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The University of Texas at Austin

Introduction to Scientific Visualization

PRESENTED BY:
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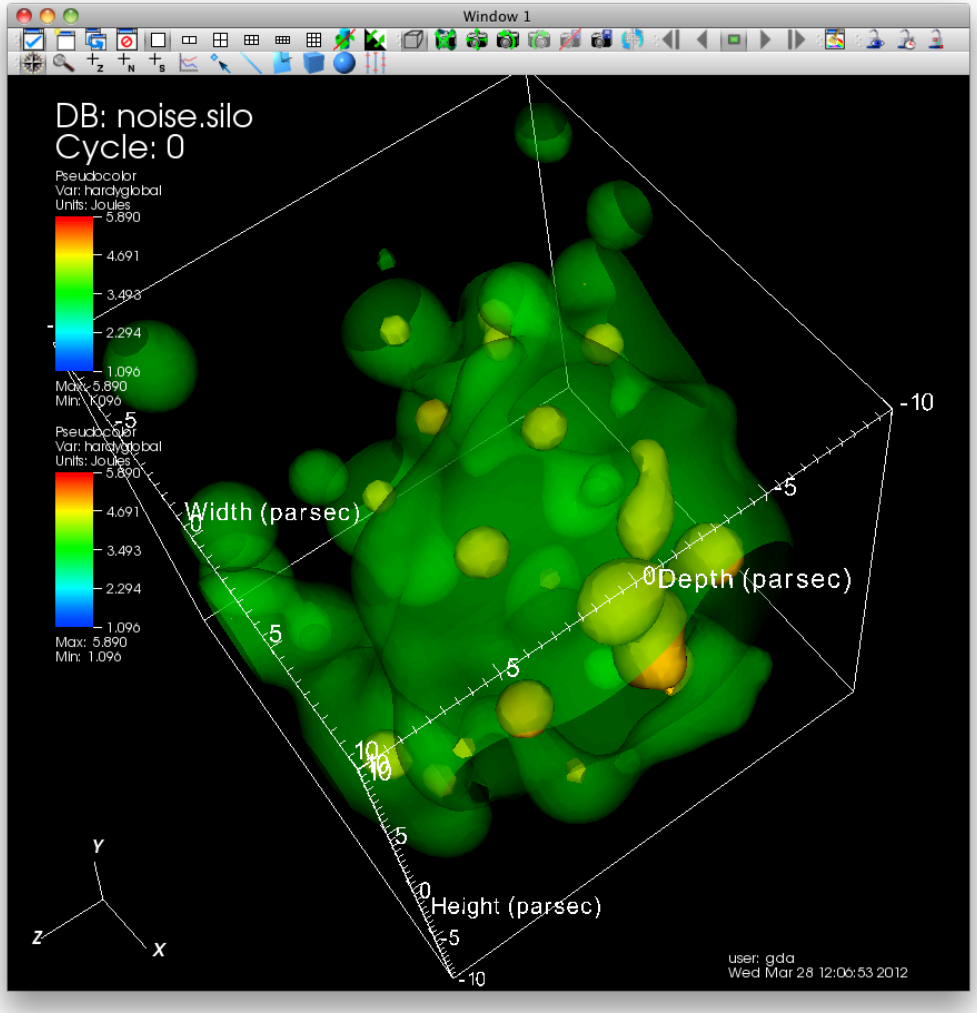
Belaboring The Point

A picture can represent *giga-, tera- and peta-bytes of data that is otherwise incomprehensible*

Belaboring The Point



Attributes

F(domain) → attributes

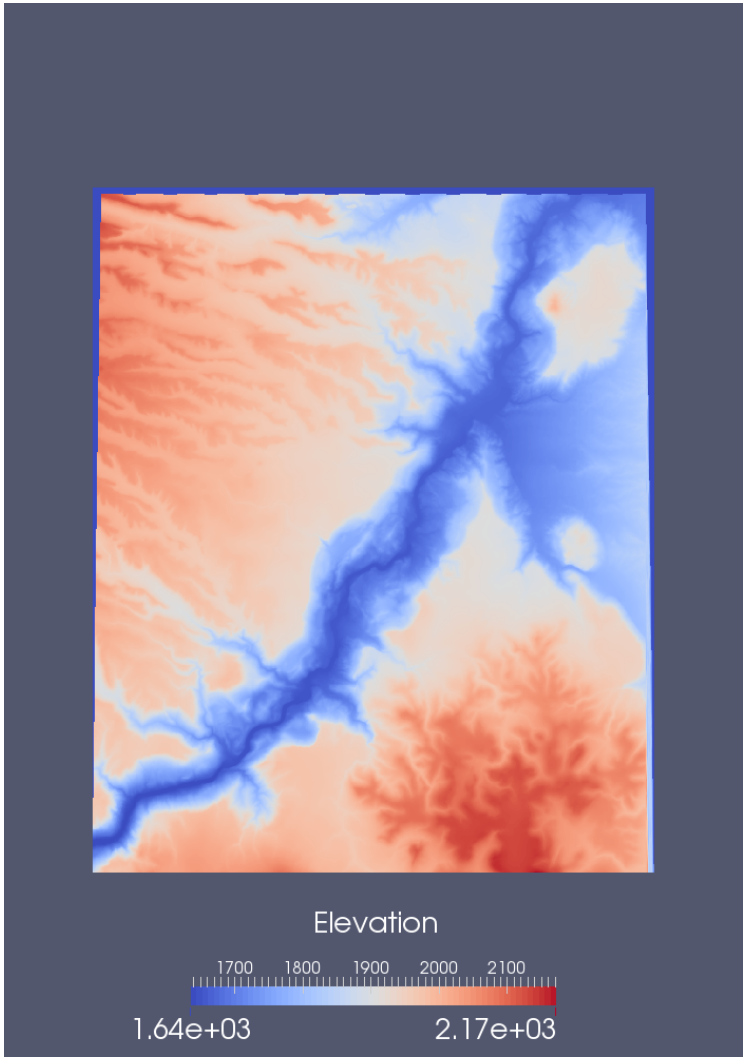
- Attributes are physical properties often represented as:
  - Scalars (e.g. temperature)
  - Vectors (e.g. wind direction)
- Lots of ways to visualize attributes

Attribute Visualization

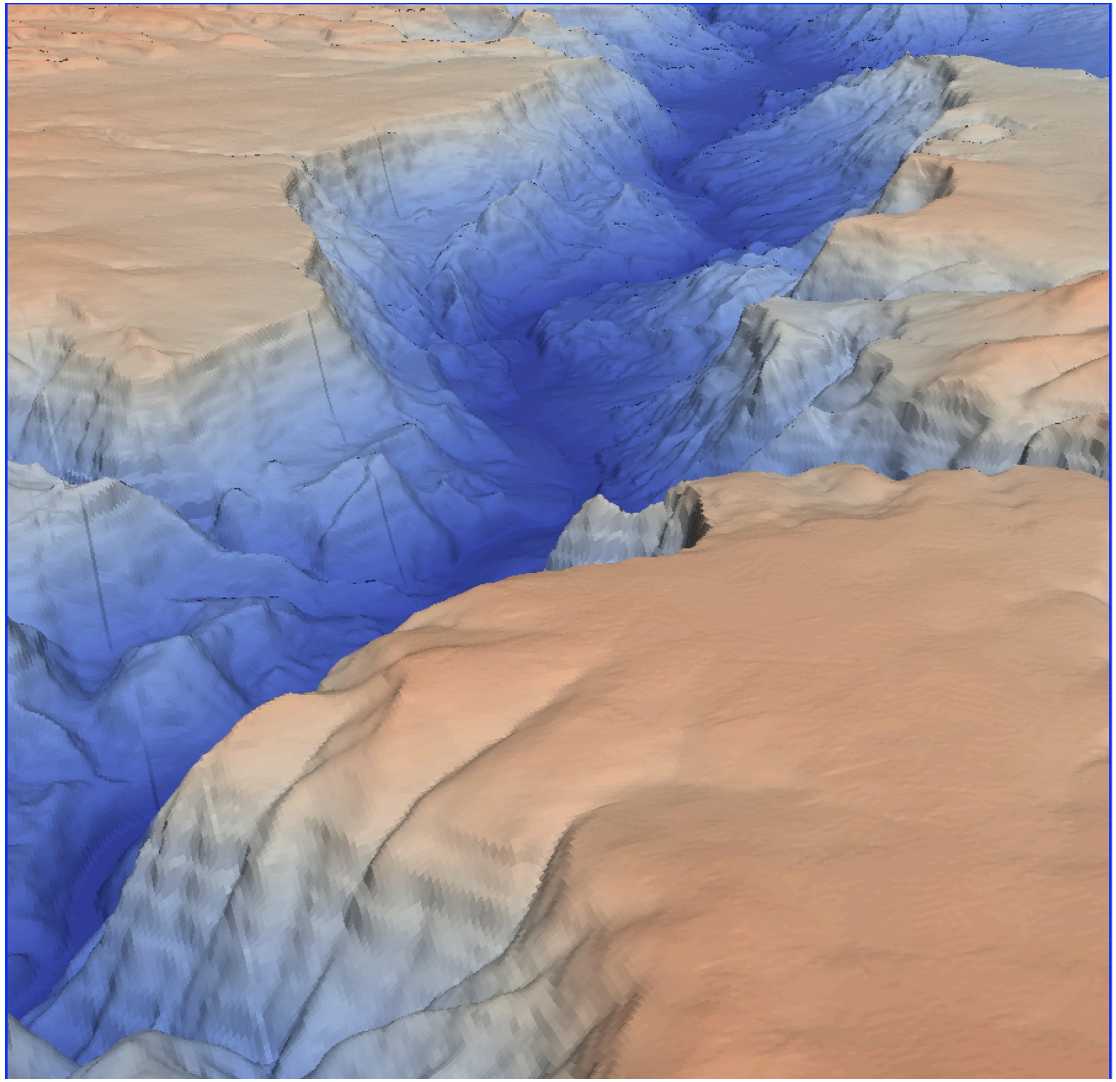
2-D Example : Terrain Elevation

F(lat,long) → elevation

- Elevation is interpreted as color
- Extra points for identifying the locale



Attribute Visualization - 3D Terrain Elevation

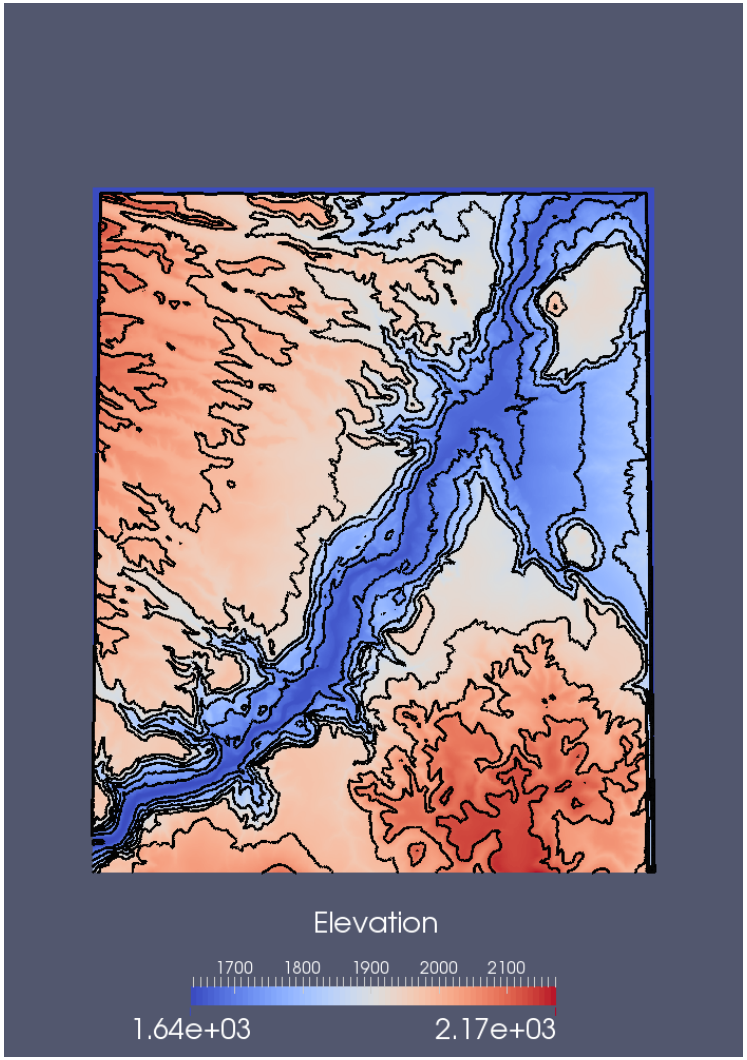


Attribute Visualization

2-D Example : Terrain Elevation

F(lat,long) → elevation

Insert contour lines to create topographic map



Attribute Visualization

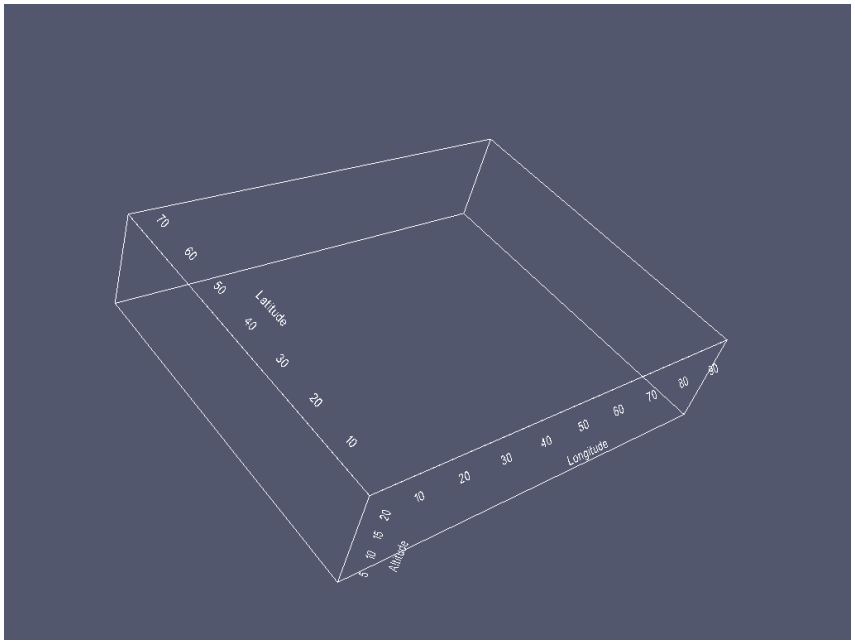
3-D Example: Weather

F(lat, lon, *alt*) →

(temp, pressure, wind…)

temp, pressure are *scalars*

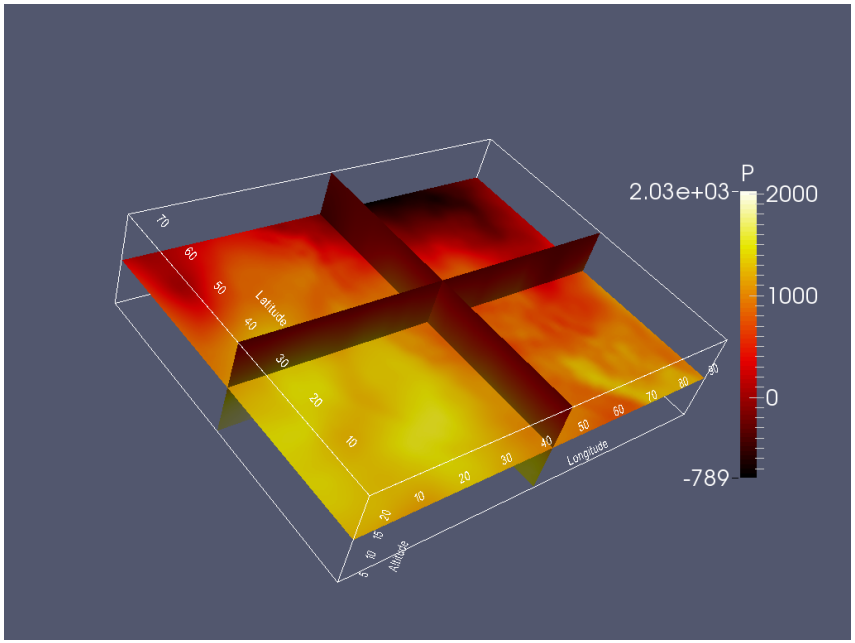
wind is a *vector*



Attribute Visualization

3-D Example: Scalars

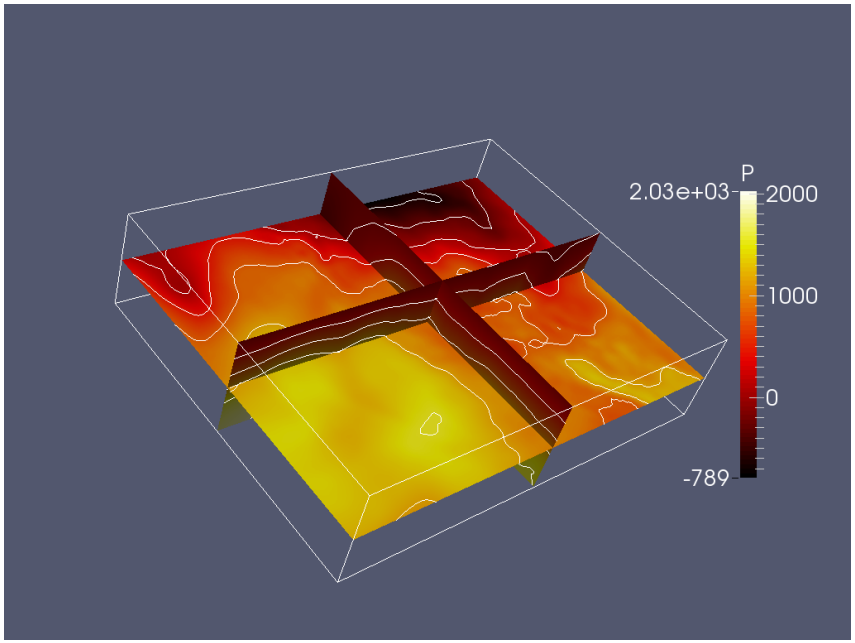
Intersect domain with 3 planes, map pressure as color



Attribute Visualization

3-D Example: Scalars

Contour planes

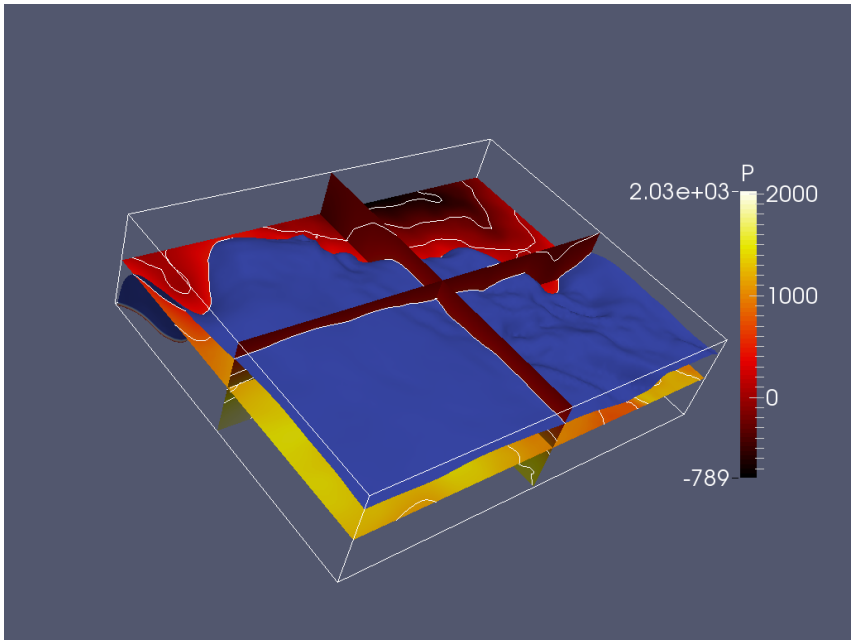


Attribute Visualization

3-D Example: Scalars

Contour planes

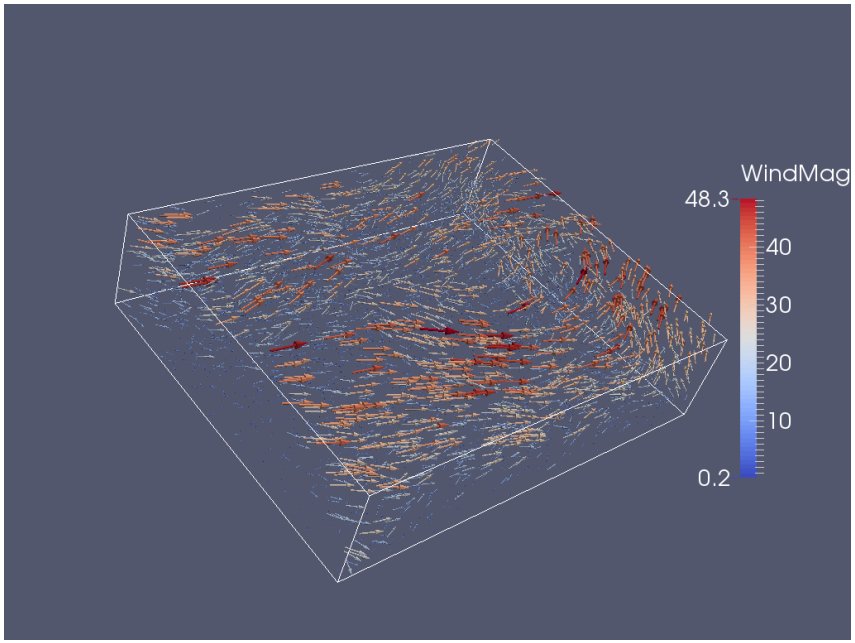
Contour in the 3D domain



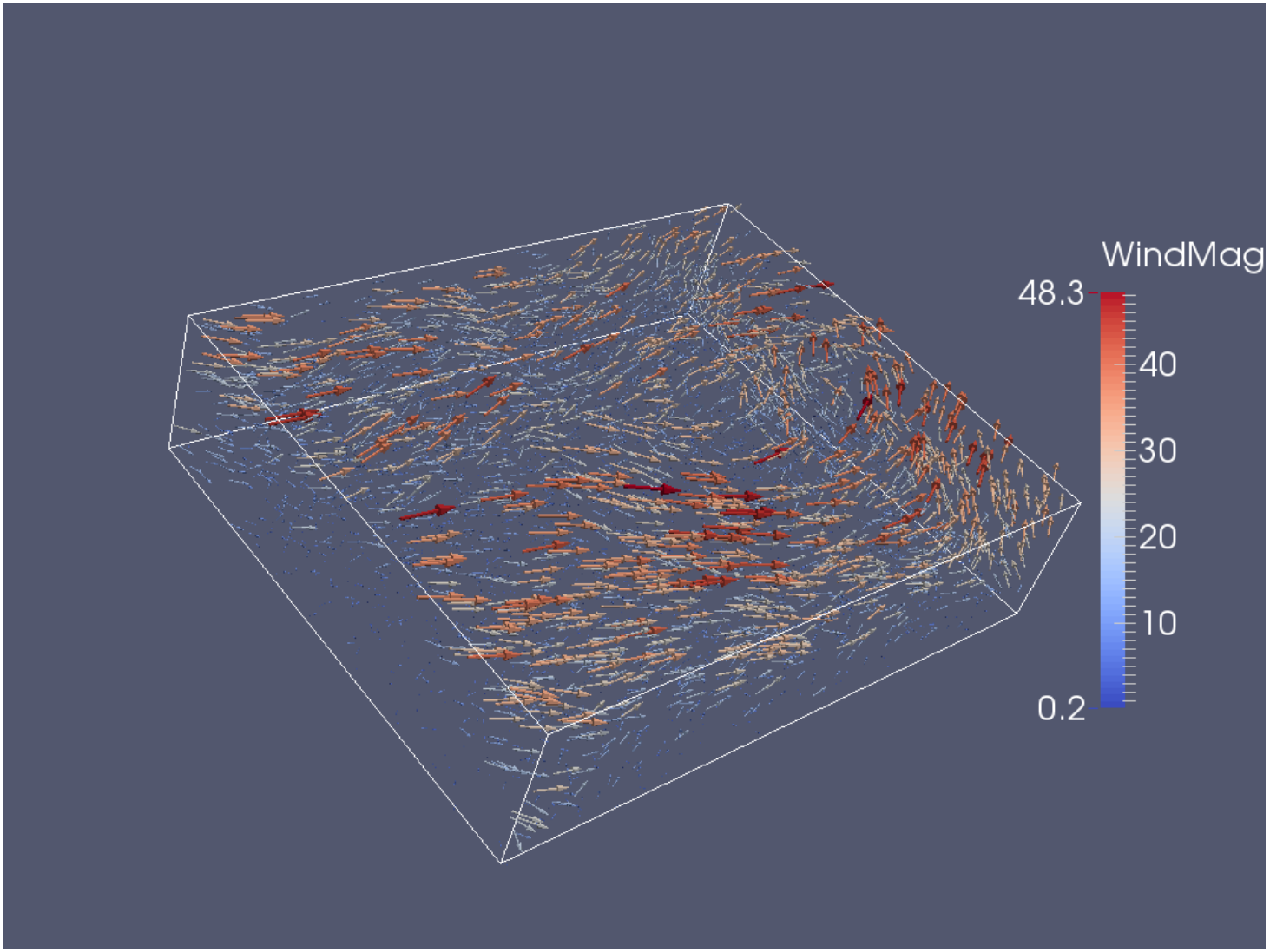
Attribute Visualization

3-D Example: Vectors

Choose a bunch of starting points, drop a bunch of massless soap bubbles and follow their paths - *Streamlines*



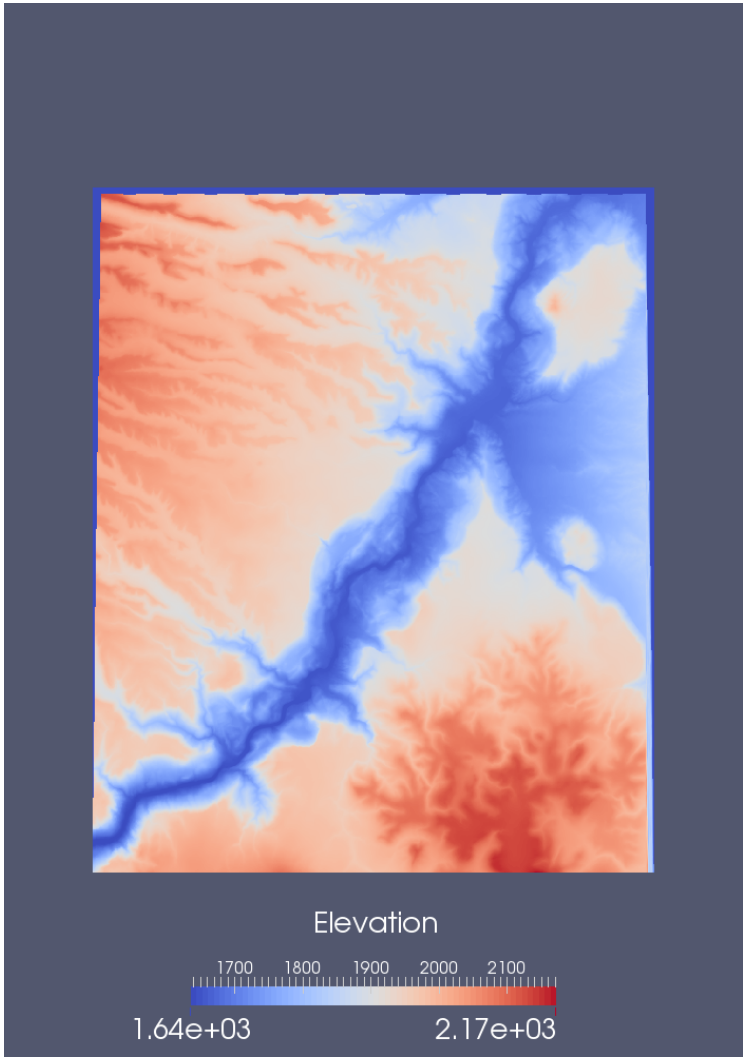
Attribute Visualization



Scientific Data Representation

Data is given explicitly at a set of sample points

Attributes (e.g. elevation) can be associated with each sample point



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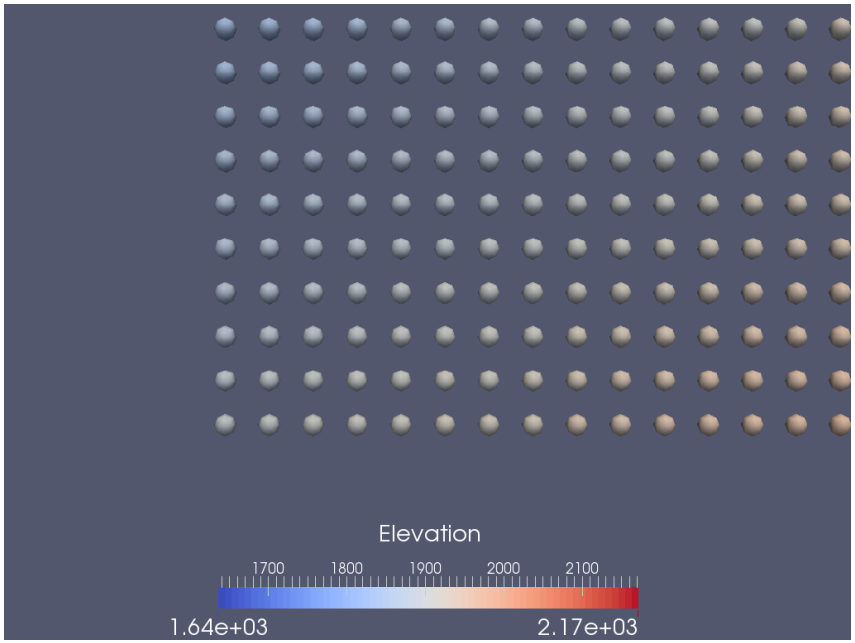

Scientific Data Representation

Looking *very* closely at bottom left (full data is 1147x1401)

Data is given explicitly at a set of sample points

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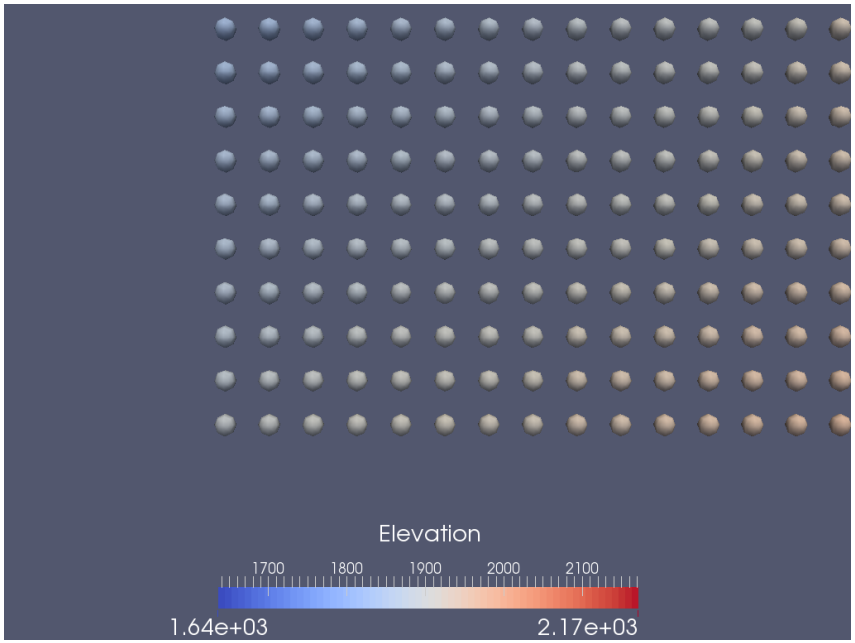


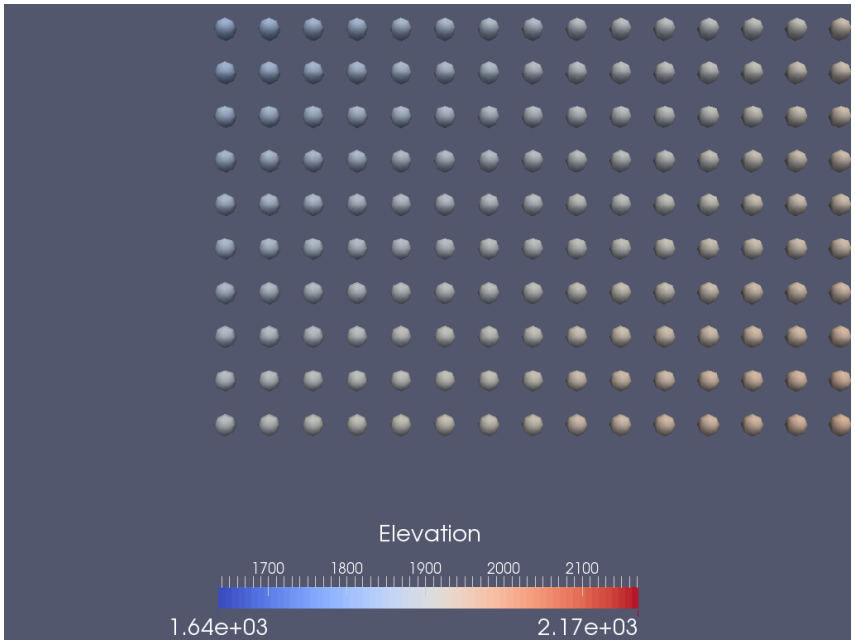
Scientific Data Representation

Looking *very* closely at bottom left (full data is 1147x1401)

Cells define how points are associated for interpolation

Here, quadrilaterals

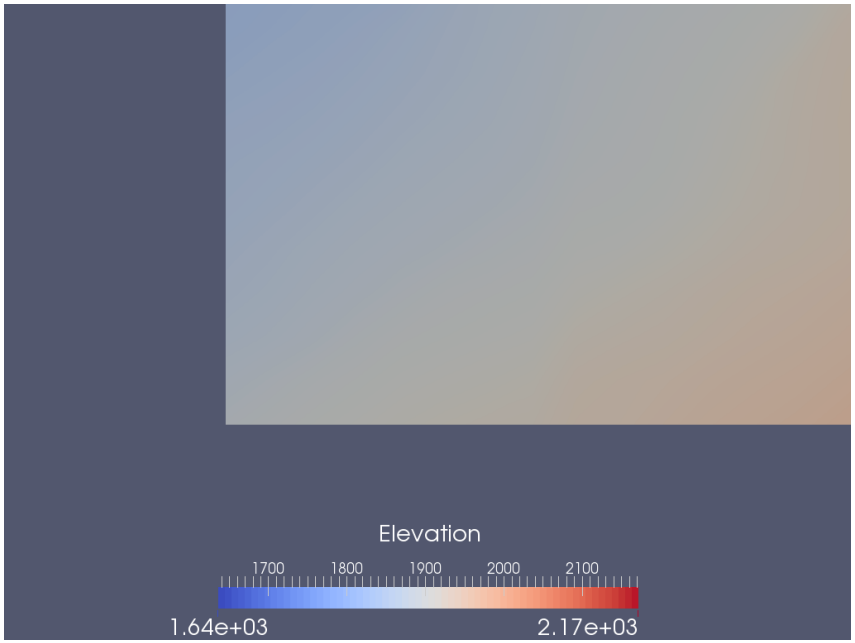
Attributes (e.g. elevation) can be associated with each sample point



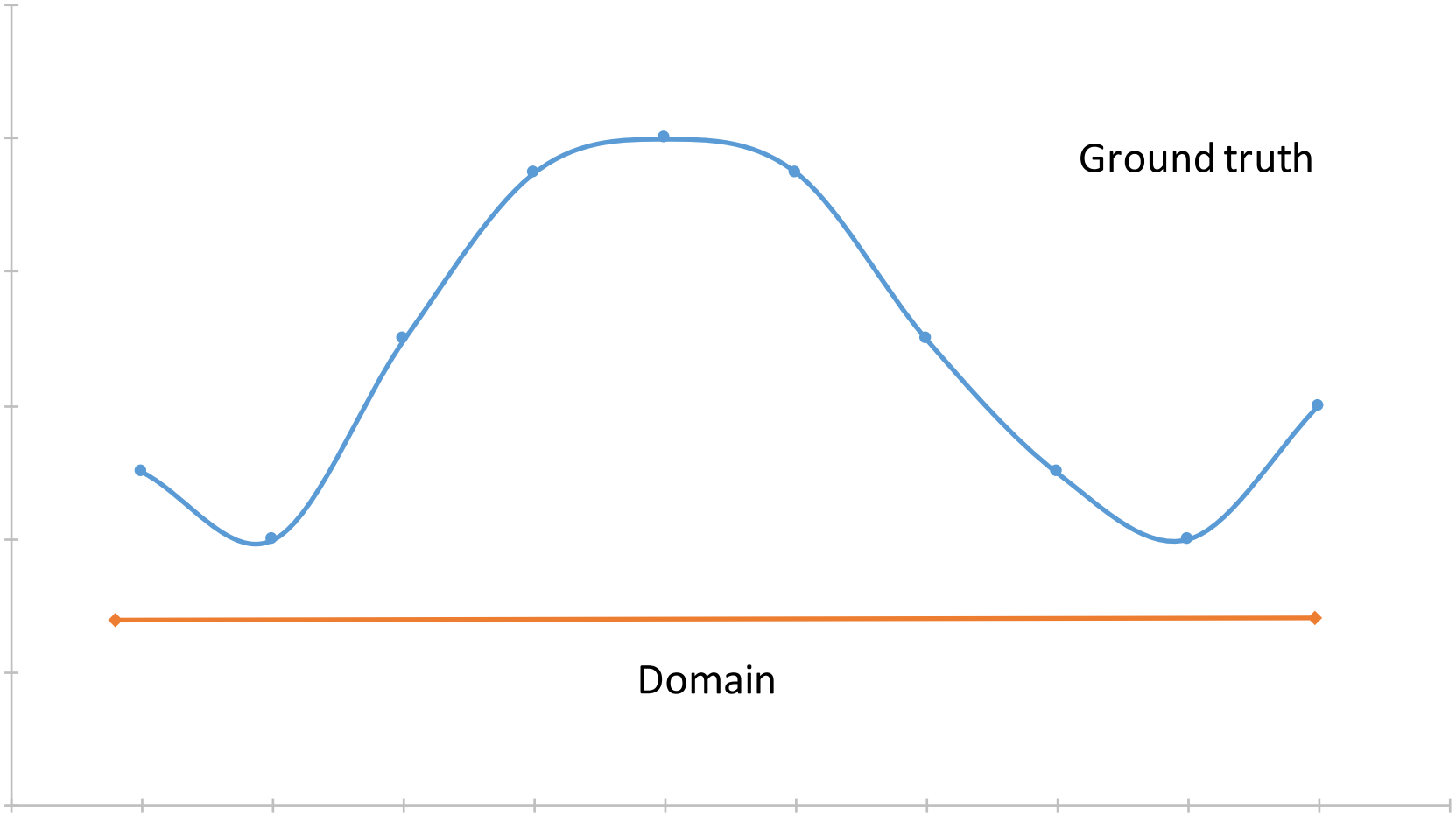
Scientific Data Representation

Looking *very* closely at bottom left (full data is 1147x1401)

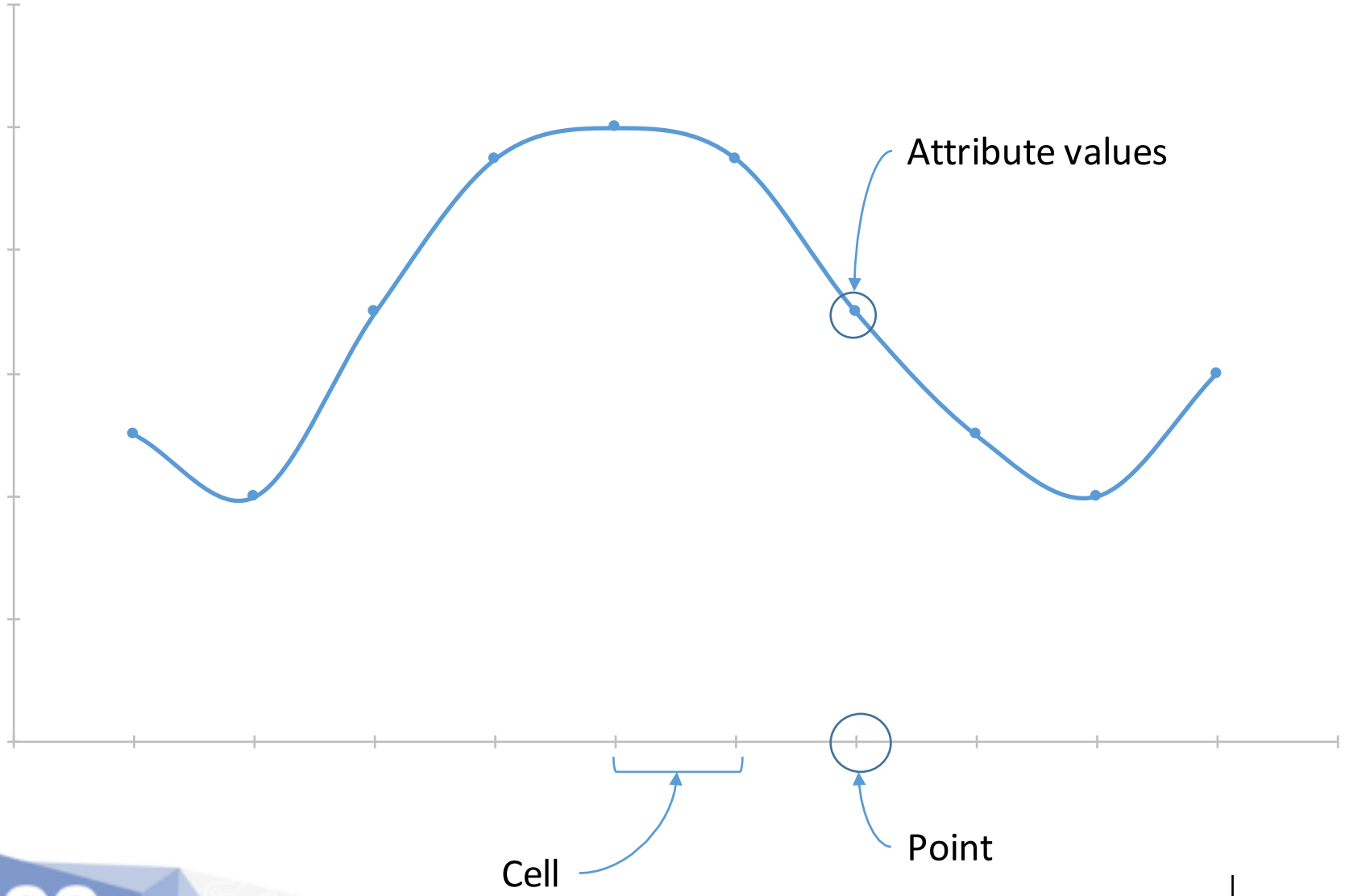
Points and cells allow the function to be approximated anywhere in the domain by interpolation



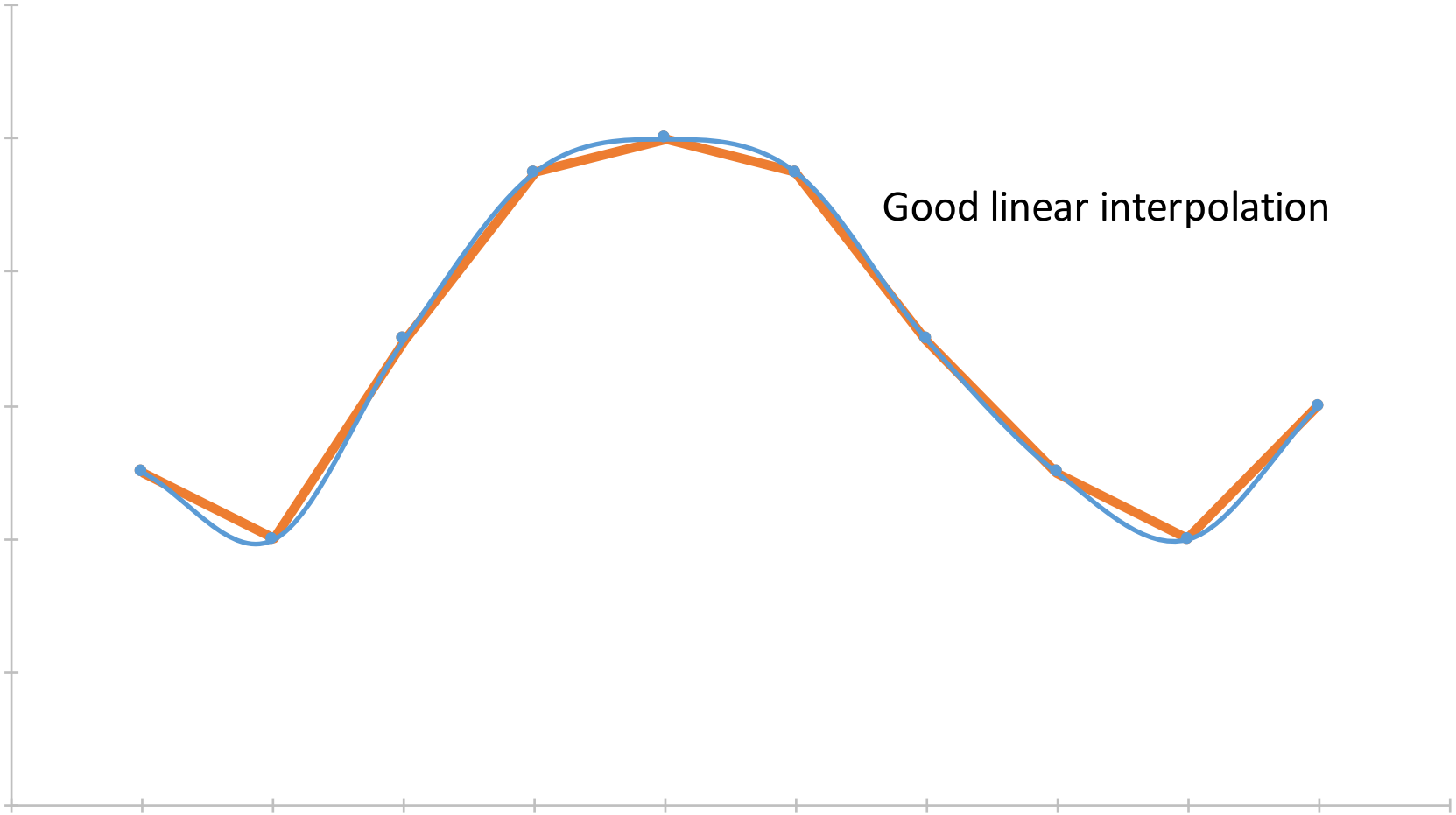
Interpolation



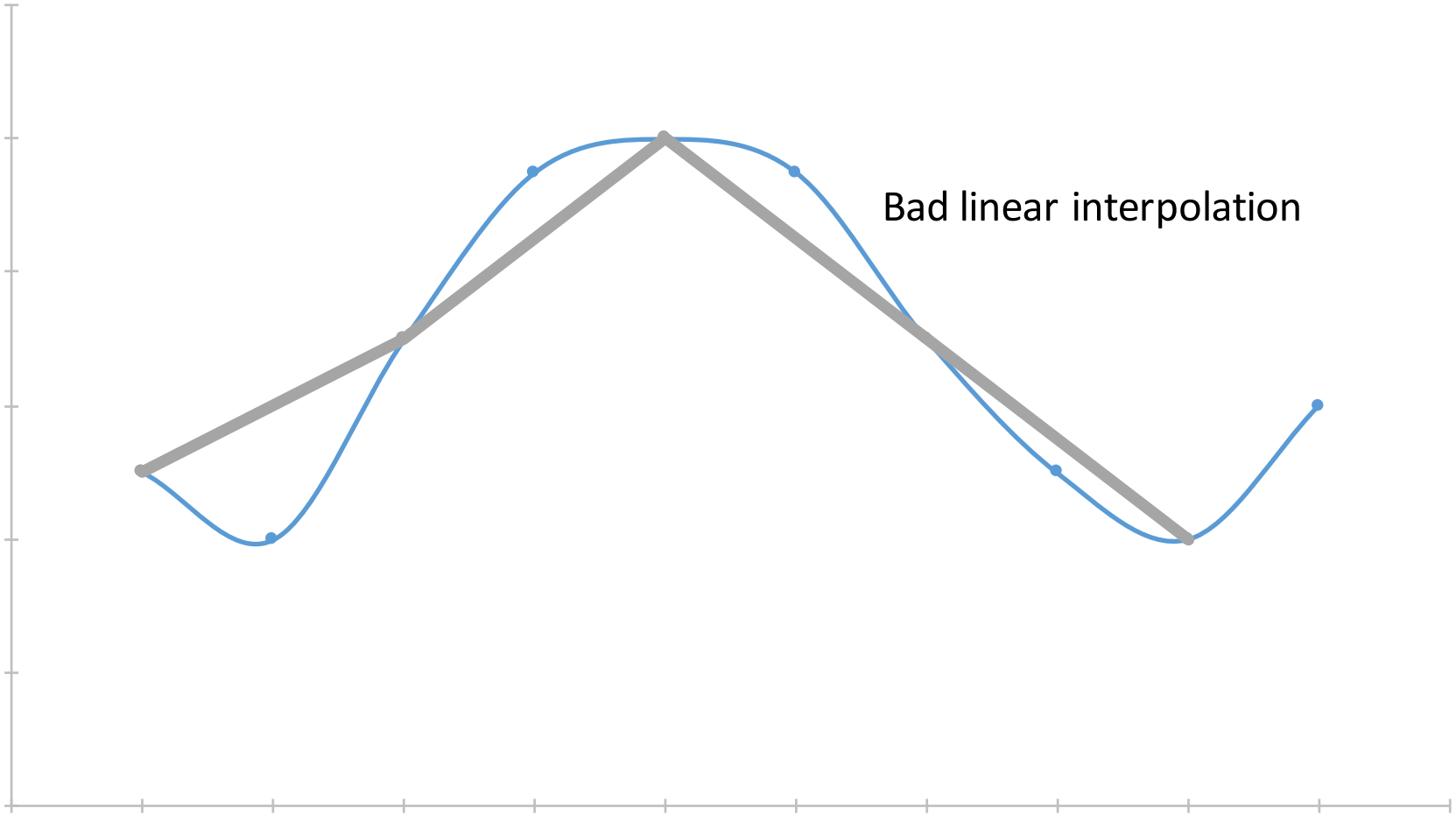
Interpolation



Interpolation



Interpolation



Interpolation

Visualization inherits grid from upstream source in a workflow

Upstream source may use higher order interpolation on grid, so accuracy may be lost

Some visualization apps support *some* higher order interpolation *(but possibly incompletely)*

Grid Points (Vertices)

1, 2, 3 … D

Explicit or compact:

X0	Y0	Z0
X1	Y1	Z1
X2	Y2	Z2
	….	
Xn	Yn	Zn

Origin	0	0	0
Deltas	1	1	1
Counts	Nx	Ny	Nz

… Delta vectors may not be orthogonal

Grid Cells (Elements)

References grid points

Lots of element types

- 0D points
- 1D line segments
- 2D triangles, quadrilaterals, …
- 3D tetrahedra, hexahedra, …

Again, explicit or compact (line segs, quads, hexes)

P0	Q0	P0
P1	Q1	R1
P2	Q2	R2
	….	
Pn	Qn	Rn

or cell counts along each dimension

Grid Types

Cartesian if points are arranged with unit steps along the orthogonal axes and cells are topologically regular

Regular if points are arranged along the axis with non-unit but equal step size along the orthogonal axes and cells are topologically regular

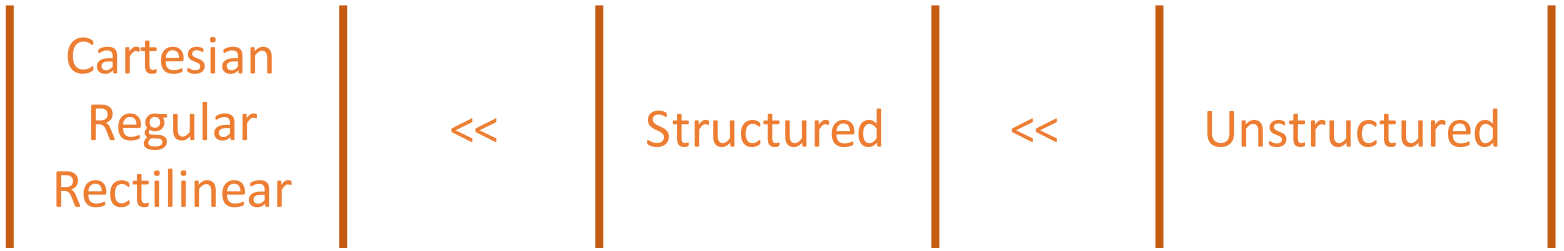
Rectilinear if points are spaced differently along each orthogonal axis and cells are topologically regular

Grid Types

Structured (Curvilinear) if points are explicitly listed but cells remain topologically regular

Unstructured if both points and cells are explicitly listed

Grid Considerations



Structured and unstructured grids:

- use *much, much* more space and compute
- allow you to use finer sampling where stuff is happening and coarse sampling where nothing much is going on

Time Varying Data

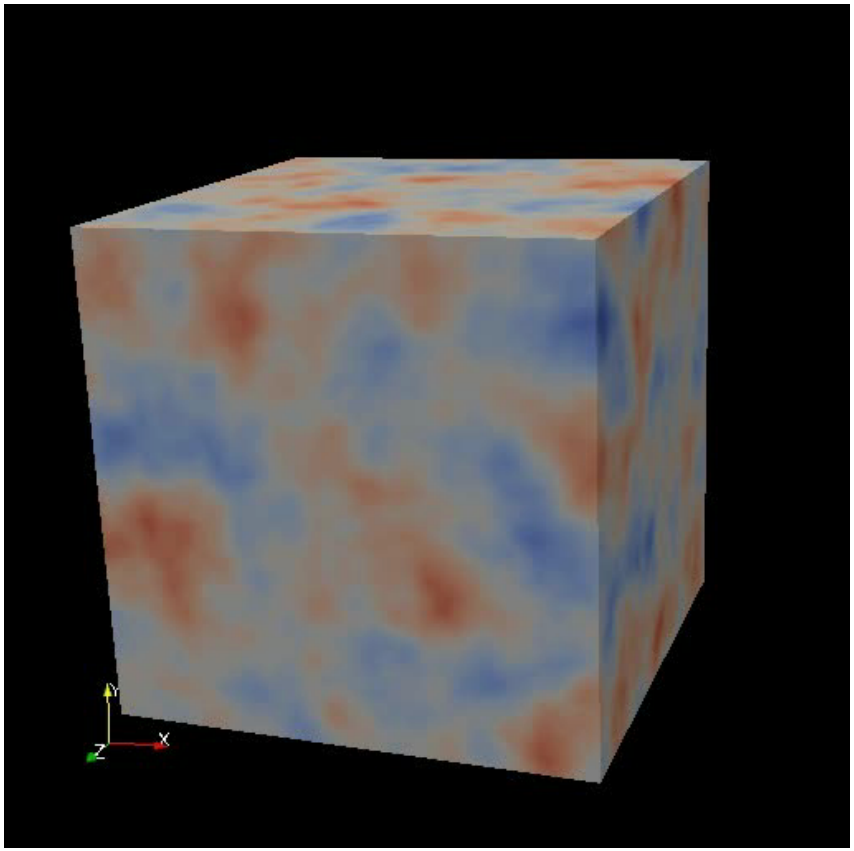
For example, *h*eat *transfer*:

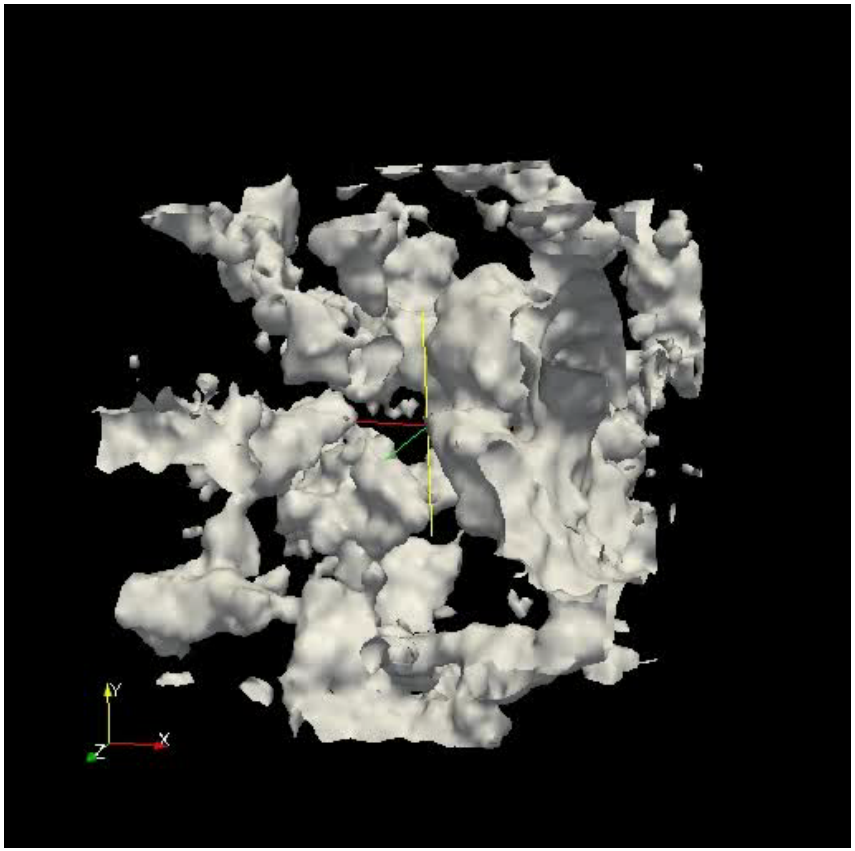
F(x,y,z,t) -> temperature

Time series

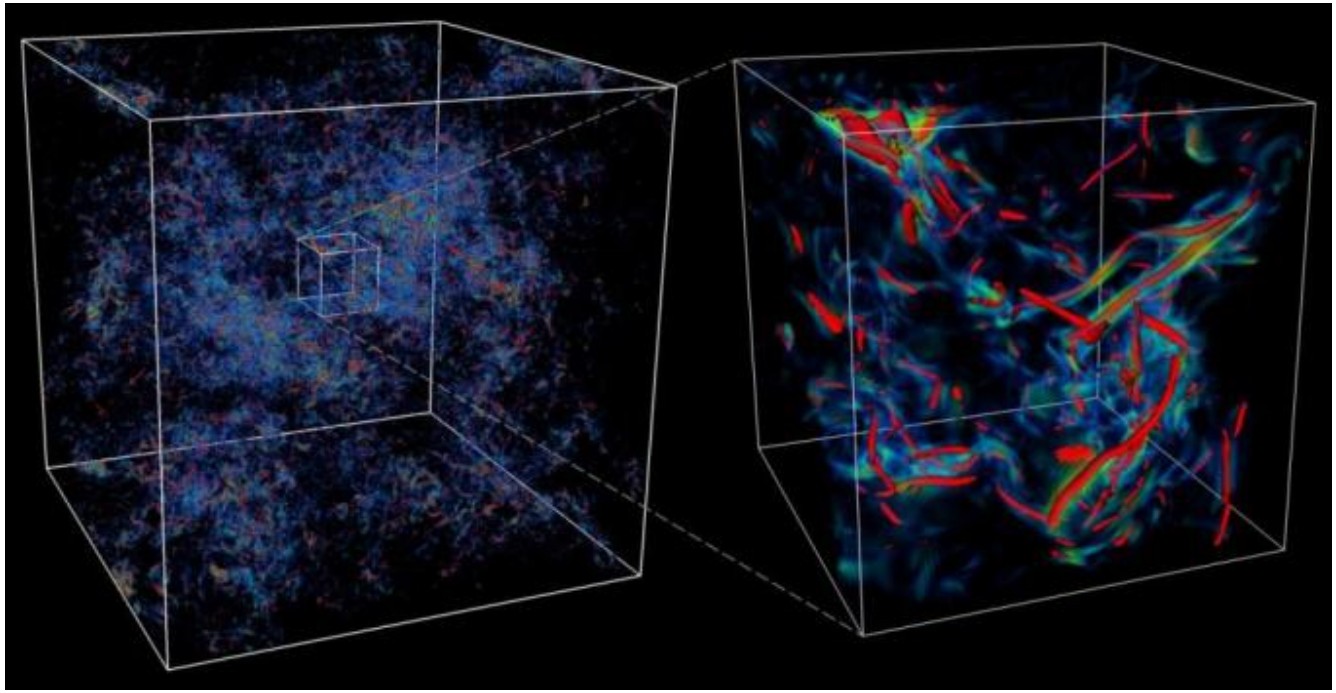
- A sequence of grids with attributes
- Representing
- Generally not interpolated in time
- Grids may be the same, or change from timestep to timestep

Varying in Time





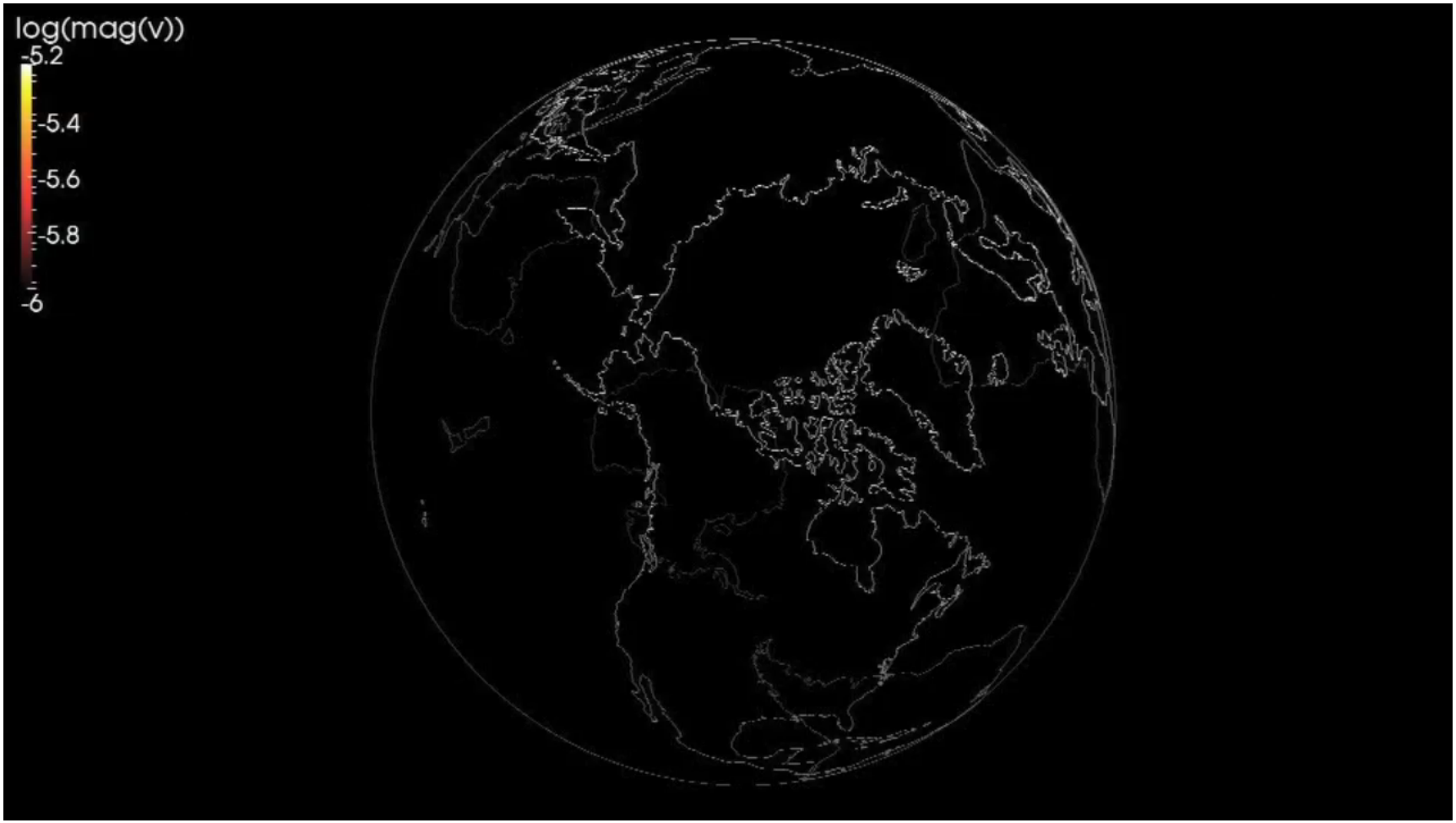
Volume Rendering



Expresses how light travels through a volume

Color and opacity controlled by a *transfer function*

Vol. Render: Seismic Wave Propagation



Thank you.

Questions