A small example for the PCViewer

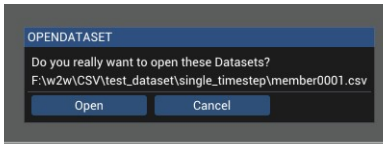
Installation:

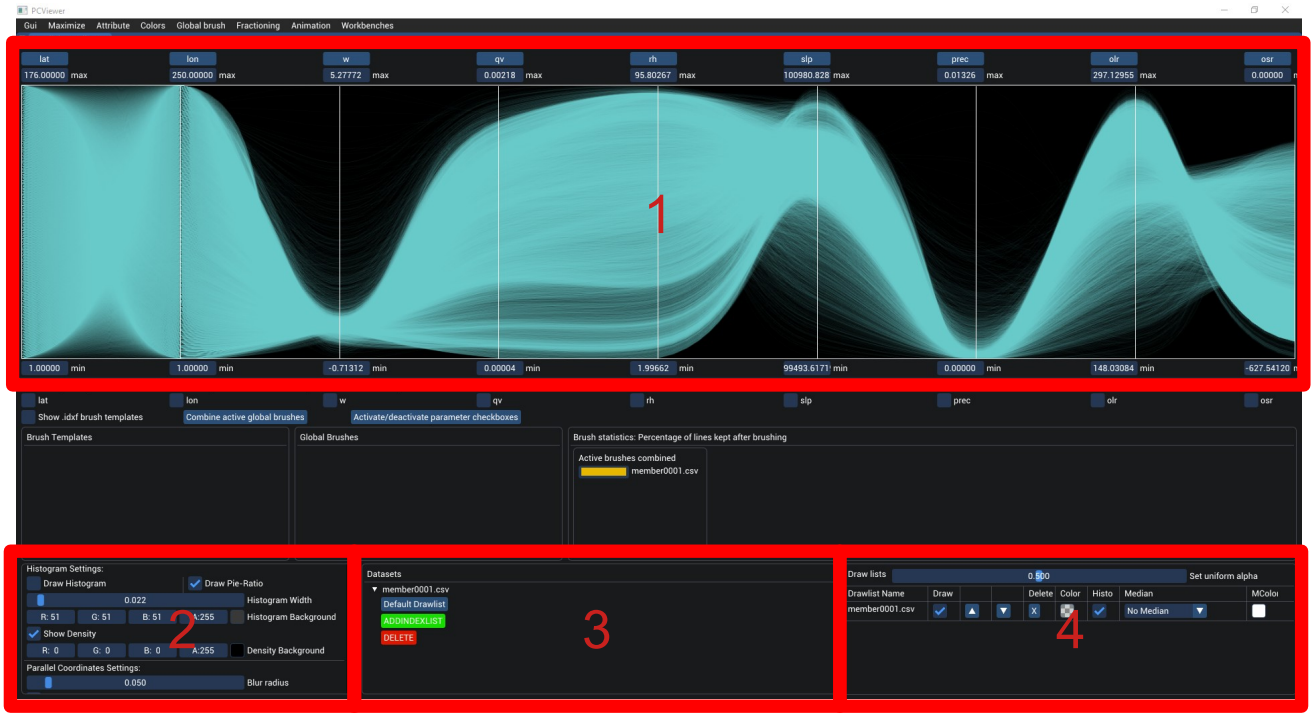
The repository for the PCViewer is https://github.com/wavestoweather/PCViewer.
For Windows a pre compiled version is put in the folder „Windows Binaries“. As a few .dll files provided by visual studio package are required to run the program you might need to install the required packages.
For Linux the PCViewer tool has to be compiled from source. Pls refer to the Readme in the repository for build details.
In the following examples data is used which is available on google drive.

Parallel Coordinates View:

To reporduce the following render open the PCViewer application and drag and drop test_dataset/single_timestep/member0001.csv into the application.

After confirming to open the data in the popup you should be able to see the following:





1: The parallel coordinates plot. Each Attribute in the dataset is one axis which are stacked next to each other. A single data point is a line which is crossing the attribute axes at the value it has at the corresponding attribute. For more information about parallel coordinates let me refer to wikipedia.
In order to adopt the parallel coordinates view one can
- change the axis order via drag on drop of the axis labels (By standard the two axis are switched, if ctrl is pressed the dragged axis is pushed into the new space and the other axes are pushed to the free spot), or
- change the axis range:
    Drag the range values to change their value
    Double click on the range values to insert a specific value
    Hover over the axis, press ctrl and use the mouse wheel to zoom in on the axis

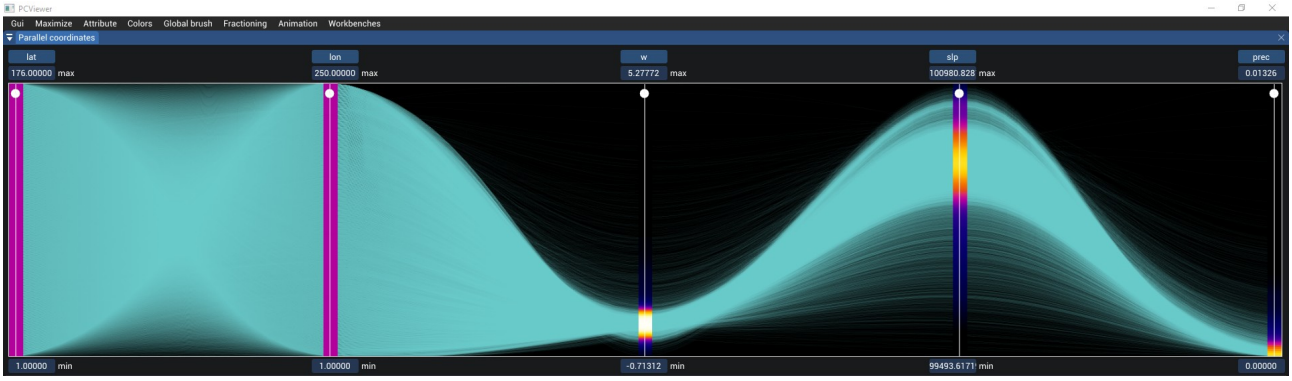
Hover over the axis, press alt and use the mouse wheel to scroll the axis

2: Settings section. Here additional settings for the parallel coordinate plot can be set. For this introduction a shortened list of settings is explained:
- Draw Histogram: activates the color histogram overlayed to the parallel coordinates plot (example shown below)
- Histogram Width: adjusts the width of the color histogram
- Blur radius: Adjusts the smoothing kernel size for the color histogram
- Render Splines: If activated the data lines are rendered as splines, else polylines are rendered
- Create default drawlist on load: automatically creates a drawlist for each dataset loaded
- Data Settings: For each attribute a toggle exists to indicate if the attribute should be shown in the parallel coordinates plot

3: Datasets section: Shows all loaded datasets. To delete a dataset open the tree node of the dataset and click on DELETE

4: Drawlists section: Shows all drawlists. Only drawlists are drawn in the plot and are the drawable instances of your datasets. If „Create default drawlist on load“ is set a drawlist for each loaded dataset is automatically created. To create a drawable instance of a dataset open the tree node of a dataset and click onto „Default Drawlist“. In the drawlist list one can deactivate the drawlist (deactivated drawlists are not rendered), adjust the ordering of the drawlists (the top most drawlist is rendered on top…), delete the drawlist, adjust the color, activate it for histogram rendering, show its median and select the color line of the median line.

If “Draw Histogram” is selected and a few attributes are disabled the following can be seen:



Brushing:
In order to brush the dataset (select subranges in the data) the concept of global brushes exists in the application.

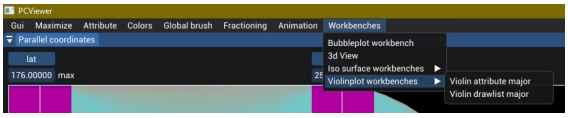
5: Brush Templates: Not interesting for this usecase
Global Brushes: List of all global brushes. To add a new global brush press the “+” button. To brush the axes click on a global brush with which you want to brush (is then highlighted), hover over the axis which you want to brush, left click on it and drag to create the brush. A box is then shown for each brush section (green box in the image above). When hovering over the brush section its min and max values are shown.
Each brush can be deactivated via the checkbox behind its name.
Brush statistics: Apart from additional information for in depth cluster analysis it shows the remaining percentile of lines still active after brushing is applied to the drawlists.

Ensemble Analysis, parallel coordinates:
To use the program for ensemble visualisation/comparison drag test_dataset/single_timestep/member0002.csv - test_dataset/single_timestep/member0050.csv into the PCViewer application (multi select and drag all into the application).

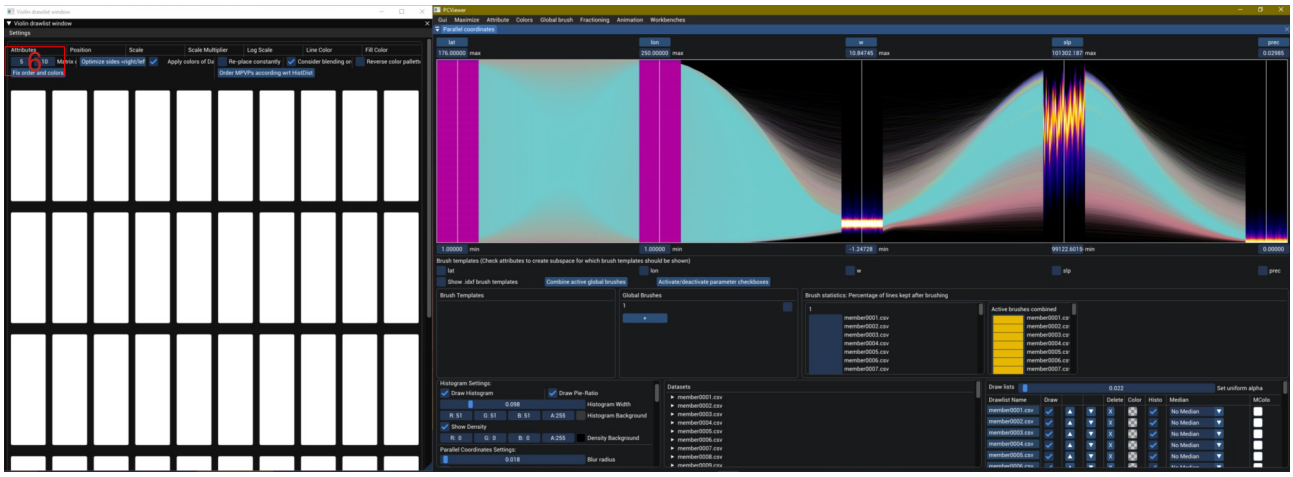
Here a first shallow comparison of the distribution of values in the ensembles for the selected attributes can be seen in the histogram. For each drawlist and thus for each ensemble member a small part of the histogram is reserved and its distribution of the values is shown color coded. For example it can be seen that the for the whole dataset for all member the w wind direction is overall quite similar, while the sea level pressure varies in the different member. Of course this variation has to be seen wrt. the range of between the min and max value of the axis. Note that the above created global brush is deactivated and thus all datapoints of the drawlists are shown.

Ensemble Analysis, stacked violin plots:

The parallel coordinates view with overlayed color histograms gives a good first intuition for some distributions to properly see details for the distributions the PCViewer application supports stacked violin plots for visual analysis.

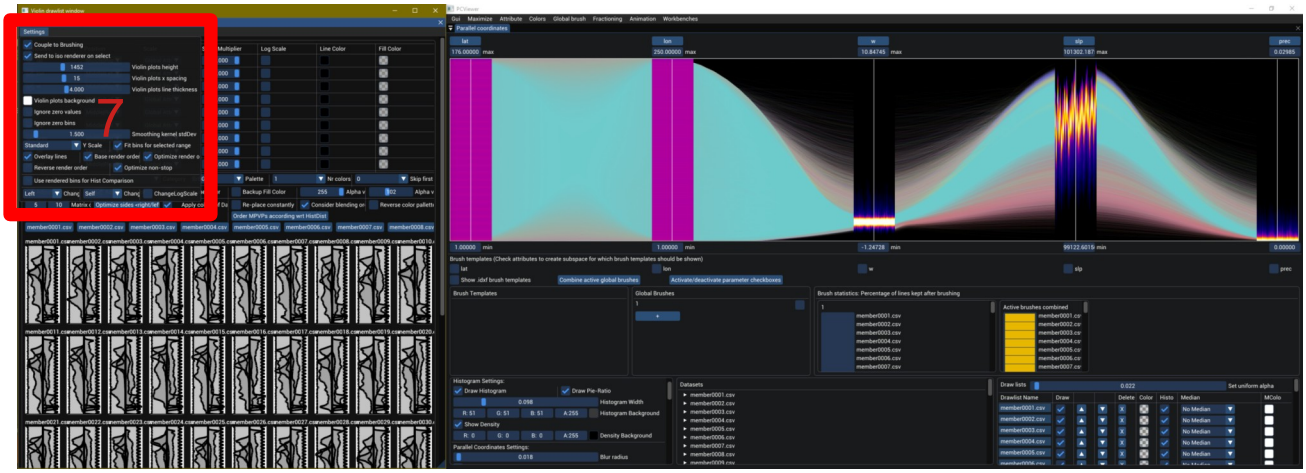


To show the stacked violin plots window go to the menu bar workbenches→Violinplot workbenches→Violin drawlist major. This should open a new window with a “+” button inside it. Drag it to your wanted size and screen position (can be outside of the standard PCViewer window) and click the “+” button to add a violin plot working space.



Here is an image of the violin plot window being positioned next to the parallel coordinates viewer and with an added violin plot working space. Note that with the two integers in 6 one can adjust the size of the violin plot matrix below. In the example a layout of 5 rows and 10 columns was chosen to show all member next to each other. To change the layout either double click on the value and type in the preferred value or drag the value to your preferred value.

To send the drawlists to the violin plots multi select the drawlists (select the first drawlsist via left click, scroll down to the last hold shift and left click on the last) and drag and drop them onto the first matrix slot. The resulting violin drawlist window should look like this7



In the settings menu (7) basic settings for the visualization and function can be set. Again a few selected settings are explained.

Couple to Brushing: If enabled the plots automatically update when a brush is updated

Send to iso renderer on select: Fast visualization on selection (will be explained later)

Violin plots height: Overall size of the violin plot workspace.

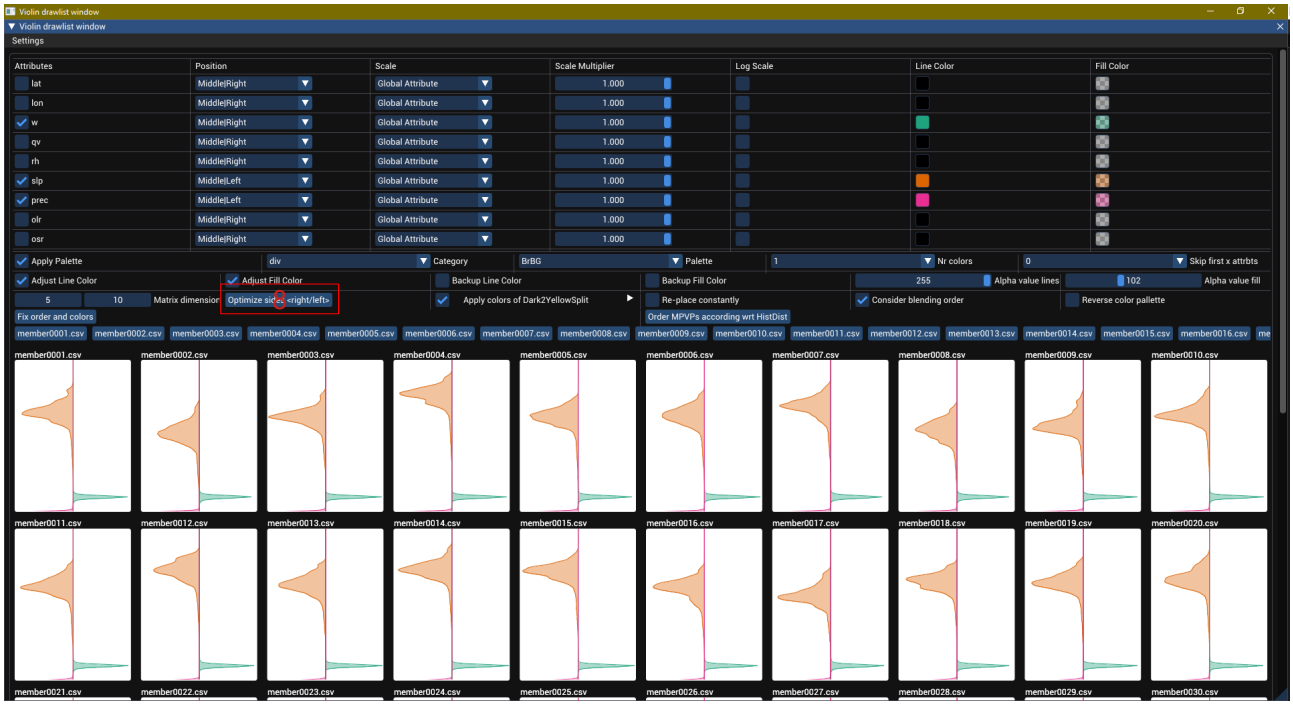
Violin plots x spacing: X space between the violin plots

Violin plots line thickness: Line thickness for the violin plots

Smoothing kernel stdDev: Size of the smoothing kernel for the violin plots

For this example the line thickness was set to 1 and the violin plots height was increased. For each drawlist now a stacked violin plot exists. One can identify which plot corresponds to which drawlist by the name above the plot.

Each plot consists of a violin plot for each attribute. This results in the stacked violin plots. In order to declutter the plots there exists a section at the top for selecting attributes for which the violin plot should be shown, where it should be positioned, how it should be scaled and which color it should appear in. The suggested approach is to select only the attributes which should be shown and then use the “Optimize side <right/left>” button (8) to automatically position the attributes and automatically assign reasonable colors to the different attributes.



If you select the same attributes and optimize the size automatically you should be able to see the same as in the image above.

The plots themselves can be switched via drag and drop.

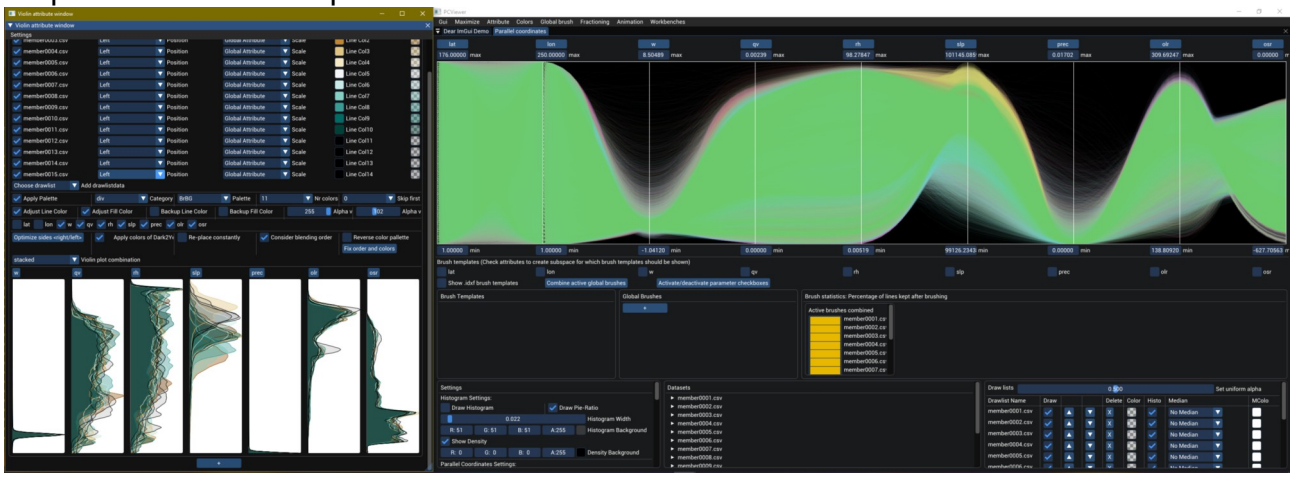
When you are using a brush at the same time and change it, all histograms are automatically updated if the “Couple to brushing” setting in the settings menu is activated.

Ensemble Analysis, stacked violin plots per Attribute:

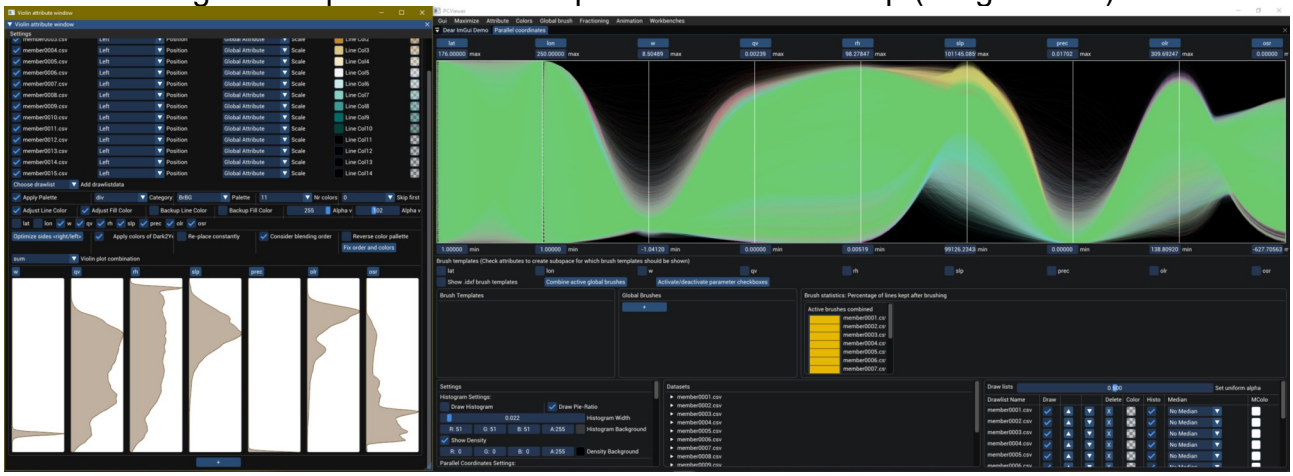
Alternatively to the stacked violin plots per Drawlist shown above the PCViewer tool also supports stacked violin plots per Attribute.

To open the “Violin attribute major” workbench go to workbenches→Violinplot workbenches→Violin attribute major and position the newly opened window as you wish.

Then create a new plot instance by clicking on the “+” Button. Now Drawlists can be added to the plot instance via drag and drop (multiple drag and drop also available) or via the dropdown menu in the plot instance.



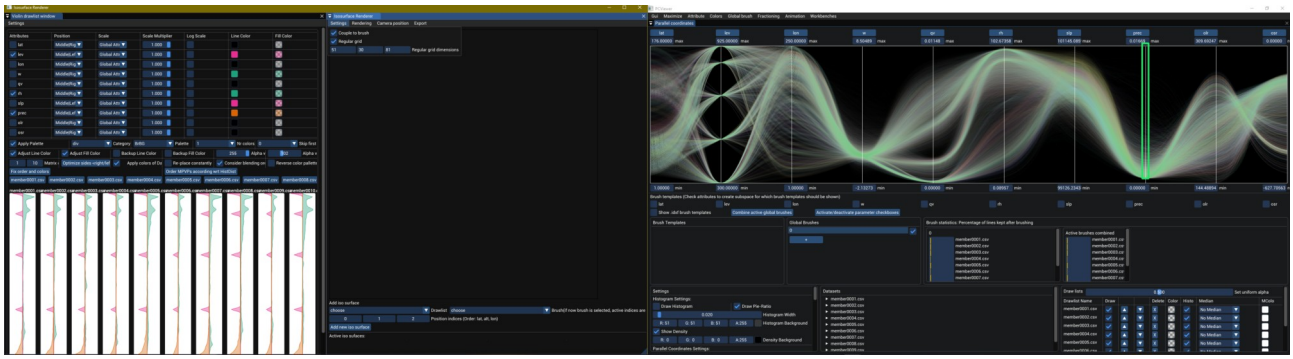
For the image above 15 member of the single_timestep test dataset were dragged into the plotting instance. The settings menu for the attribute major violin plots is the same as for drawlist major violin plots (for explanation of settings see section above).
The plot instance is structured as follows:
First is the list of all loaded drawlists. For each drawlist one can set the activation, the plot position, the attribute scale, the outline color and fill color.
Then there is a small section for automatic color assignment. By simply changing the “Nr colors” parameter an automatic assignment of colors for the first n colors will take place.
Below this section a list of all attributes with check boxes can be used to select the attributes for which the violin plots should be shown.
The next settings in the same line as “Optimize sides <right/left>” are deactivated for attribute major violin plots.
The drop down “Violin plot combination” can be used to switch between the stacked view of plots or the summed view, where in the stacked view one can see all violin plots for each loaded drawlist stacked upon each other (image above) and in the summed view one can see a single violin plot with all violin plot values summed up (image below).



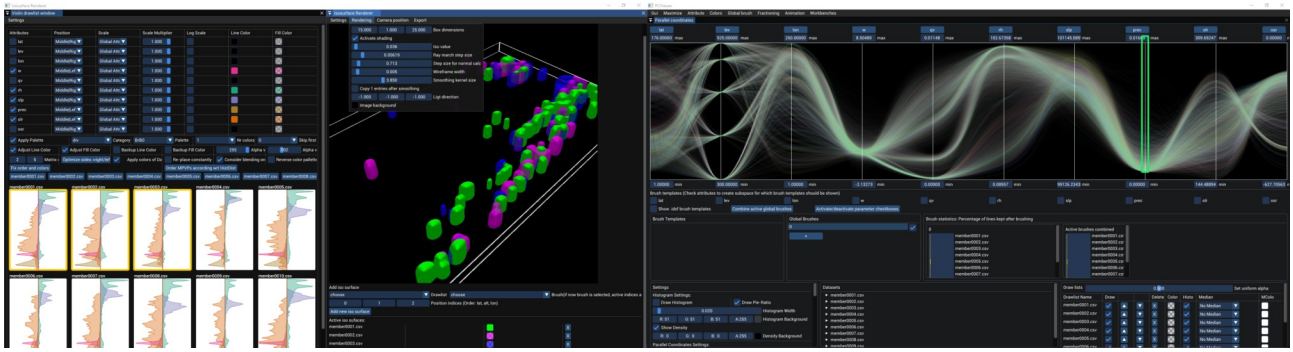
In this figure the summed violin plot can be seen. The color, position, line color and fill color of the violin plot are determined by the first drawlist loaded.

Ensemble Analysis, stacked violin plots, 3d visualization:
As weather data is spacial data a 3d visualization of the currently brushed subset of the data is very useful to get a better understanding of the 3d space.

For this an iso surface renderer is available under workbenches→Iso surface workbenches→Iso surface workbench. Again position the created window as you want (btw. docking is available for windows to easier configure the workspace).



For the image above load all .csv files in test_dataset/single_timestep_3d/ . Further a global brush has been created for precipitation and all drawlists are shown in the violin drawlist window. Further the Isosurface Renderer window is opened. To properly display the data first the domain size has to be set. In the Isosurface Renderer window under the settings menu activate Regular grid, and set the Regular grid dimensions to 176, 5, 250. Further at the bottom of the window of the isosurface renderer set the Position indices to 0, 1, 2. Now the data can be converted correctly to a regular grid.



In order to render a drawlist in the 3d renderer the easiest way is to select violin plots in the violin drawlist window. To select drawlists simply hold down ctrl and select the violin plots which should be sent to the 3d renderer.
In order to show the 3d render correctly you might have to adjust some settings in the Rendering menu.
Again a few settings in the Rendering menu are explained:

- Box dimensions: The regular grid which was set before can be stretched in each axis by typing in the box dimensions. If the dimensions are set to [1,1,1] then the whole 3d domain will be seen as a cube. In order to see everything better I adjusted the box dimensions for this example to [12,1,25].
- Ray march step size: the step size used for ray marching. Lower values mean higher quality while the rendering time increases
- Wire frame width: Wire frame thickness of the box showing the edges of the 3d domain
- Smoothing kernel size: Smoothing kernel size for spacial smoothing. For high values small 3d structures start to disappear and large structures show a smoothed core.
- Copy 1 entries after smoothing: If enabled enforces small structures to be kept.

In order to navigate in 3d space hover over the view with the mouse and use W,A,S,D,Q,E to fly. For higher fly speed hold down the shift key. To pan the camera hold down the left mouse button and move the mouse up,down,left,right.