

Visual Analytics Tools for the Global Change Assessment Model

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GCAM Simulation

- When exploring the impact of various conditions or scenarios in climate change mitigation policies, it is possible to generate hundreds or even thousands of datasets making it near impossible to individually investigate them.
- Each dataset has been generated using varying parameters which may have minimal impact on the outputs while others may have a more drastic impact.

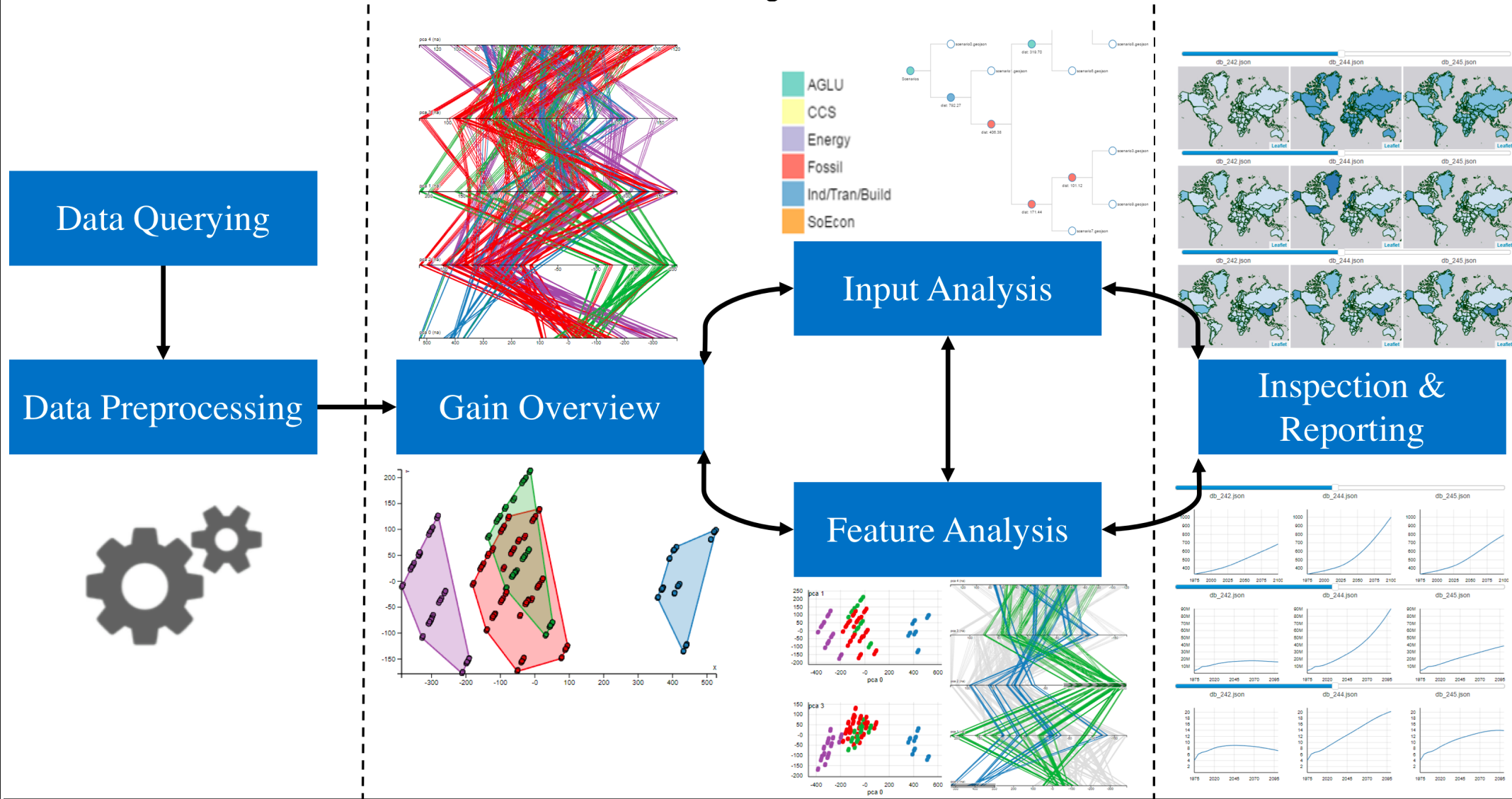


Challenges

- How to:
 - query the databases?
 - process the data?
 - analyze and compare those result?
 - inspect and visualize specific features or attributes?



Visual Analytics Framework



Collecting the Data

- RGCAM
 - XML - Queries
- Node.js
 - Parallel Processing
 - Multi-core
 - Slurm



Preprocessing

- Python
 - scikit-learn
 - PCA
 - Clustering
 - Hierarchical
 - K-Means
- Node.js
 - Data cleaning
 - Organization
 - Metric calculations

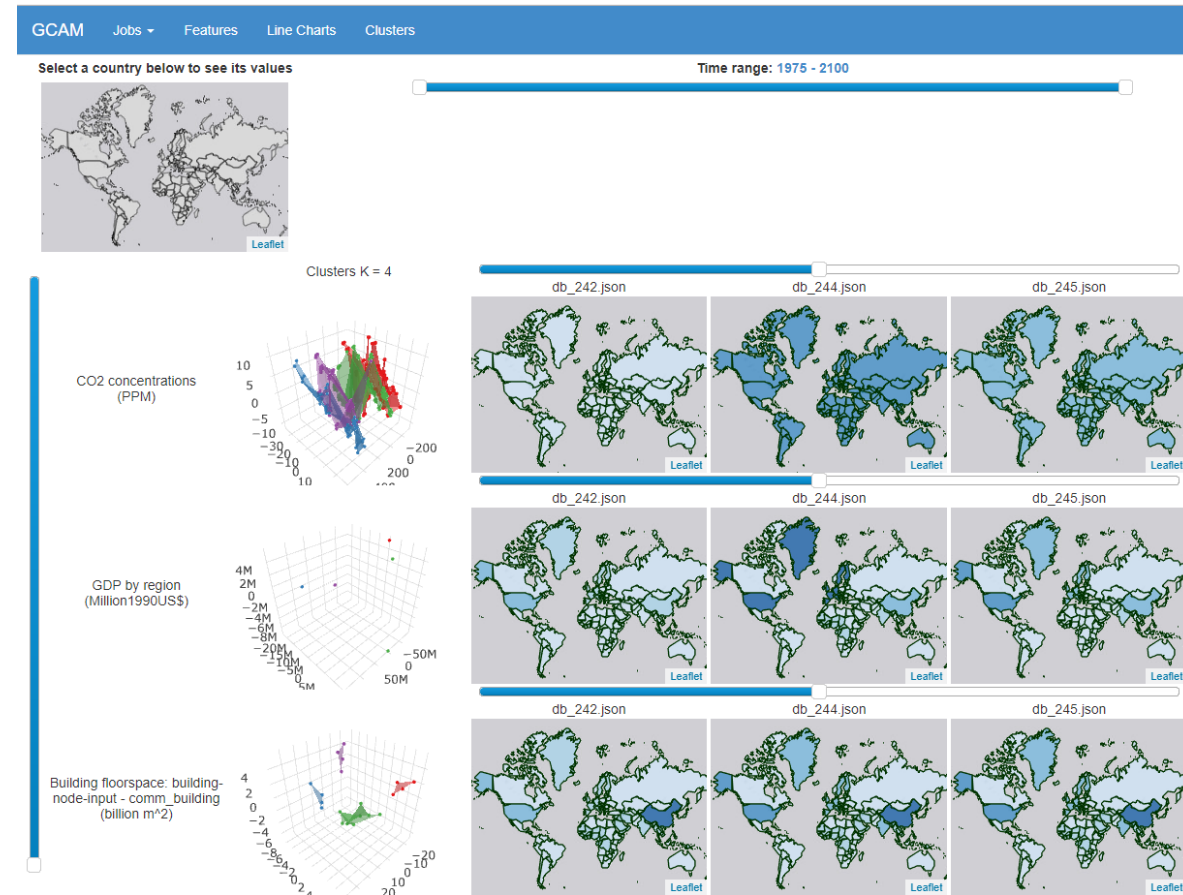
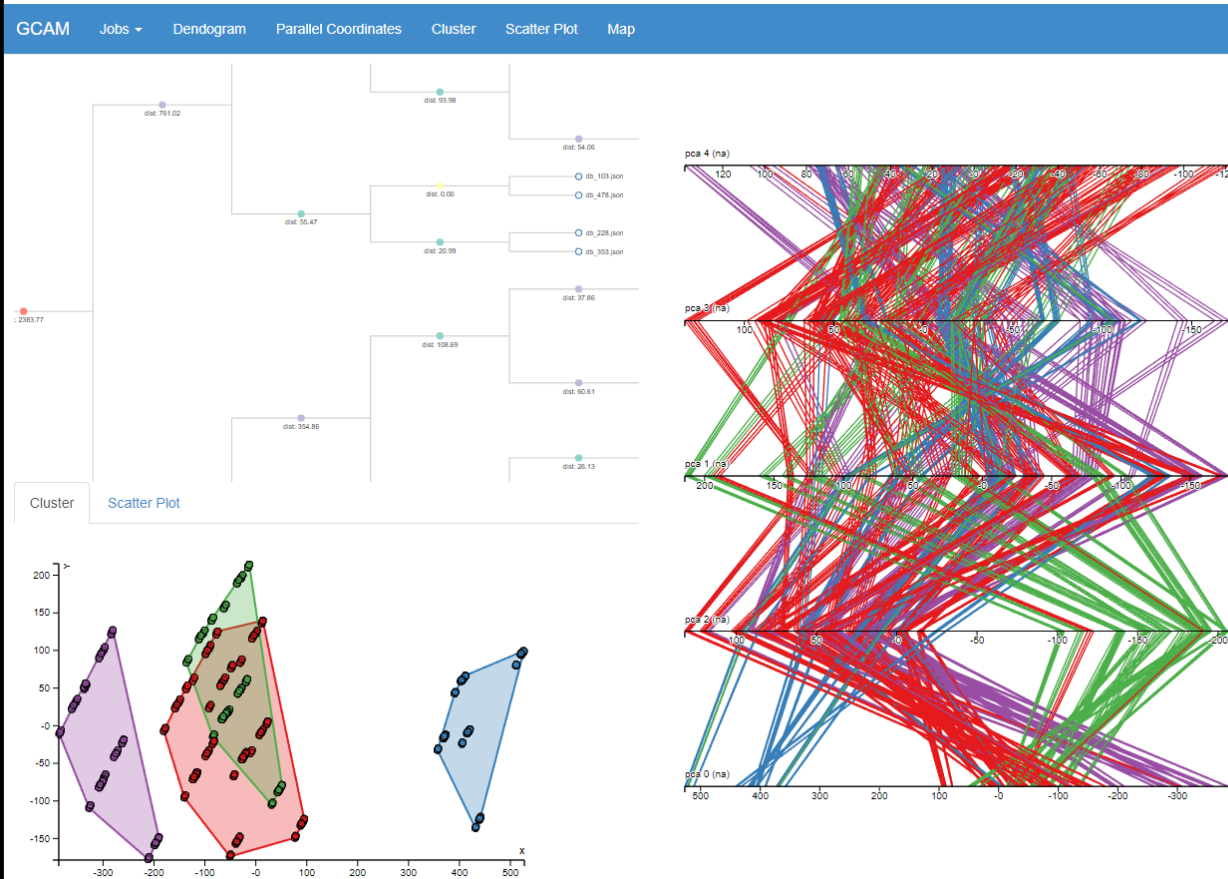


Visual Analytic Tools

Analyze

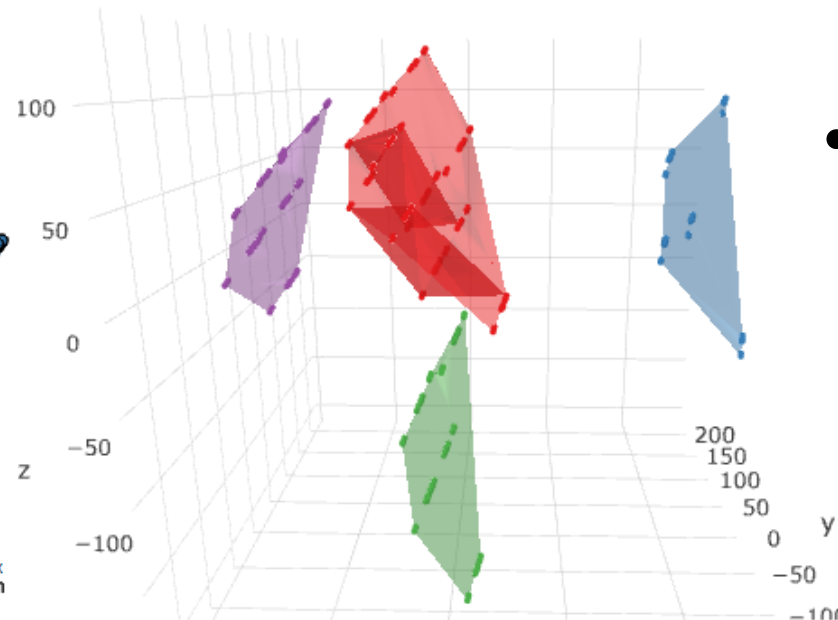
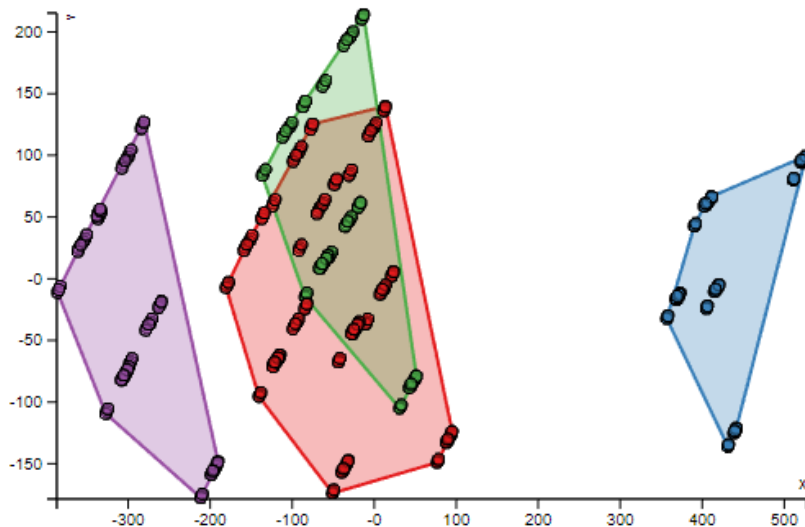


Inspect & Report



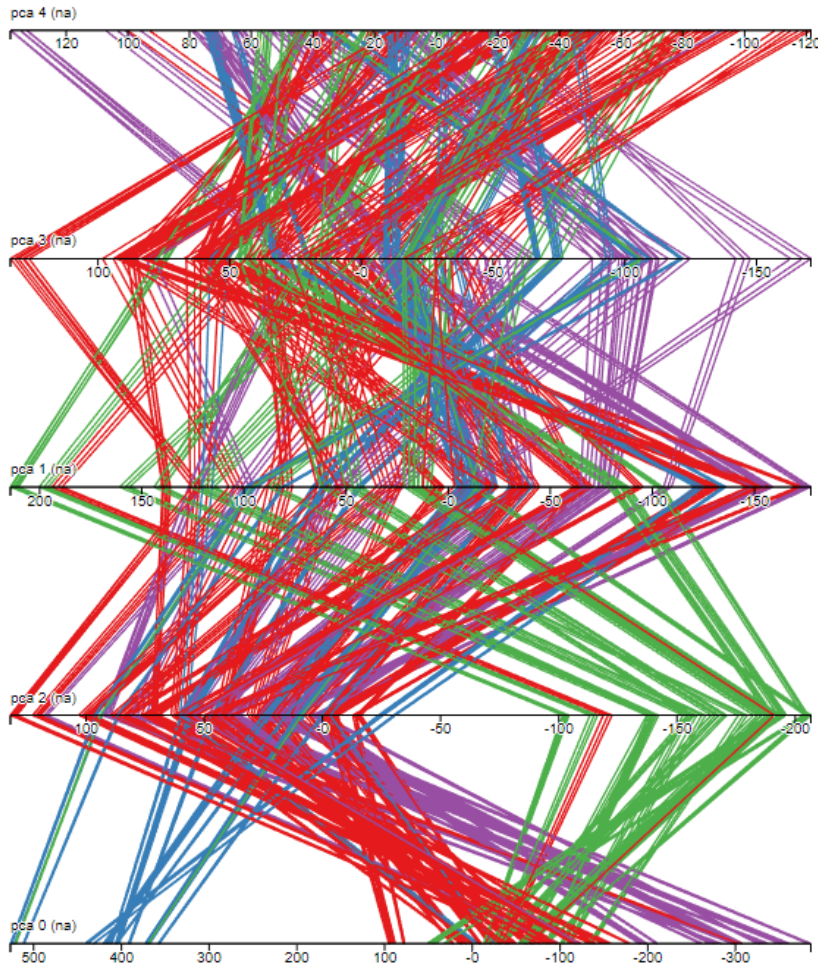
Cluster View

- The Cluster View shows the PCA plot of all scenarios and their clusters from K-Means.



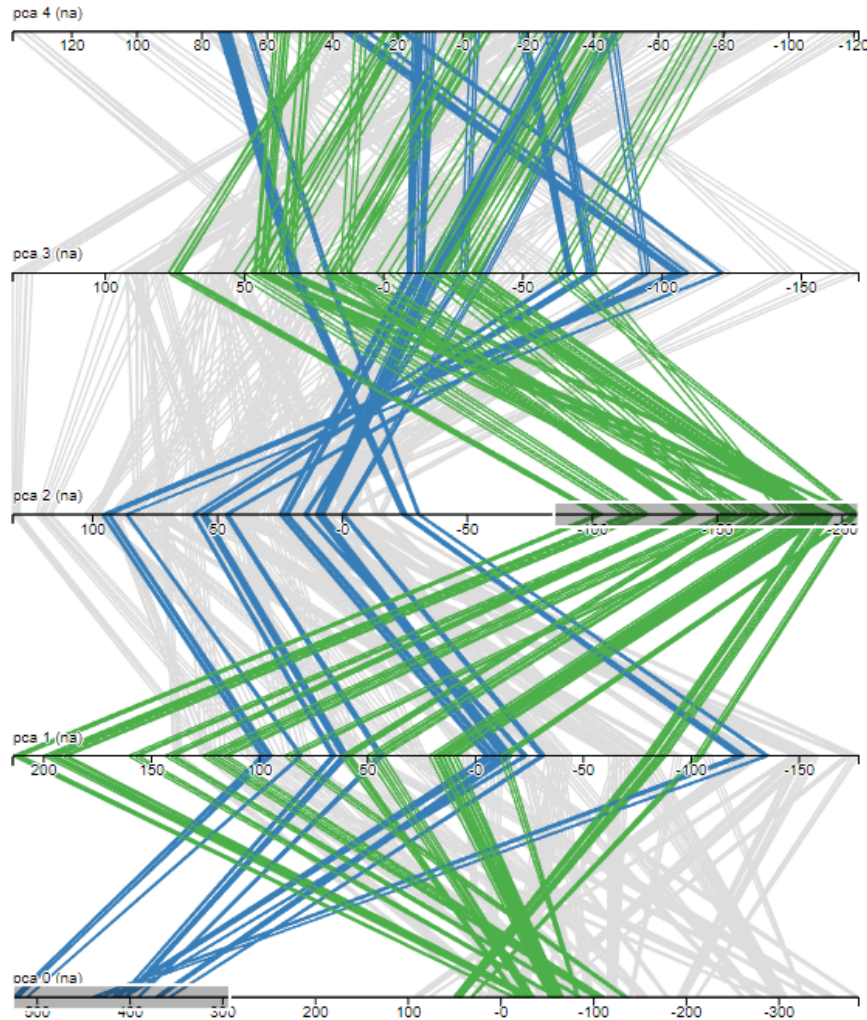
- This view provides a spatial overview of each scenario and shows their similarity based on locality and clustering.
- Each dot represents a different scenario and the coloring is used to show which cluster they belong to.

Parallel Coordinates View

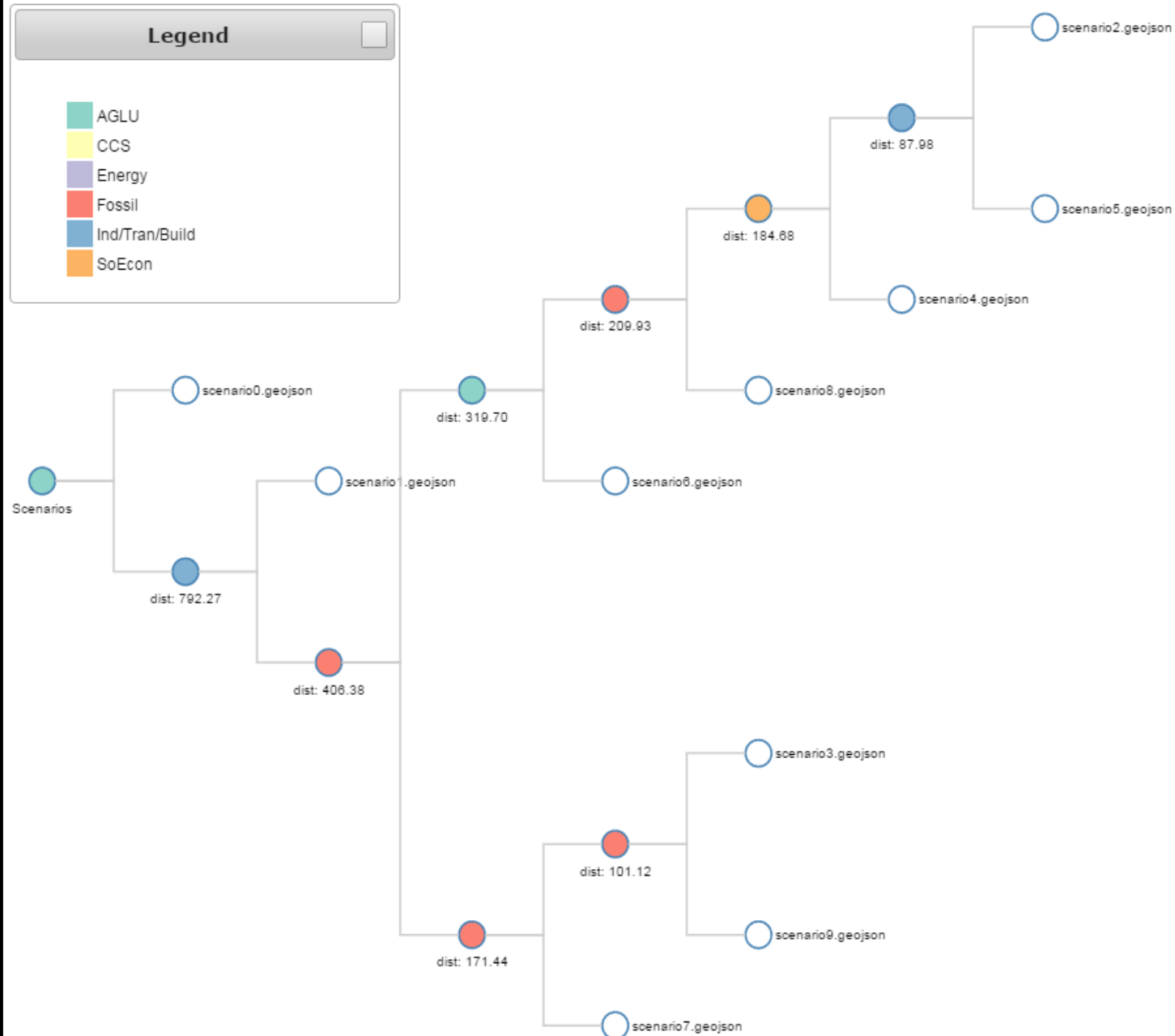


- Displays the output values for each region or scenario based on the selected queries.
- The plot can display the actual values or the slope of the values.
- The user can select to examine the data across all years as a summation or average, they can select the value from a specific year in the simulation, or they can select the principle components.

Filtering options: Brushing



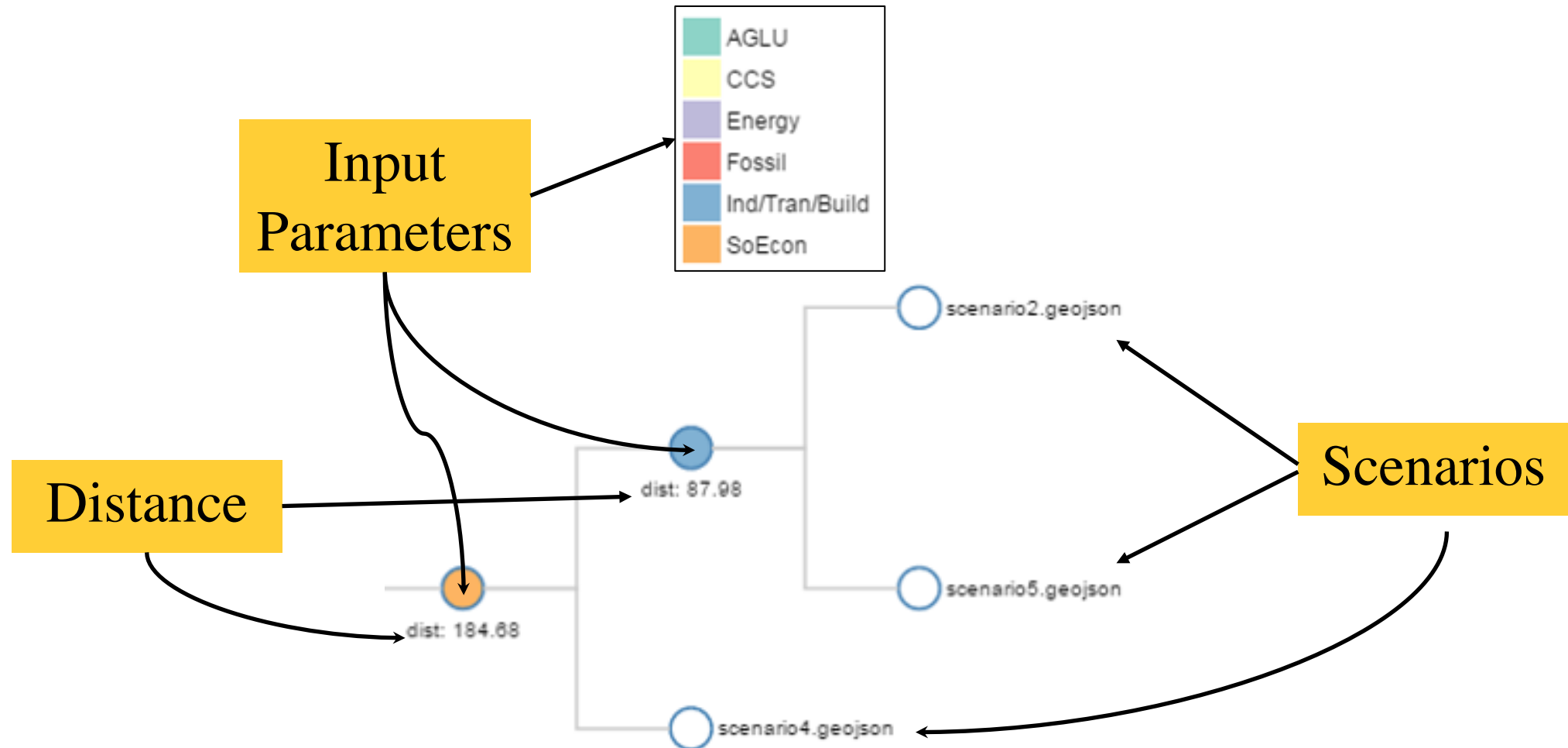
- Each axis represents a different feature from the output query or principal component.
- The user can brush along the axis to filter out scenarios that are not within the extent of the brush.
- Each new brush can either:
 - combine previously filtered values with the new data under brushing
 - apply additional filtering to previously filtered values



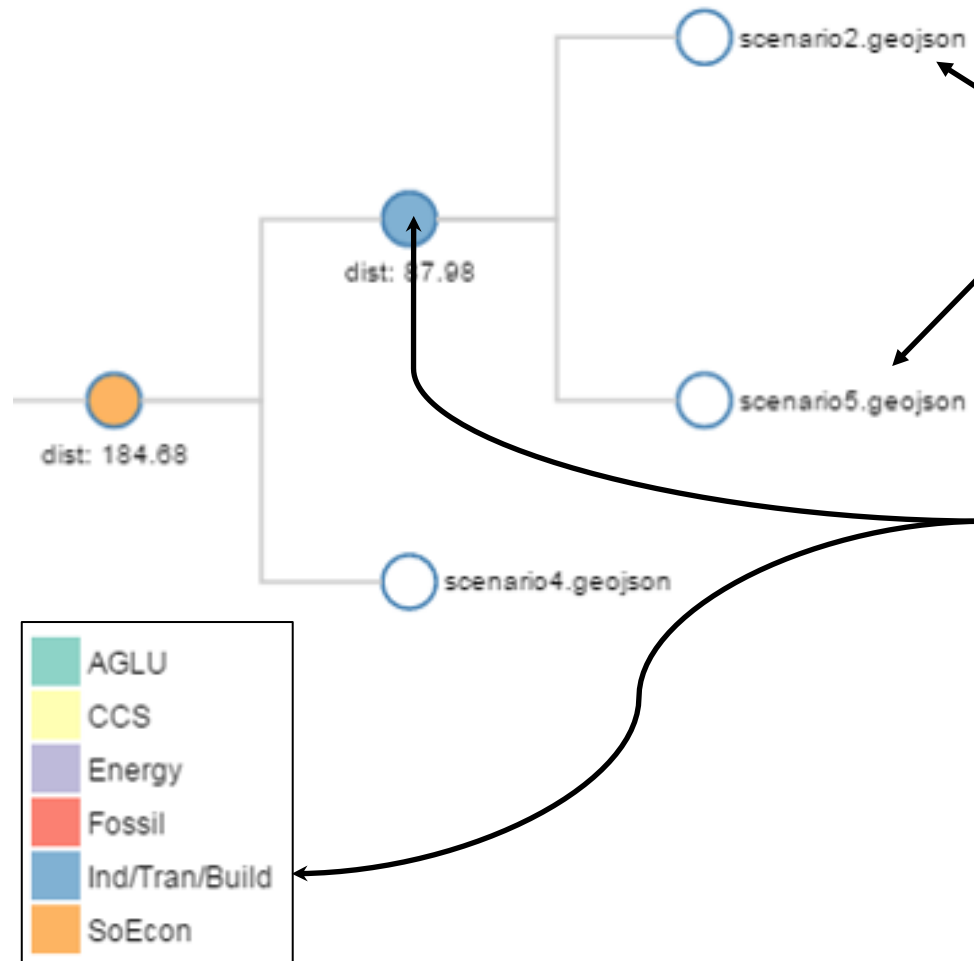
Dendrogram View

- The dendrogram view shows the hierarchy of clusters formed when running when running all of the provided scenarios through hierarchical clustering.
- The view is draggable and zoomable allowing the user to easily explore the hierarchy.
- Nodes are clickable providing filter mechanisms.

Dendrogram View Cont.



Node Labeling Example



Scenario 2 inputs: Energy: 0, CCS: 0, SoEcon: 1,
AGLU: 0, **Ind/Tran/Build: 0**, Fossil: 1

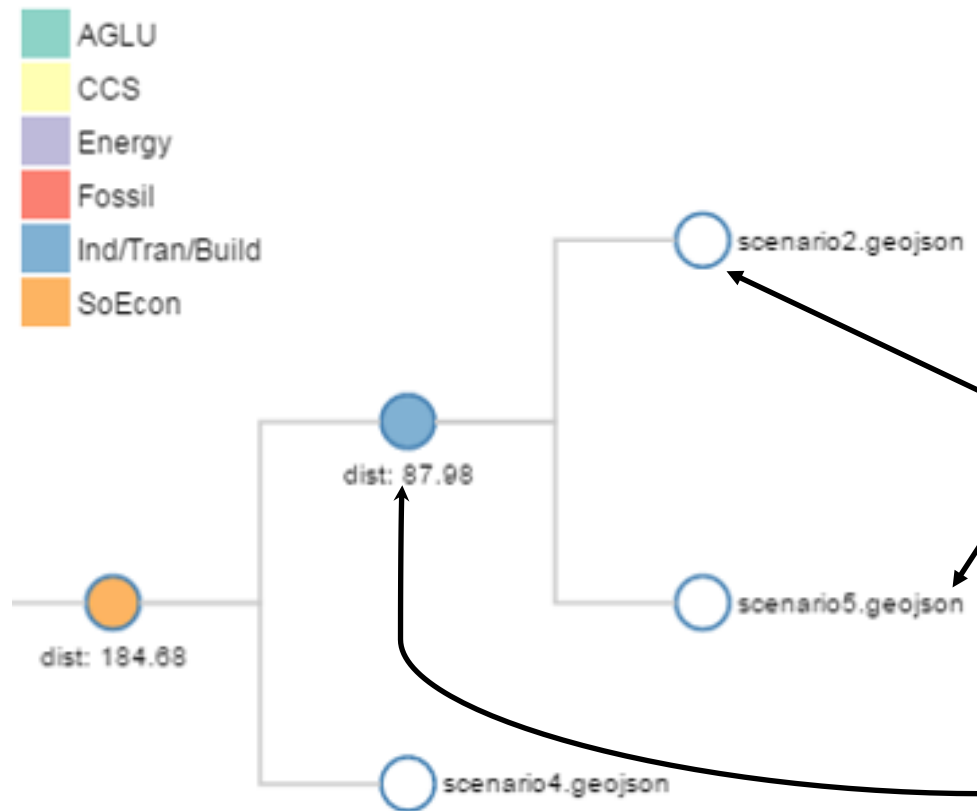
Scenario 5 inputs: Energy: 0, CCS: 0, SoEcon: 1,
AGLU: 0, **Ind/Tran/Build: 1**, Fossil: 1

By applying the difference equation below we find
the greatest difference between Scenarios 2 and 5 to
be Ind/Tran/Build so the parent is colored **Blue**.

$$Diff_P = \sum_{R \in P} Absolute\ Value(Cluster1_{P,R} - Cluster2_{P,R})$$

Where R is the Rth record of parameter P.

Merging Inputs for Parent Nodes



Parent Node inputs are determined by merging the inputs of child nodes such that colored nodes at the higher level indicate which variables have a smaller impact on the scenario similarity.

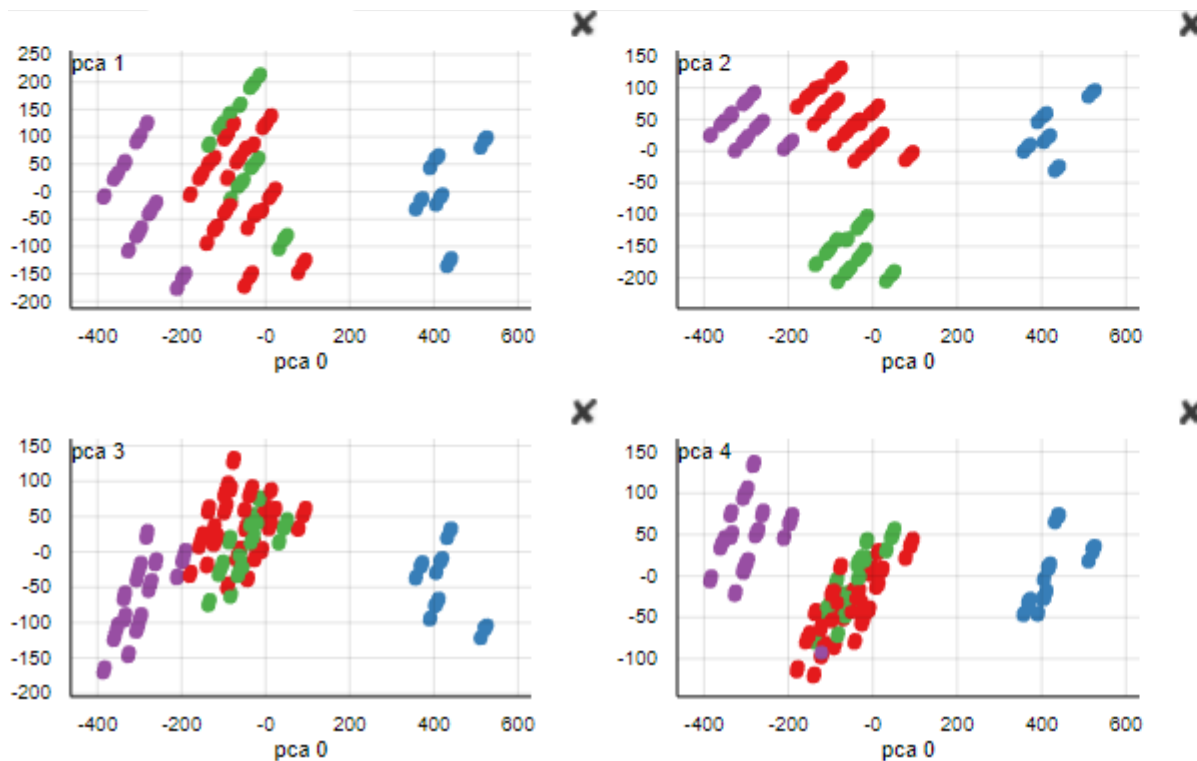
Scenario 2 inputs: Energy: 0, CCS: 0, **SoEcon: 1**, AGLU: 0, **Ind/Tran/Build: 0**, **Fossil: 1**

Scenario 5 inputs: Energy: 0, CCS: 0, **SoEcon: 1**, AGLU: 0, **Ind/Tran/Build: 1**, **Fossil: 1**

Merged Parent Node: Energy: 0, CCS: 0, **SoEcon: 2**, AGLU: 0, **Ind/Tran/Build: 1**, **Fossil: 2**

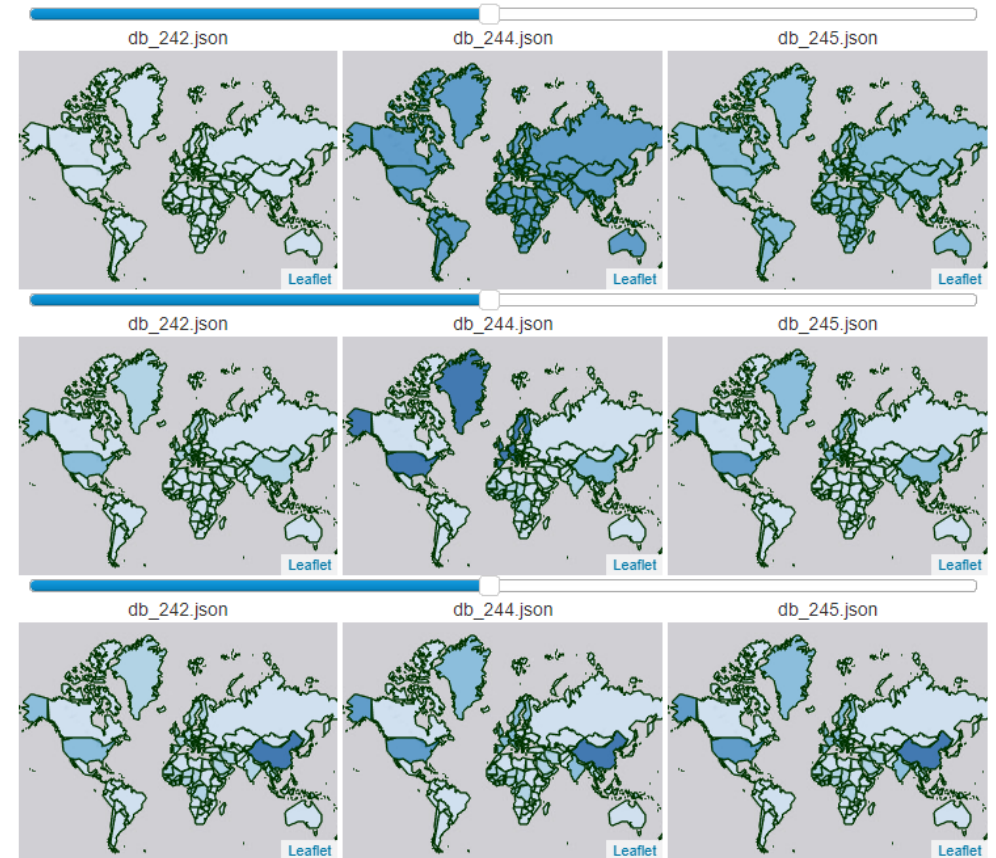
Scatter Plot View

- The scatter plot view shows scatter plots for selected x & y axis from the queries performed on the GCAM databases as well as principal components.



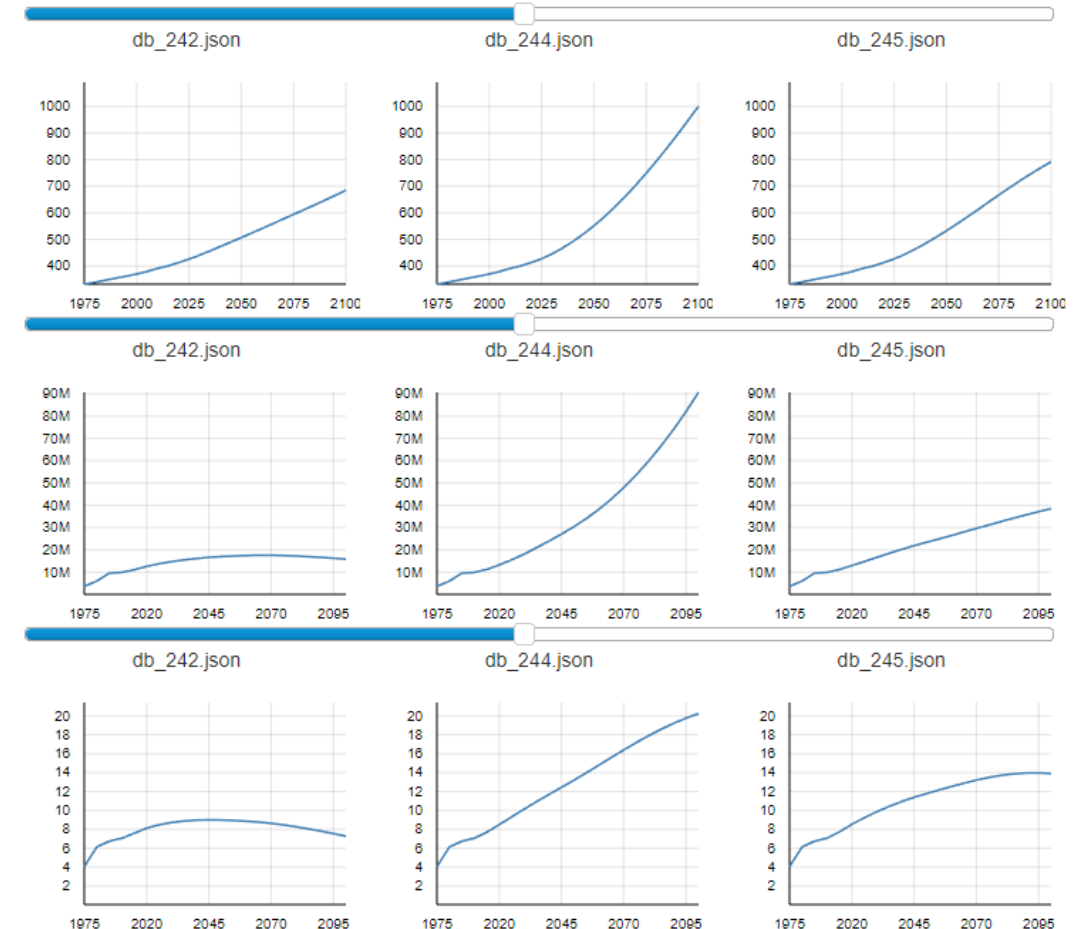
Region Explorer

- The region explorer shows geographical maps of selected scenarios for queries extracted from GCAM databases.
- This view supports global and regional values.



Value Explorer

- The value explorer shows line charts of selected scenarios for queries extracted from GCAM databases.
- This view supports global and regional values.



Demo

Thank You

- Contributions
 - Visual analytics framework for GCAM simulation analysis
 - Workflow and tools for analyzing, comparing, and inspecting simulations
- Future Work
 - More visualization features
 - UI improvements
 - Additional interactions
 - Adaptive processing

Questions?

