Visual Reconciliation of Alternative Similarity Spaces in Climate Modeling

Jorge Poco[1], Aritra Dasgupta[1], Yaxing Wei[2],
William Hargrove[3], Christopher R. Schwalm[4], Deborah N. Huntzinger[4], Robert Cook[2],
Enrico Bertini[1] and Claudio T. Silva[1]

[1]**New York University**, [2]Oak Ridge National Laboratory,
[3]United States Forest Service, [4]Northern Arizona University

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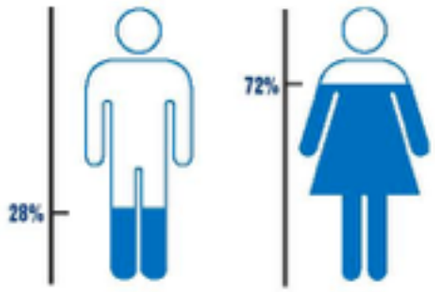
demographics



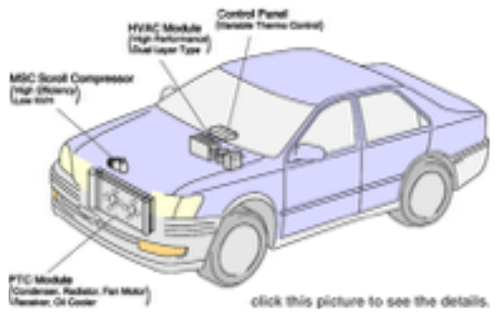
age, gender, race, occupation, …

disease

symptoms, medications, …

patients

features



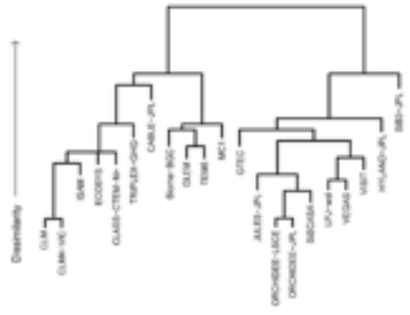
make, model, year, mileage, …

transaction

profit, sales, customer profile, …

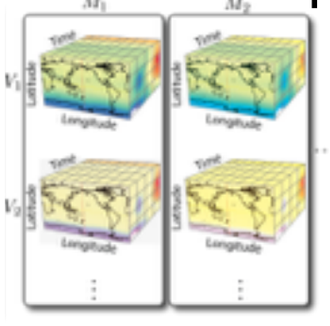
cars

model structure



soil conditions, process details

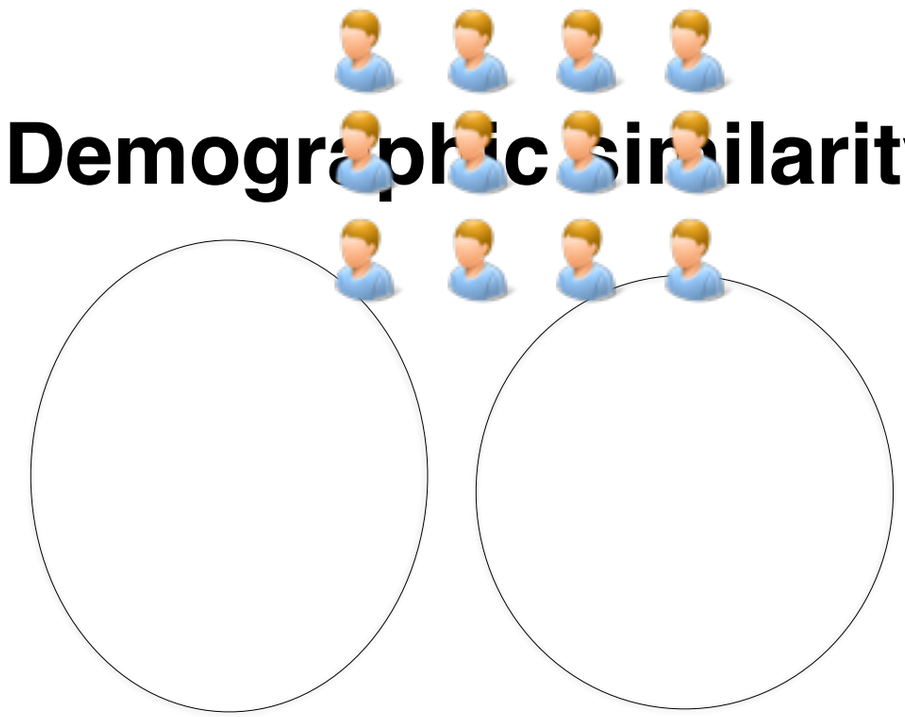
model output

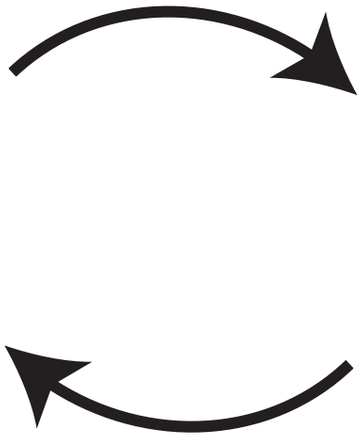


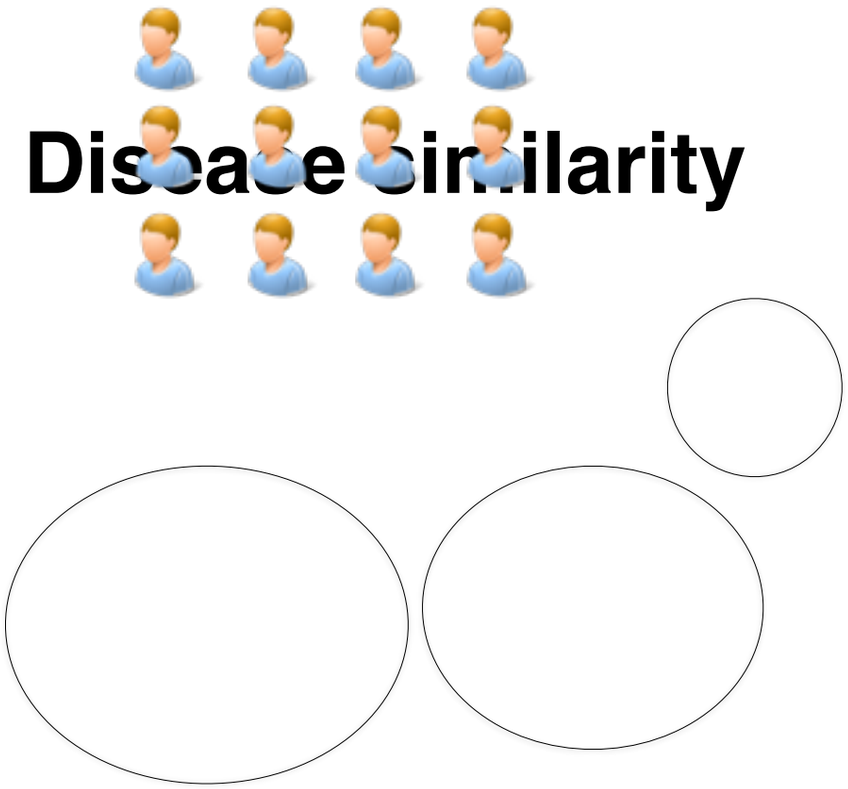
space and time variable

climate

Patients







Challenges

Heterogeneous data spaces

Reduce visual complexity

Level of Abstraction

Ensure domain experts trust the visualization

Parameter Exploration

Develop effective navigation strategies

Contribution

A *visual reconciliation* technique for iterative refinement of grouping criteria which is supported by a visual feedback model for comparing the alternative similarity spaces in climate modeling.

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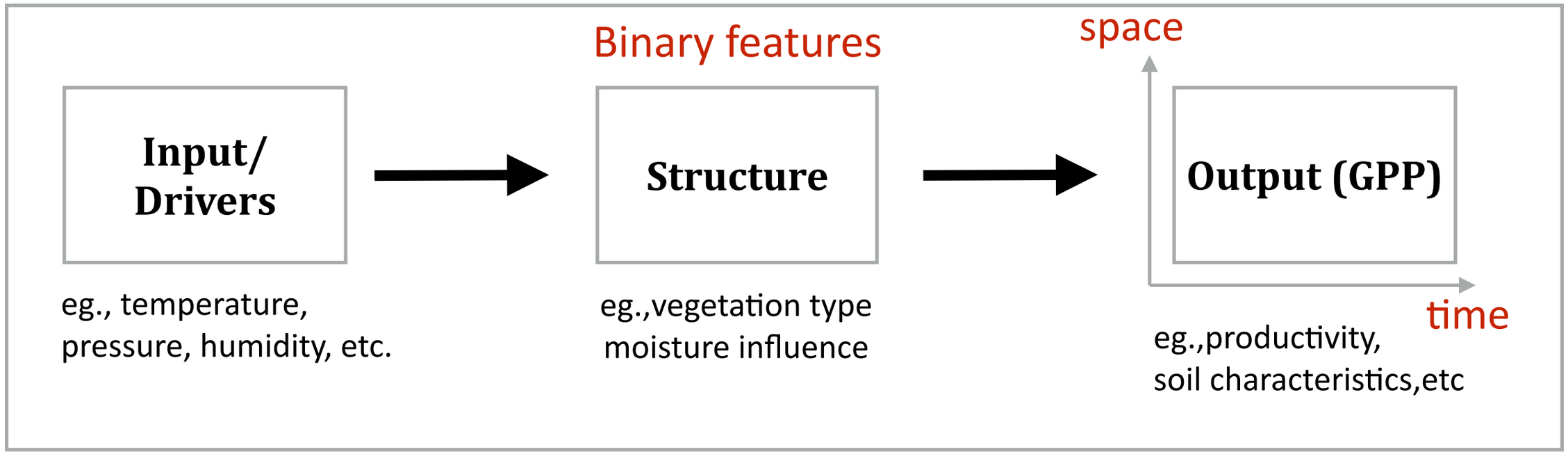
Model Simulation

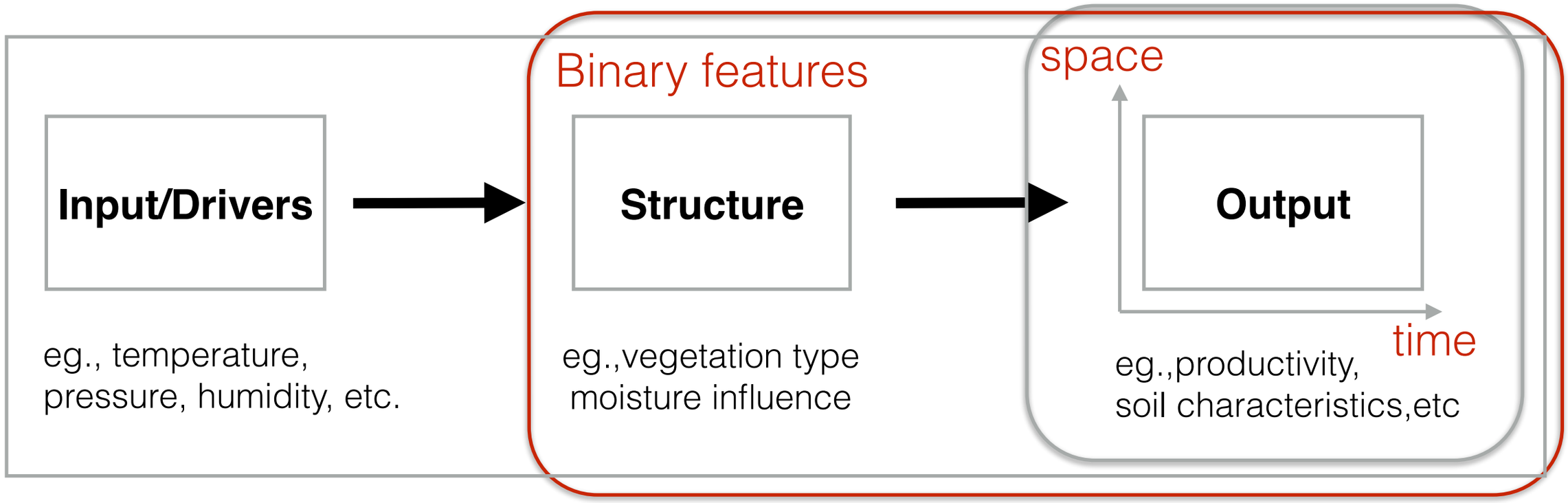
ecosystem processes

carbon exchange



Holy grail: Analyze similarity among
model **input**, model **structure** and model **output**

(EuroVis 2014) Previous Work- SimilarityExplorer: A Visual Inter-Comparison Tool for Multifaceted Climate Data



(VAST 2014) Visual Reconciliation of similarity between model structure and model output

Related Work

- **Automated Methods**
  Consensus Clustering *[Monti et al., Machine Learning 2003]*
  Redescription Mining *[Ramakrishnan et al., SIGKDD 2004]*

- **Visual Feedback in High-dimensional Data Spaces**
  Cognitive feedback model *[Hu et al., TVCG 2013],*
  Representative factor generation *[Turkay et al., TVCG 2012]*

- **Visual Parameter Space Analysis**
  Conceptual framework *[Sedlmair et al., InfoVis 2014]*

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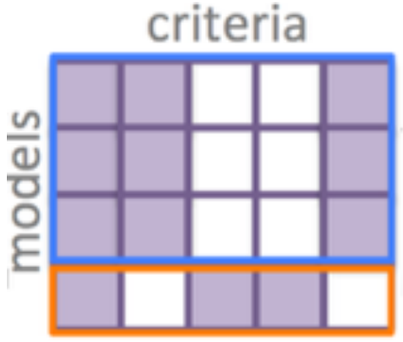
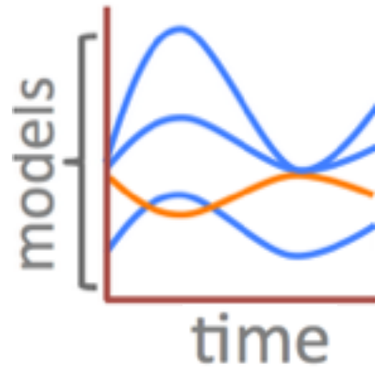


Binary Data

15 models

20-30 criteria

2^{30} possible groupings!

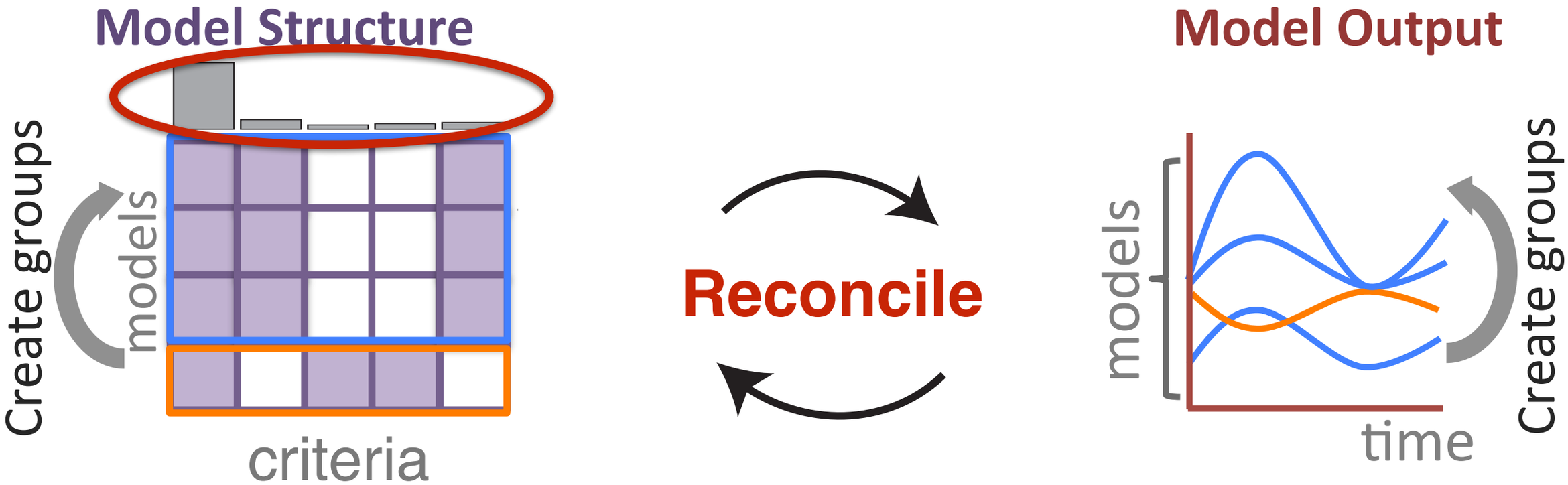


Time-varying Data

15 models

12 time steps

Many possible clusterings!

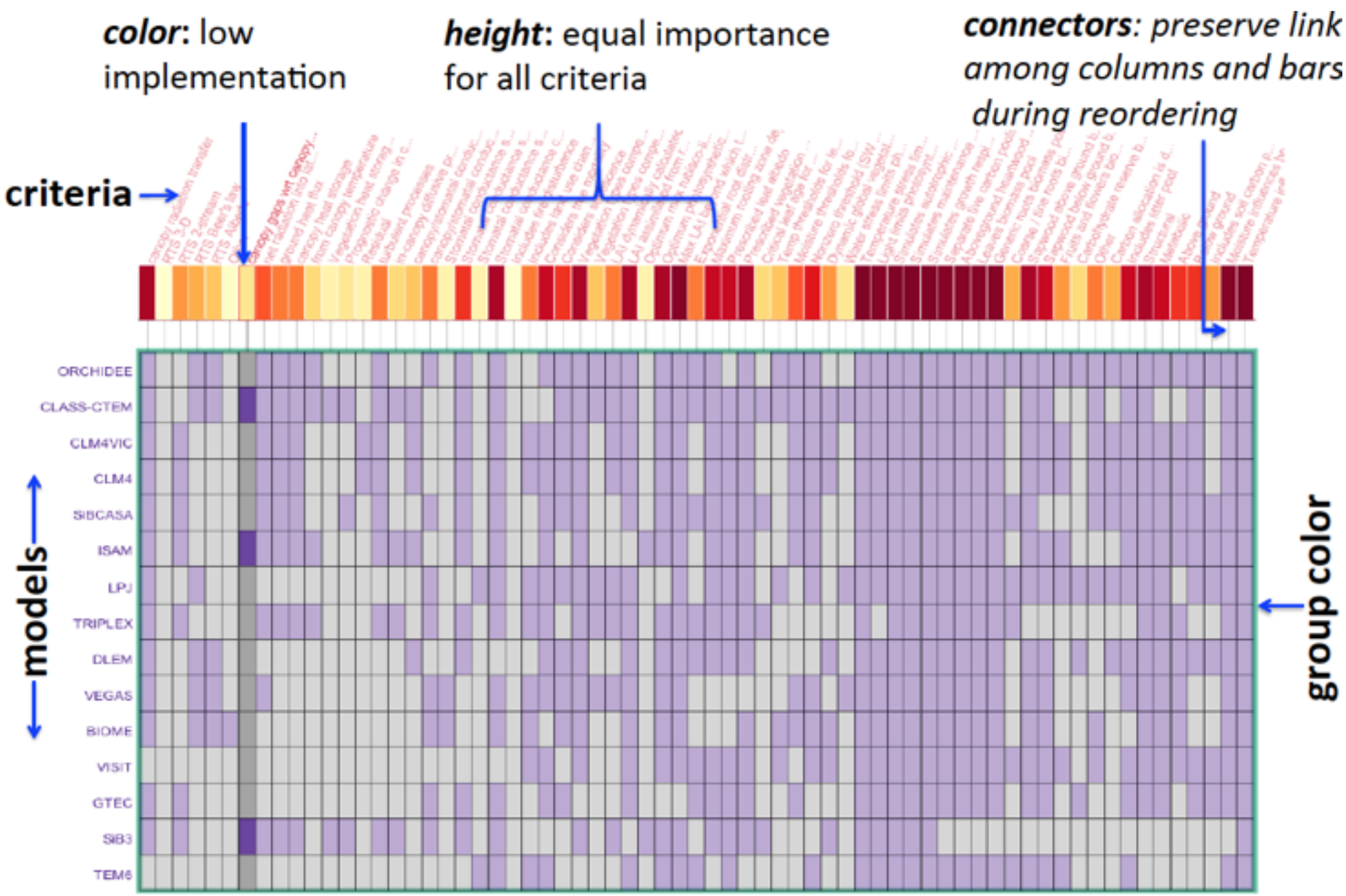


How does similarity in model structure affect model output?

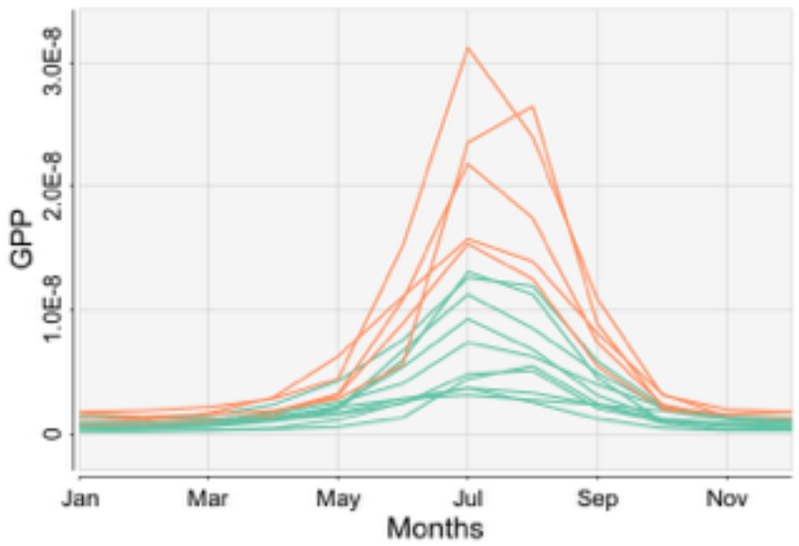
How does similarity in model output affect model structure?

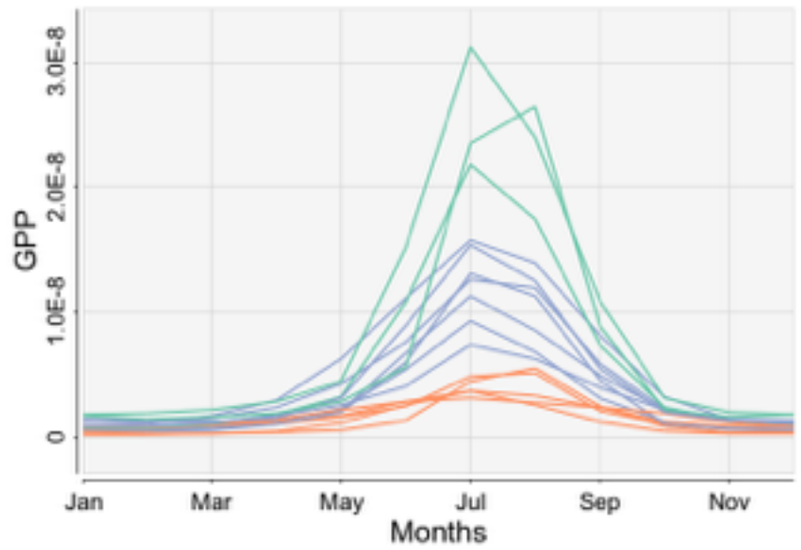
What is the importance of the different structural criteria in model similarity?

Matrix View

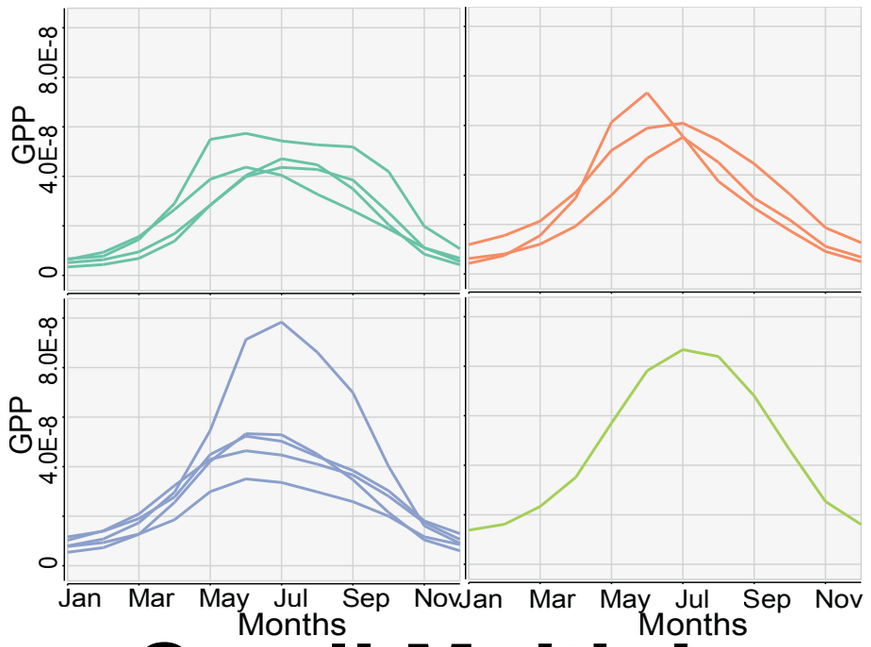

color: low implementation
height: equal importance for all criteria
connectors: preserve link among columns and bars during reordering
criteria
ORCHIDEE
CLASS-CTEM
CLM4VIC
CLM4
SIBCASA
ISAM
LPJ
TRIPLEX
DLEM
VEGAS
BIOME
VISIT
GTEC
SIB3
TEM6
models
group color

Time Series View





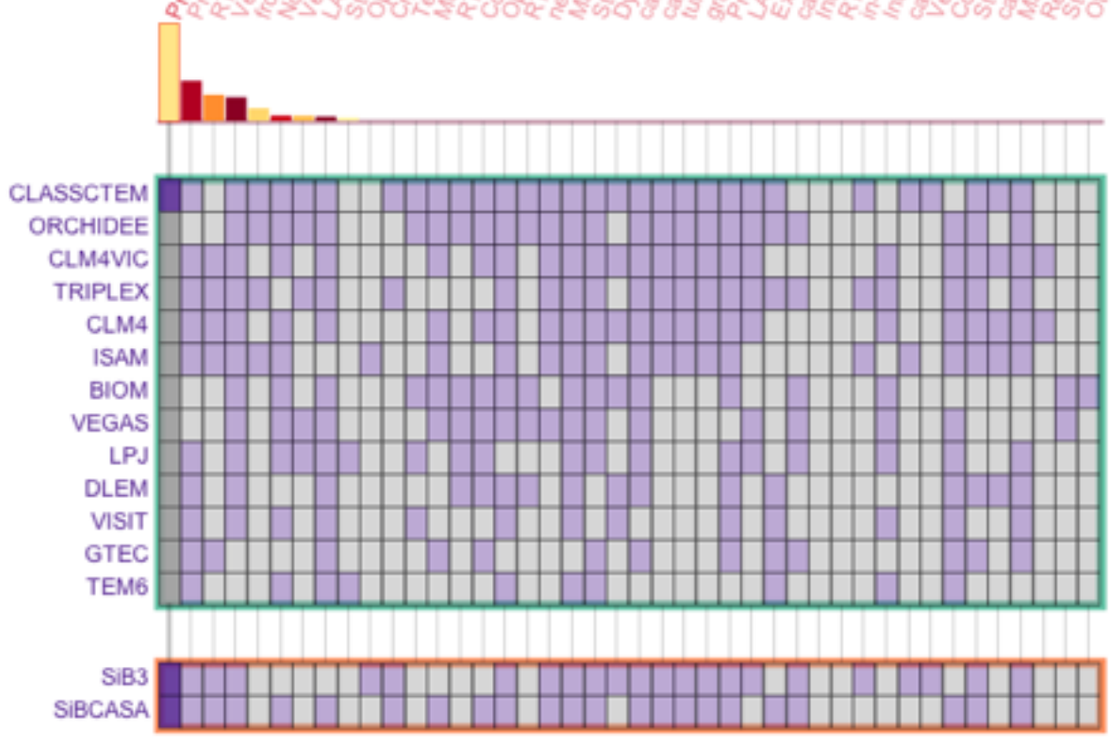
Alternative Clusterings



Small Multiples

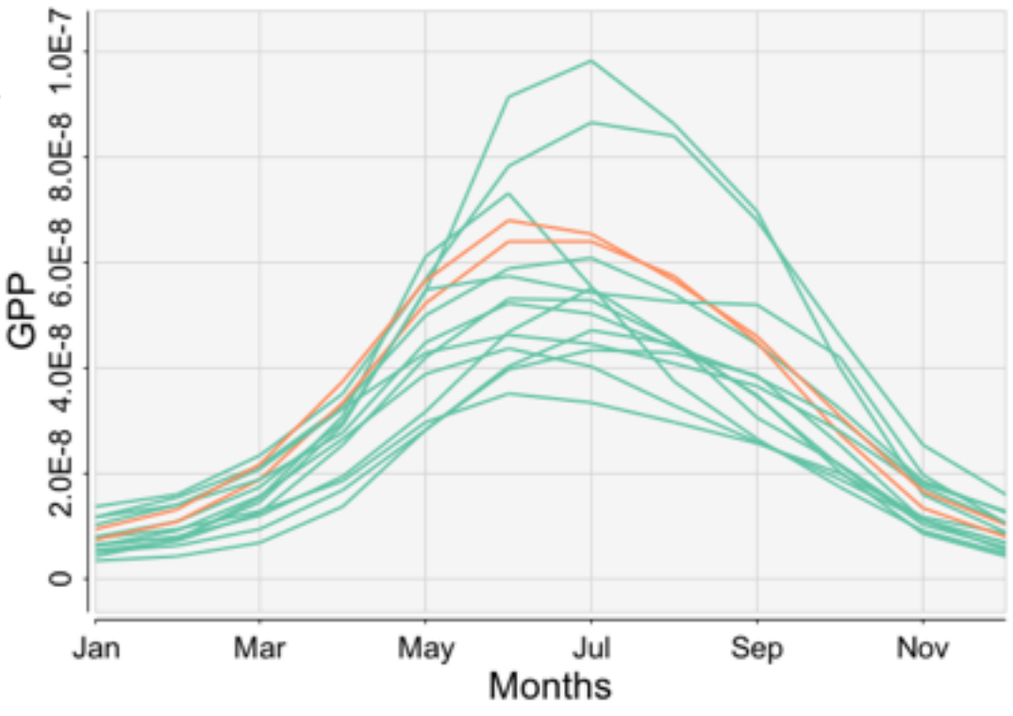
Optimization

$$v(x_i, x_j)^2 - \hat{d}(y_i, y_j)^2 \|^2$$



$$= 1$$

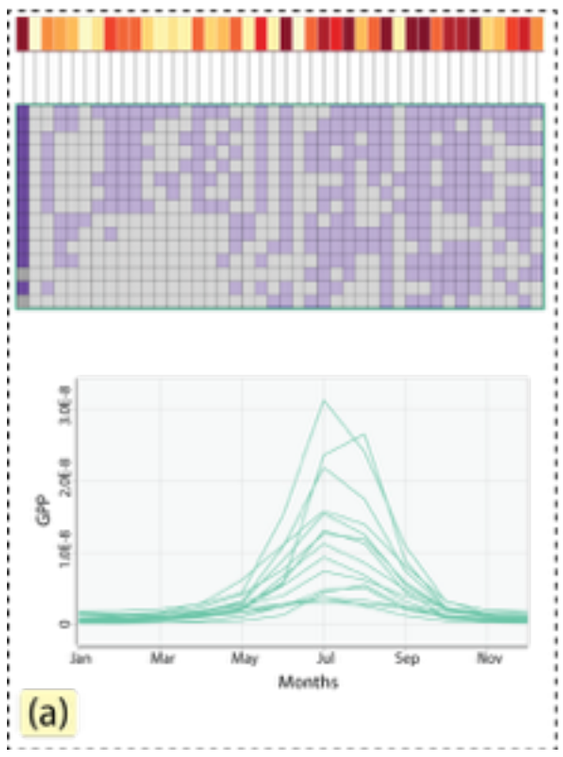
$$\tilde{d}^w$$



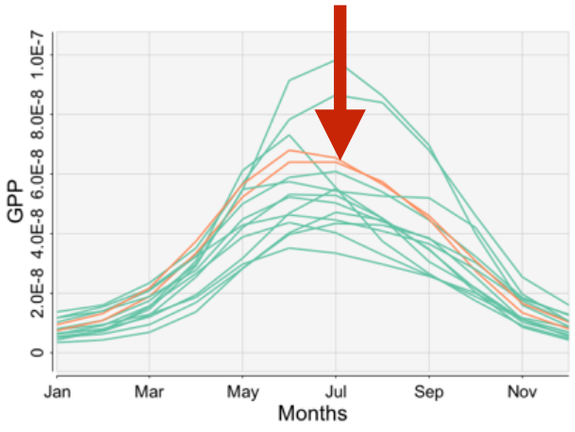
subject to $w_k \geq 0,\ k = 1, \ldots, q.$

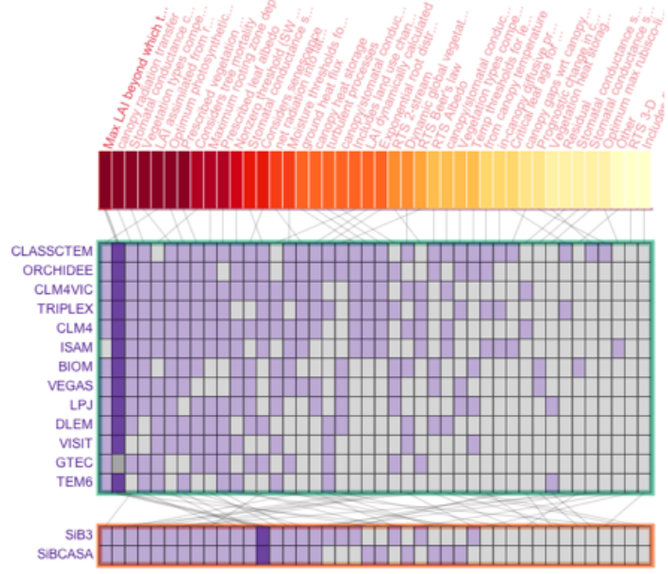
Interactions

Reconcile structure with output

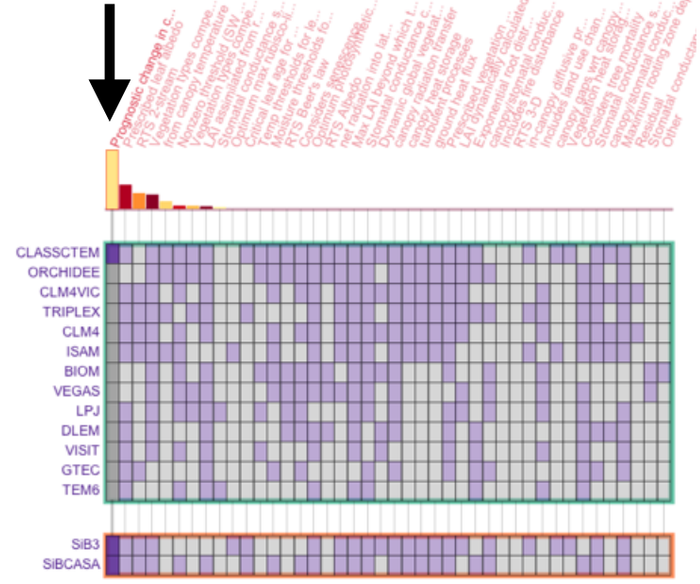


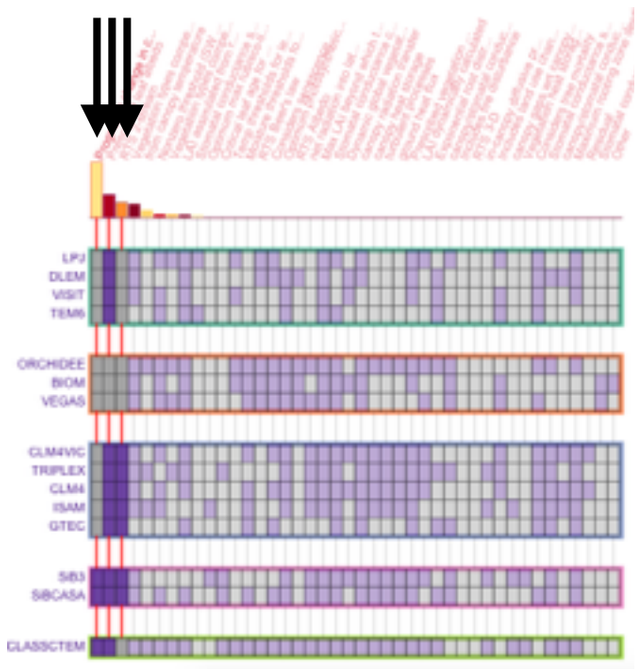
Reconcile output with structure



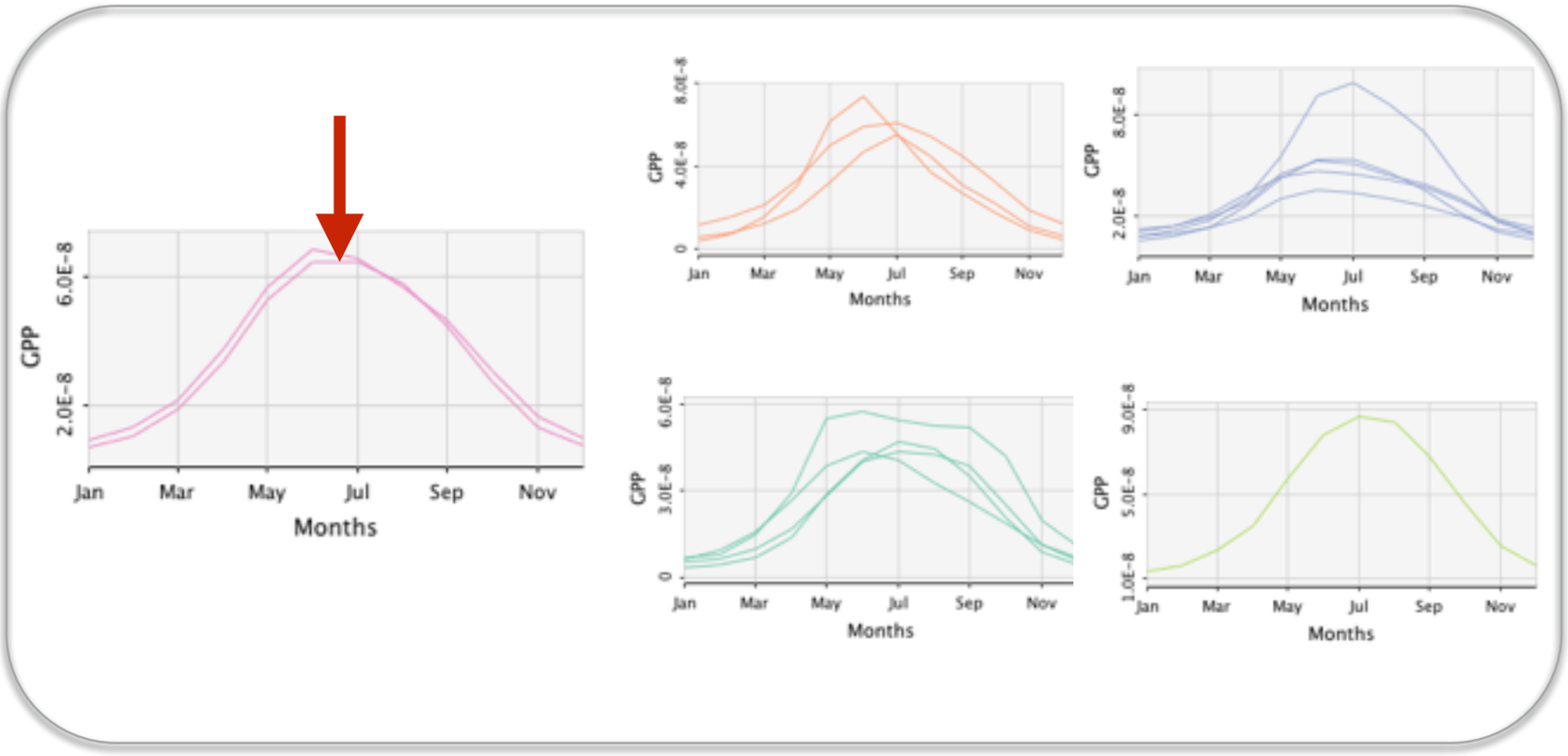


Optimize





Split



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Conclusion

- *Alternative similarity spaces are ubiquitous.* We focus on one application domain: climate modeling.

- We propose a *visual reconciliation technique* for binary data and time-varying data.

- Positive feedback from scientists

  “One of the most valuable functions of the technique is to effectively remove from consideration the complications created from model structures, that have little to no effect on outputs, and to effortlessly show and rank the differential effects on output created by seemingly related or unrelated model structures.”

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Thank You!

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Collaborators: Members of the Exploration, Visualization, and Analysis Working Group under DataONE.

http://vgc.poly.edu/projects/VisualReconciliation/

jpocom@nyu.edu
adasgupt@nyu.edu