Web-based Visualization: Overview of Client and Server-side Techniques and their Use in GeoJS and CDATWeb

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Overview

Rendering Modes

- Client side
- Server side
- Mixed

Tools

- ParaViewWeb / vtkWeb
- Cinema
- GeoJS

CDATWeb

Conclusion

Client Side Visualization

SVG: D3, snap.svg, Raphaël

Supports basic shapes, paths, and polygons

Native support for mouse events and CSS

Too slow for large numbers of elements

Canvas: Paper, Fabric, Cinema, Bokeh

Fast pixel level access for 2D graphics

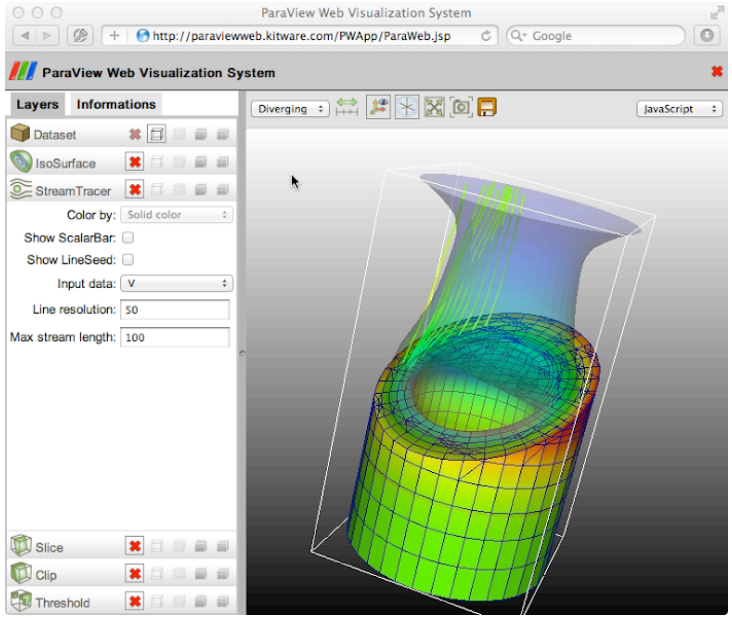
No native 3D support

WebGL: VGL, Three

Fast, GPU accelerated 3D graphics

Not as widely supported among browsers/devices

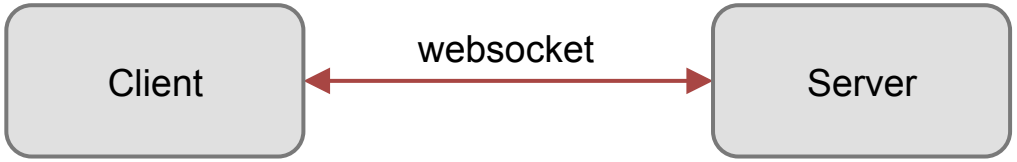
Server Side Visualization



- Renders images on the server and streams them to the client.
- Requires large server infrastructure and may not scale well for large numbers of users on a typical web-server (memory or processing limitations).
- Ideal for serving the visualization using existing code base
- Not ideal for pre-computed analysis or visualization

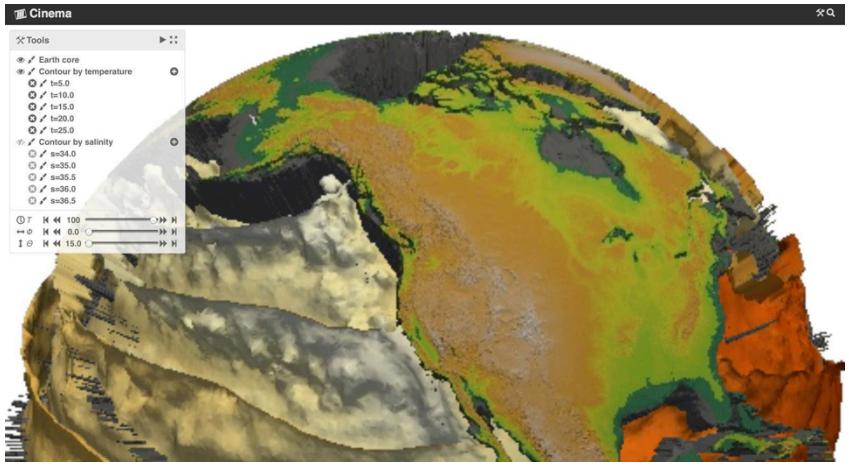
ParaViewWeb / vtkWeb

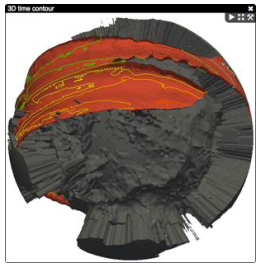
Uses Autobahn to stream data between the client browser and the server ParaView instance. Communication is transmitted via Remote Procedure Calls (RPC) over websockets to minimize latency.

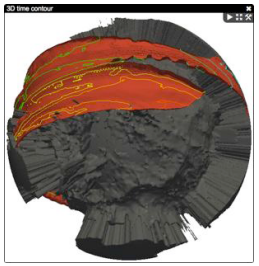


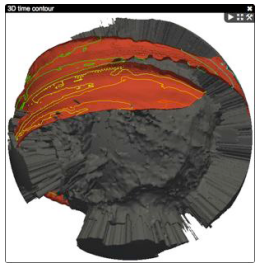
- Clients can remotely call ParaView python methods on the server.
- The server renders the scene and transmits data back to the client.
- User interactions are seamlessly passed from client to server.
- The ParaViewWeb server can stream results as images or GL primitives to be rendered with VGL.

Mixed Mode

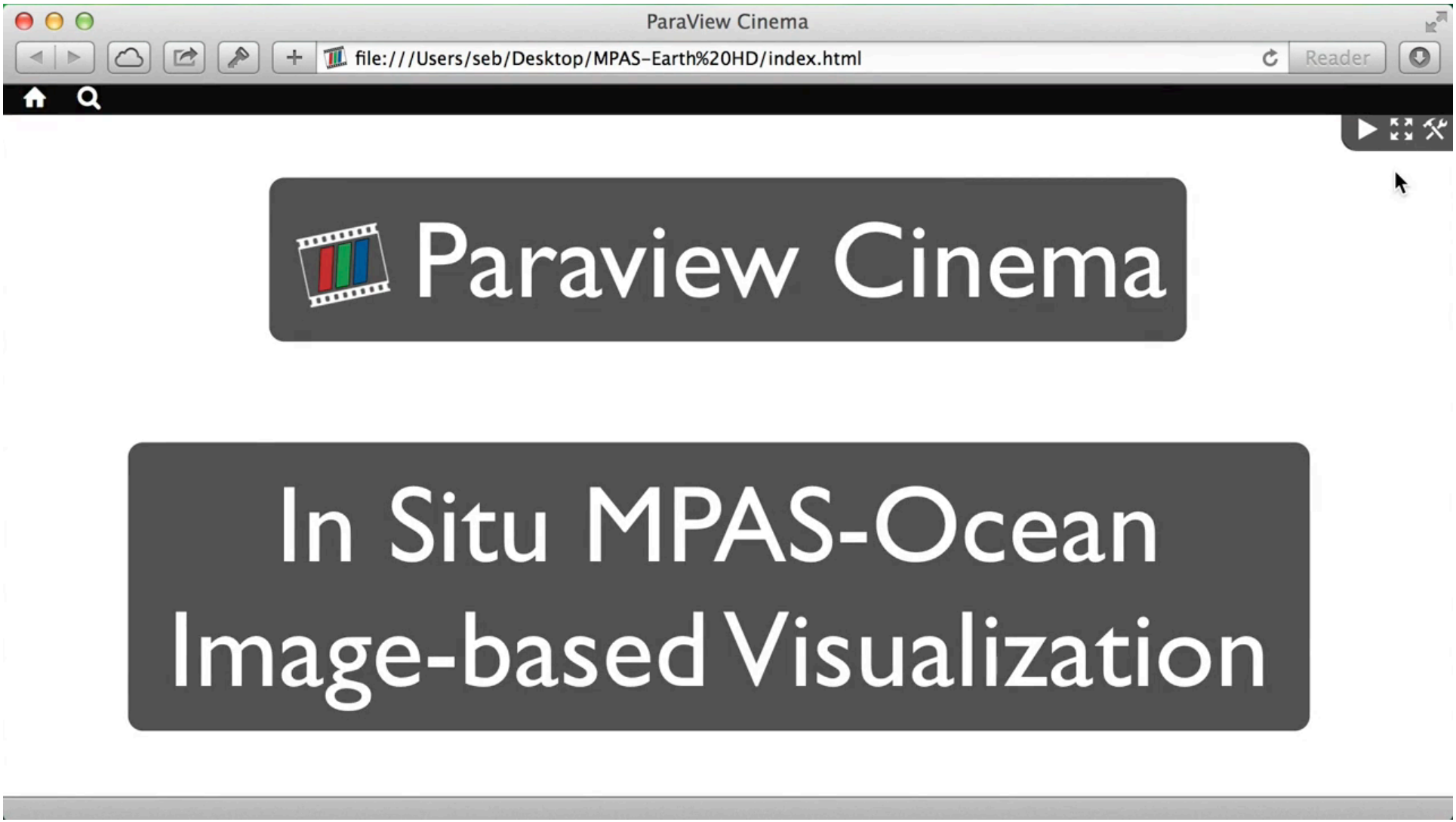


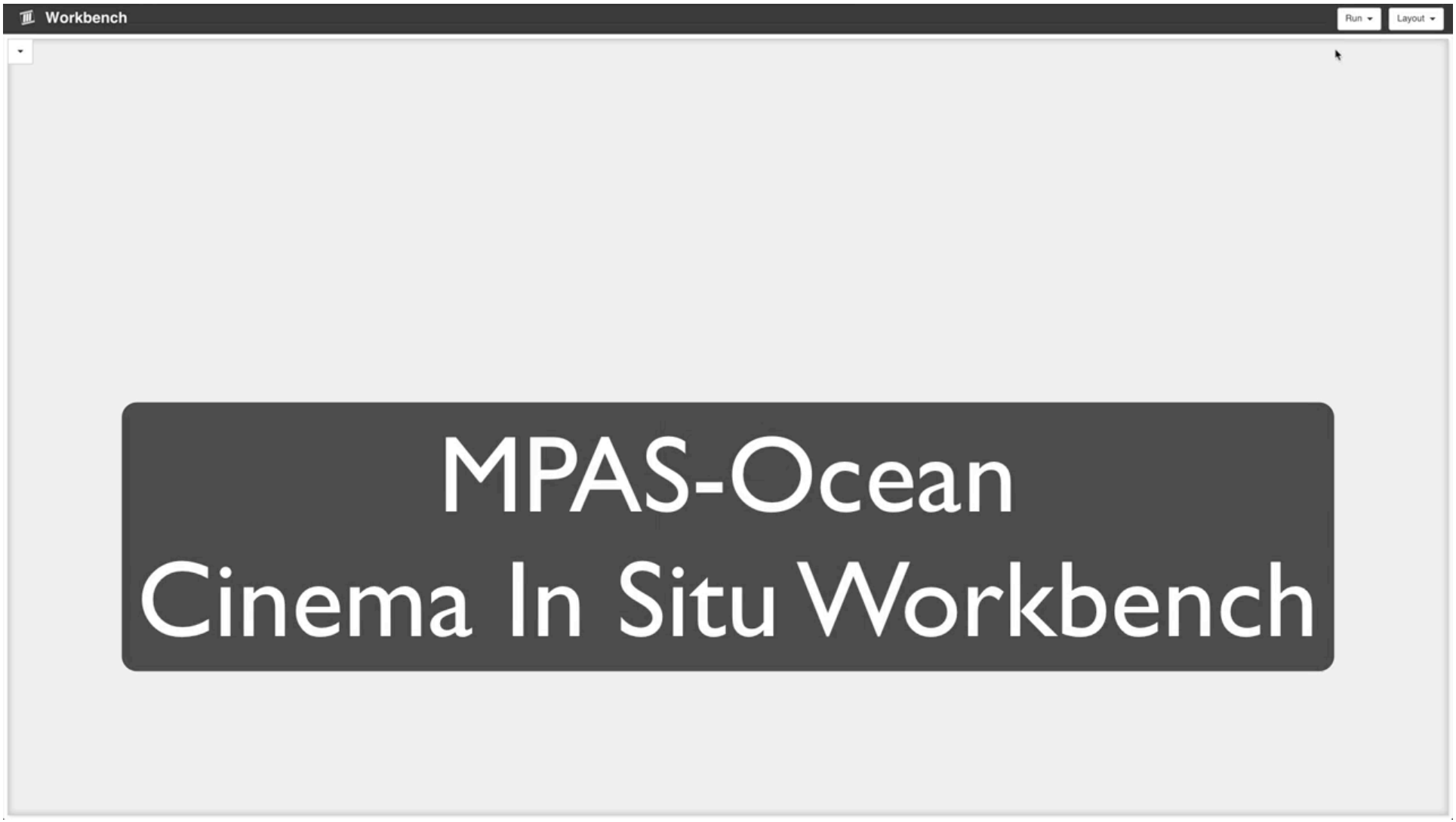






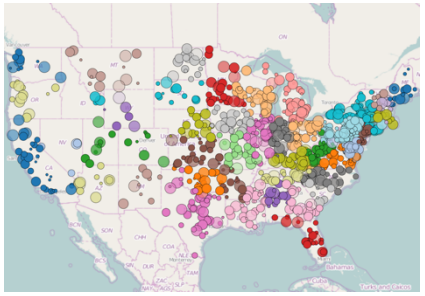
- Images are renderers on the server and stored as data arrays
- Fixed viewpoints
- Composition is done on the client side using WebGL or Canvas2D
- Visualization using image database

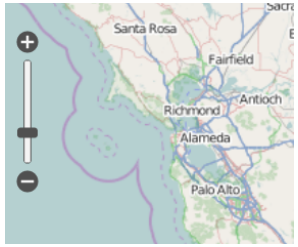

ParaView Cinema
file:///Users/seb/Desktop/MPAS-Earth%20HD/index.html
Reader
Paraview Cinema
In Situ MPAS-Ocean
Image-based Visualization

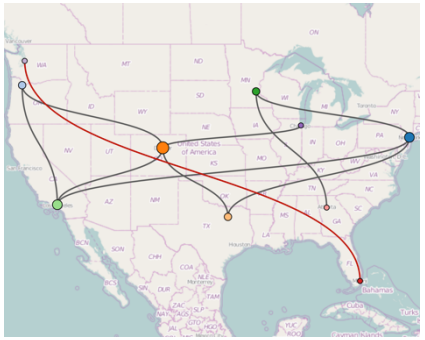

Workbench
Run
Layout
MPAS-Ocean
Cinema In Situ Workbench

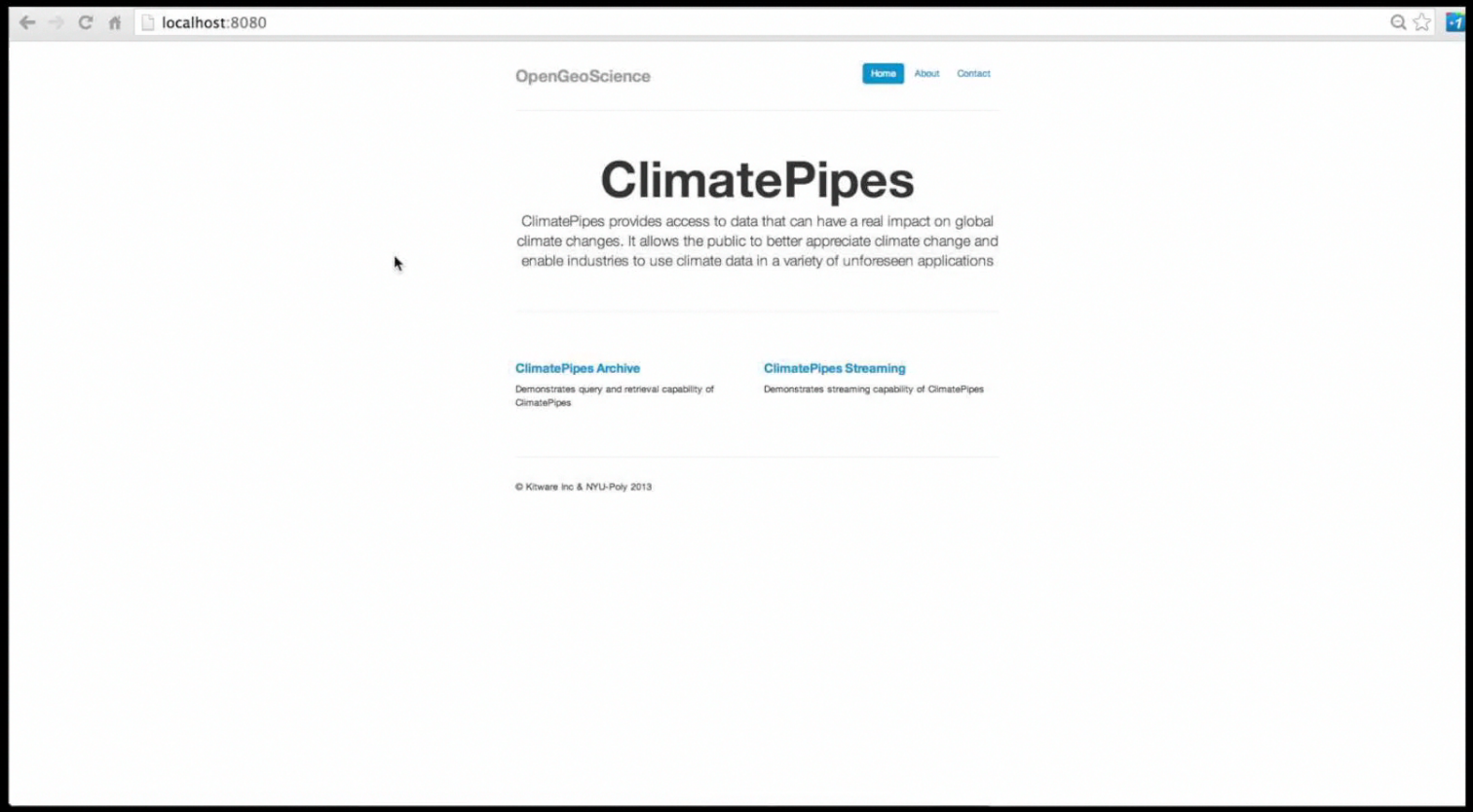
GeoJS: A geospatial visualization and mapping framework

- Combine GL, Canvas, and SVG graphics into a single visualization
- Unified API for generating features in SVG or GL
- Designed to perform well with large datasets
- Features provide DOM-like mouse events
- Provides low level access to underlying APIs, i.e. SVG layers expose D3 selections that are synced to the map
- Actively developed and maintained with new features added almost daily
- Supports scientific visualization, geo-visualization, GIS, and infovis





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ClimatePipes
ClimatePipes provides access to data that can have a real impact on global climate changes. It allows the public to better appreciate climate change and enable industries to use climate data in a variety of unforeseen applications
ClimatePipes Archive
Demonstrates query and retrieval capability of ClimatePipes
ClimatePipes Streaming
Demonstrates streaming capability of ClimatePipes
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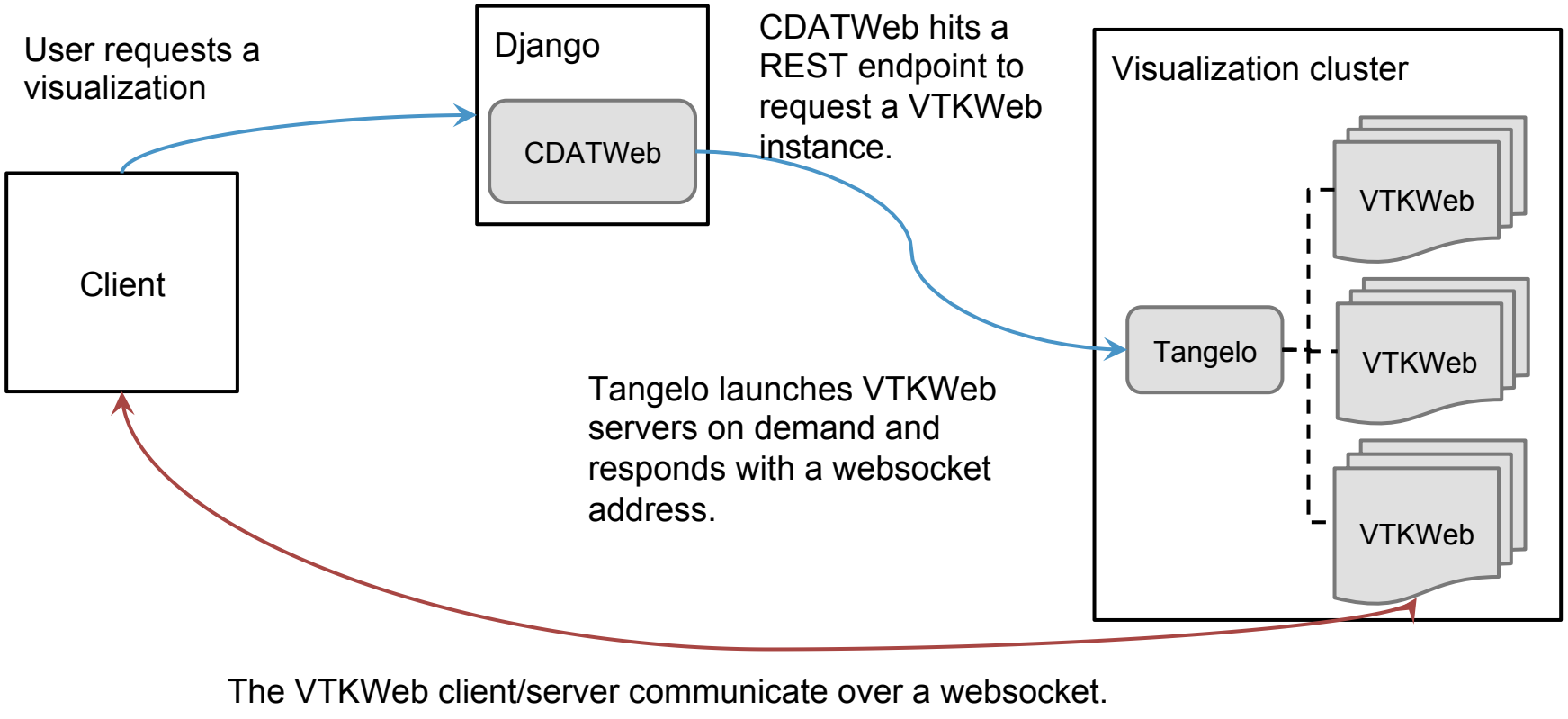
GeoJS: Feature API

```
layer.createFeature('point', options)
  .data(data)
    .position(function (d) { return {x: d.x, y: d.y}; })
    .style('fillColor', function (d) { return d.color; })
    .style('fillOpacity', function (d) { return d.opacity; })
    .style('strokeColor', 'black')
    .geoOn(geo.event.feature.mouseover, function (evt) {
      evt.data.opacity = 0.75;
      evt.data.color = 'red';
      this.modified();
      this.draw();
    })
    .geoOn(geo.event.feature.mouseout, function (evt) {
      evt.data.opacity = 0.25;
      evt.data.color = 'steelblue';
      this.modified();
      this.draw();
    })
    .draw();
```

All feature types use a flexible data binding API making it easy to customize appearance and behavior per marker

- Similar to D3
- Works for both SVG and GL
- Mouse events can propagate to features in all layers (not just the top)

CDATWeb Visualization Components



Final Thoughts

- Web visualization is now ready for production
- Use of web visualization for exploratory data analysis (EDA) or scientific purposes is emerging
- Flexibility is good: Ability to switch between client, server or mixed modes
- Web visualization tools for scientific datasets are in scarcity