

Multivariate Analysis in VisIt

Robert Sisneros

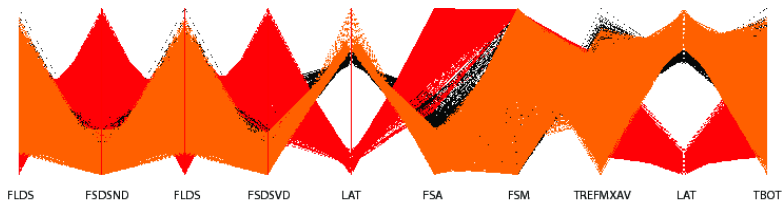
Oak Ridge National Lab

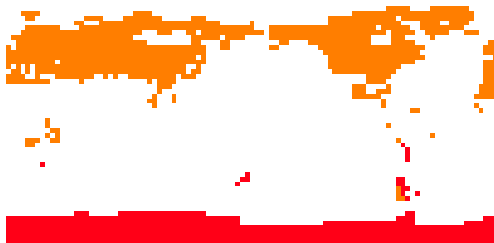
April 27, 2011

Goals

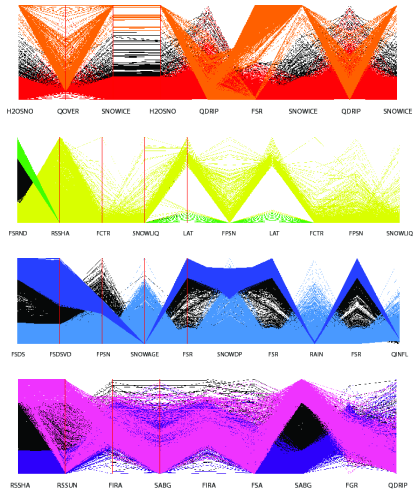
- ▶ Algorithmically visualize and understand multivariate data
 - ▶ Attributes
 - ▶ Interactions among attributes
- ▶ System for specifying high-dimensional models
 - ▶ General, unconstrained
 - ▶ Implemented as an operator in VisIt
- ▶ Address basic visualization problem: "What/how much can we show in visualizations?"

High-dimensional Rendering (Parallel Coordinates)

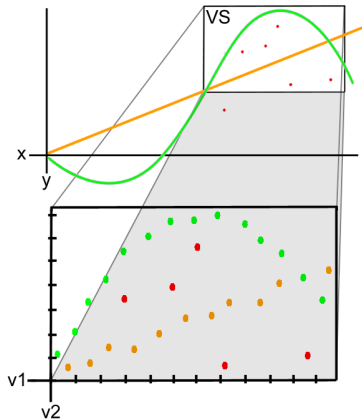




How Many High-Dimensional Relationships?







- ▶ Specifying models
 - ▶ Specified concurrently
 - ▶ Sets of high-dimensional points
 - ▶ From space created by selected variables
 - ▶ Each point classified by its distance to candidate models
- ▶ Calculating distances
 - ▶ Distances calculated from data point to nearest model specification point
 - ▶ Different metrics
 - ▶ Different spaces

GUI

Specify Models

Variables	hydroxyl_ra...	stoichiomet...
Timesteps	Current	Current
Point 1	0	.42

Select Calculation Space:

☐ Variable ☒ 0-1 ☐ log ☐ Probability

Distance Selections:

☒ Euclidean ☐ Manhattan ☐ Maximum ☐ Minkowski ☐ Canberra

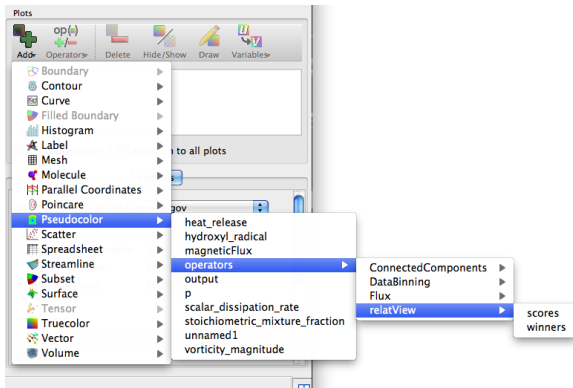
Normalizing Scores:

☐ None ☐ Individual Models ☒ All Models

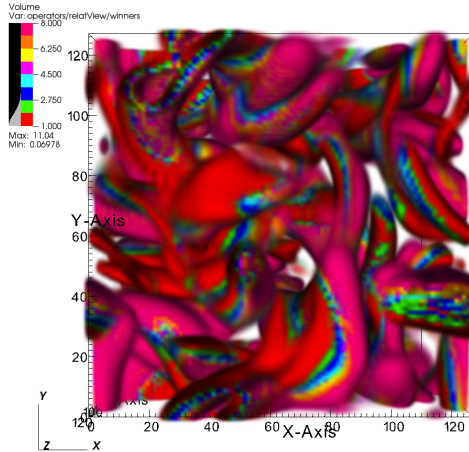
Output

- ▶ At each spatial location:
 - ▶ Model ID with minimal distance
 - ▶ Distance
- ▶ Operators creating new variables in VisIt?

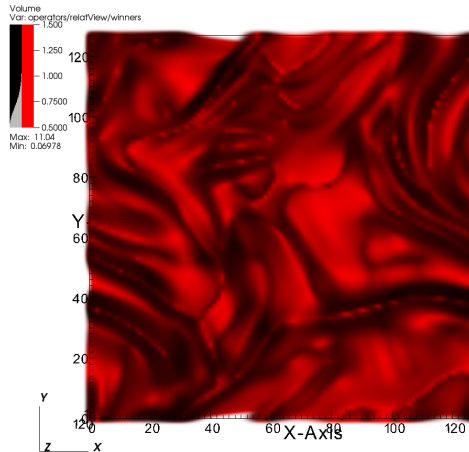
Yes!



Multiple Attributes



Simple Models

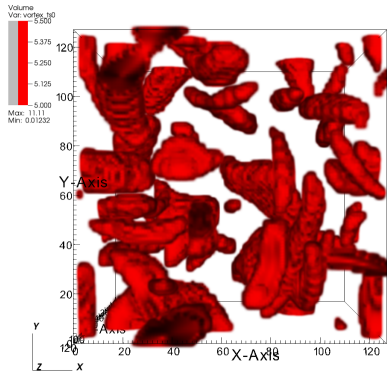
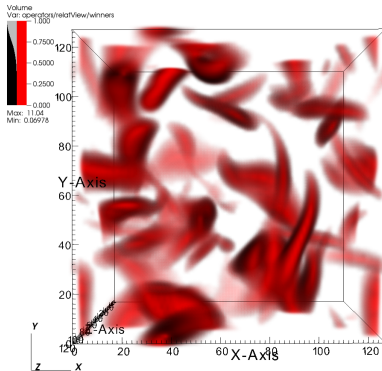


The Specification

Specify Models

Variables	vortex_ts0	vortex_ts1
Timesteps	Current	Current
Point 1	0	0
Point 2	1	1
Point 3	2	2
Point 4	3	3
Point 5	4	4
Point 6	5	5
Point 7	6	6
Point 8	7	7
Point 9	8	8
Point 10	9	9
Point 11	10	10
Point 12	11	11

Using Scores

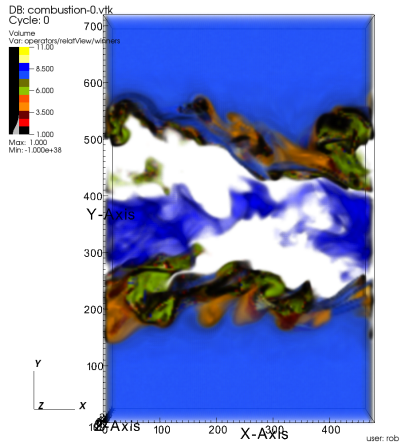
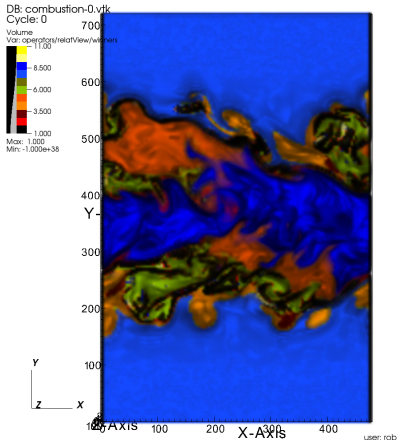


Complex Models: The Specification

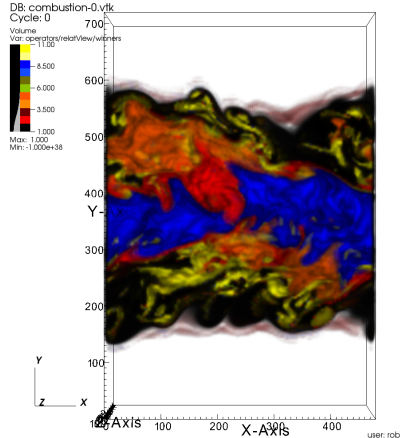
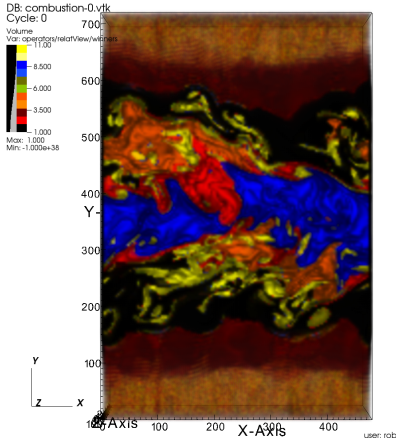
Specify Models

Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...
Timesteps	Current	Current	Current	Current	Current
Point 1	a	a	a	a	a
Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...
Timesteps	Current	Current	Current	Current	Current
Point 1	m	a	a	a	a
Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...
Timesteps	Current	Current	Current	Current	Current
Point 1	M	a	a	a	a
Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...
Timesteps	Current	Current	Current	Current	Current
Point 1	a	m	a	a	a
Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...
Timesteps	Current	Current	Current	Current	Current
Point 1	a	M	a	a	a
Variables	heat_release	hydroxyl_ra...	scalar_dissi...	stoichiomet...	vorticity_m...

Complex Models



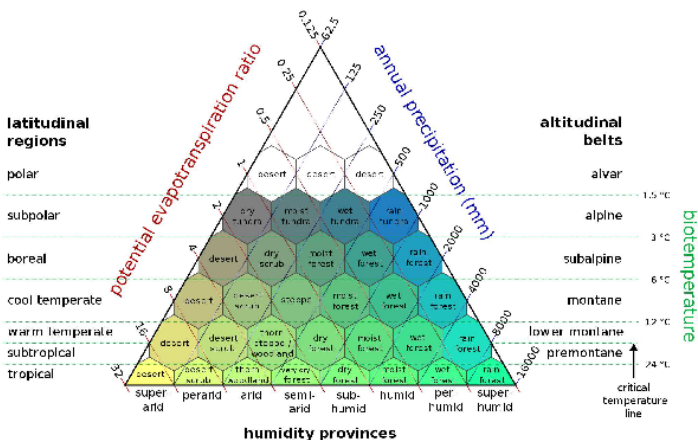
Complex Models: Probability Space



Climate Change via Holdridge Life Zones

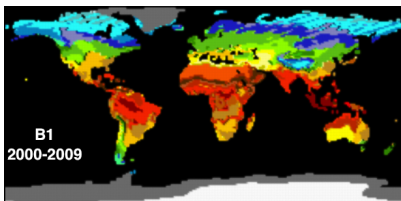
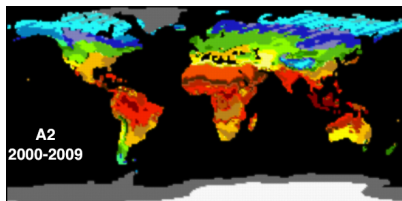
- ▶ System for classification of land areas based on atmospheric conditions
- ▶ Used to analyze vegetation pattern alterations due to global warming
- ▶ Specification as 3-dimensional models ideal for visualization approach

Canonical Representation of Life Zones

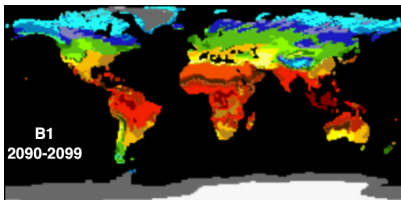
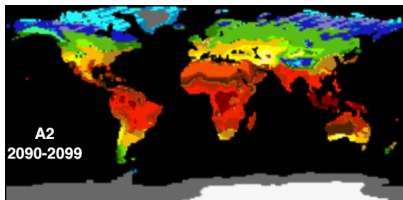


- ▶ Two different emission scenarios of CCSM 3 climate simulation data (2000-2099)
- ▶ A2
 - ▶ High global emissions
 - ▶ Continuously increasing population
 - ▶ Slow technological change
- ▶ B1
 - ▶ Low global emissions
 - ▶ Population peaks at 2050 then declines
 - ▶ Introduction of clean and resource-efficient technologies
- ▶ Data averaged into first (2000-2009) and last (2090-2099) decade

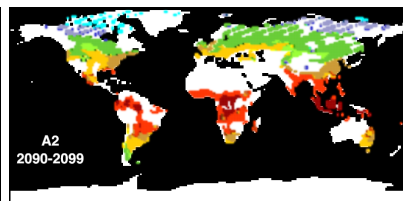
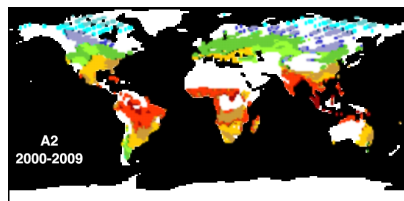
The First Decade



The Last Decade



Should I Move?



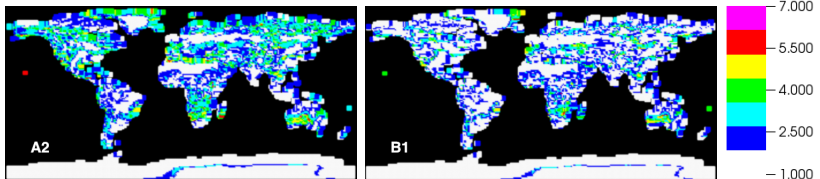
Future Work

- ▶ System upgrades
 - ▶ Temporal analysis
 - ▶ Save subspaces vs. rendering subspaces
 - ▶ "Pick" mode
- ▶ Application to Astrophysics simulation data

To Models: Definitions

- ▶ Interactions formally identifiable as a set where collections of predicates are true
 - ▶ E.g. $x|P(x)$, predicate may be $x > 4$
- ▶ Build hypothetical predictive models
 - ▶ Representation for any data point
 - ▶ Use models for classification
- ▶ Approach similar to model-based clustering

Persistence Metric



Magnitude of Change Metric

