6.1 PNG Screenshot

Click PNG (high-res) in the Actions panel to save a high-resolution screenshot of the current map view. The file is saved with the variable name and timestamp in the filename.

6.2 Export Menu

The Export dropdown (next to PNG) provides additional formats:

Format	Description	Use Case
NetCDF (current)	Current time step as a NetCDF file	Further analysis in Python/Matlab/R
NetCDF (time series)	All time steps as a single NetCDF file	Full dataset export
GeoTIFF (current)	Current time step as a georeferenced raster	GIS software (QGIS, ArcGIS)
GeoTIFF (time series)	All time steps as individual GeoTIFF files	Time-lapse GIS analysis

6.3 CSV Export

CSV export is available from each analysis tool window. All CSVs include full timestamps (YYYY-MM-DD HH:MM:SS). The Hovmöller CSV uses long format with one row per time-depth combination.

6.4 Animation and Video

1. Click Animate to preview the animation in the map window.
2. Click Stop to halt the animation.
3. Check MP4 or GIF (or both) in the Video? options.
4. Click Animate again — the application renders each frame and encodes the file.
5. Alternatively, use Video from frames to assemble frames from a previously exported folder.

Format	Notes
MP4	Compressed video, small file size. Requires FFmpeg in the system PATH.
GIF	Animated image, larger file. No external dependencies required.

Animations results are stored in “C:\Users\”user:name”\MOHID_ANIMATIONS\”

! *MP4 export requires FFmpeg to be installed and accessible in the system PATH. Download from https://ffmpeg.org*

7. Troubleshooting

Problem	Possible Cause	Solution
Map tile backgrounds do not appear	No internet, or Tyler not compiled into the executable	Check internet. Ensure Tyler.jl was added with Pkg.add before compiling.
Application shows blank map	HDF5 file structure not recognised	Verify the file is a MOHID HDF5 output with a Results group.
Vectors button shows N/A	No velocity/wind variables detected	Check variable names. Add mohid_vectors.json for non-standard names.
T-S Diagram shows a warning	Temperature or salinity not found	Load a file containing both variables (can be separate files).
Export fails silently	Output folder not writable	Choose a different output folder (Desktop or Documents).
Animation is very slow	Large dataset or many time steps	Reduce the depth/time range before exporting.
Close File option not working	Only one file loaded	Use Open File... to replace it instead.
First launch is very slow	Julia precompilation running	Wait 10–20 seconds; subsequent launches are faster.

8. Mouse and Keyboard Reference

8.1 Map Navigation

Action	Result
Left-click drag	Pan the map
Scroll wheel	Zoom in / out
Right-click	Open context menu (Time Series, Profile, Hovmöller, T-S Diagram)
Double-click	Reset zoom to full extent

8.2 Click Modes

The Click Mode dropdown at the bottom selects what happens when you left-click on the map:

Mode	Action on click
Click Mode (default)	Shows coordinates and value at clicked point in the status bar
Time Series	Opens Time Series window for clicked point
Vertical Profile	Opens Vertical Profile window for clicked point
Hovmöller	Opens Hovmöller window for clicked point
T-S Diagram	Opens T-S Diagram for clicked point
Area select	Drag a rectangle to select an area for T-S or Vertical Pofile analysis

9. Planned Features

The following features are planned for future versions of MOHID Visualizer:

9.1 Vertical Slices

Vertical slice plots (also known as transects or cross-sections) will allow the user to draw a line across the map and visualise a variable in the vertical plane along that line. This is particularly useful for examining stratification, fronts, and upwelling zones.

- XZ and YZ cross-sections at any arbitrary angle
- Interactive selection of the transect line by clicking two points on the map
- Depth on the vertical axis, distance along transect on the horizontal axis
- Overlay of velocity vectors in the plane of the slice
- Export to CSV, PNG, and NetCDF

9.2 Other Planned Enhancements

Feature	Description
Particle tracking	Display Lagrangian particle trajectories from MOHID output
Bathymetry overlay	Show the seafloor topography as a shaded contour layer
Statistics panel	Spatial statistics (mean, std, min, max) over a selected region
Comparison mode	Side-by-side view of two variables or two time steps
Custom projections	Support for projected coordinate systems beyond lat/lon

✓ If you have feature requests or find bugs, please contact the development team. Your feedback helps prioritise the roadmap.