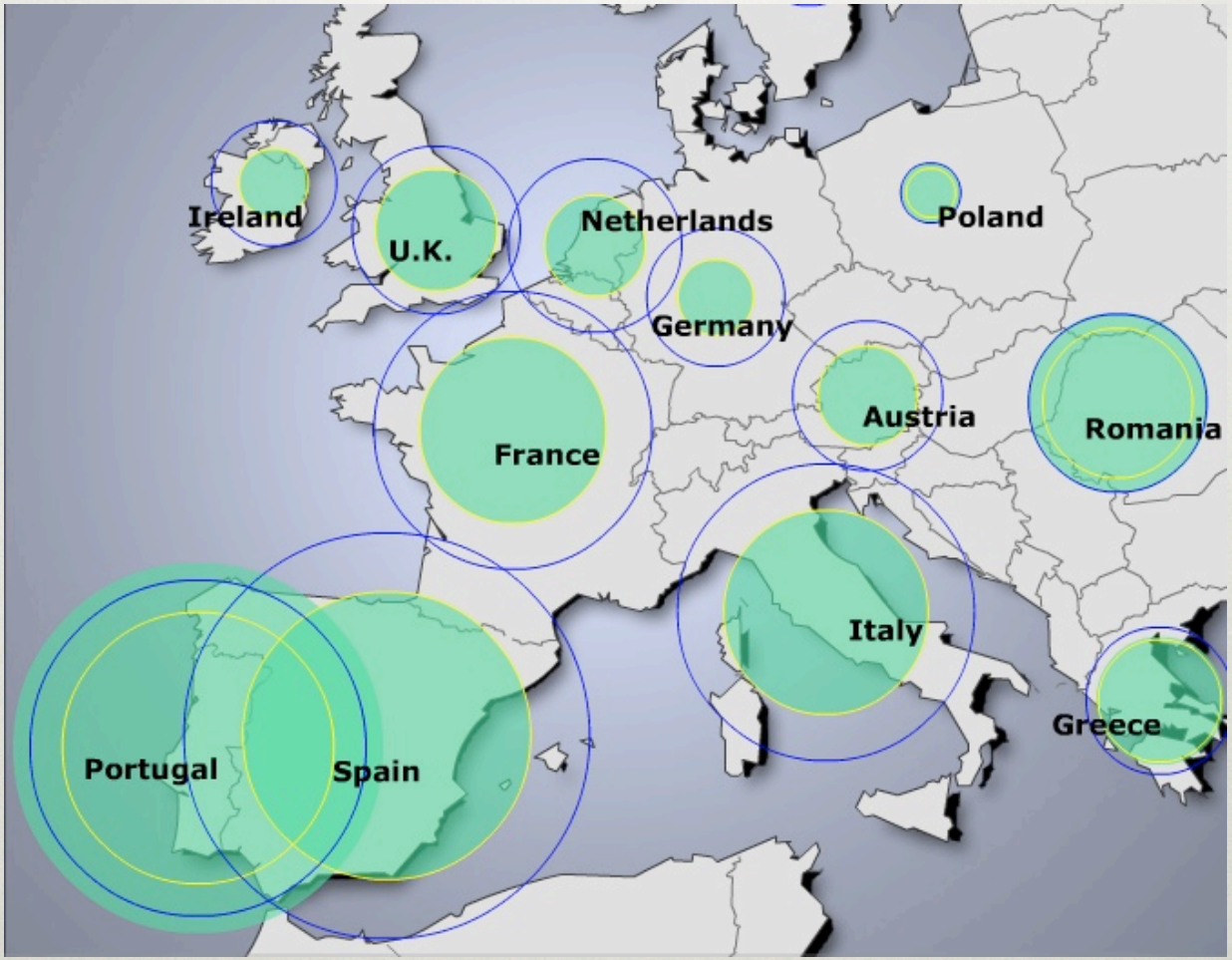
Visualizing Geographic Processes and the role of Visualization in Scientific Research

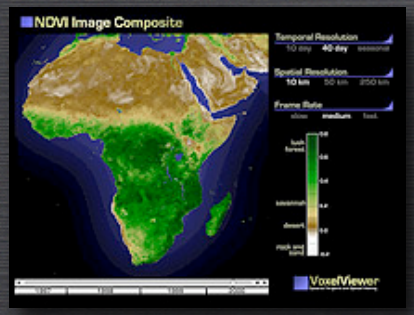


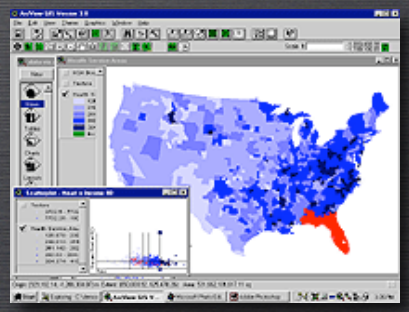
Overview

What is **Geovisualization**?

Why is the work **needed**?

What are its **applications** and uses?

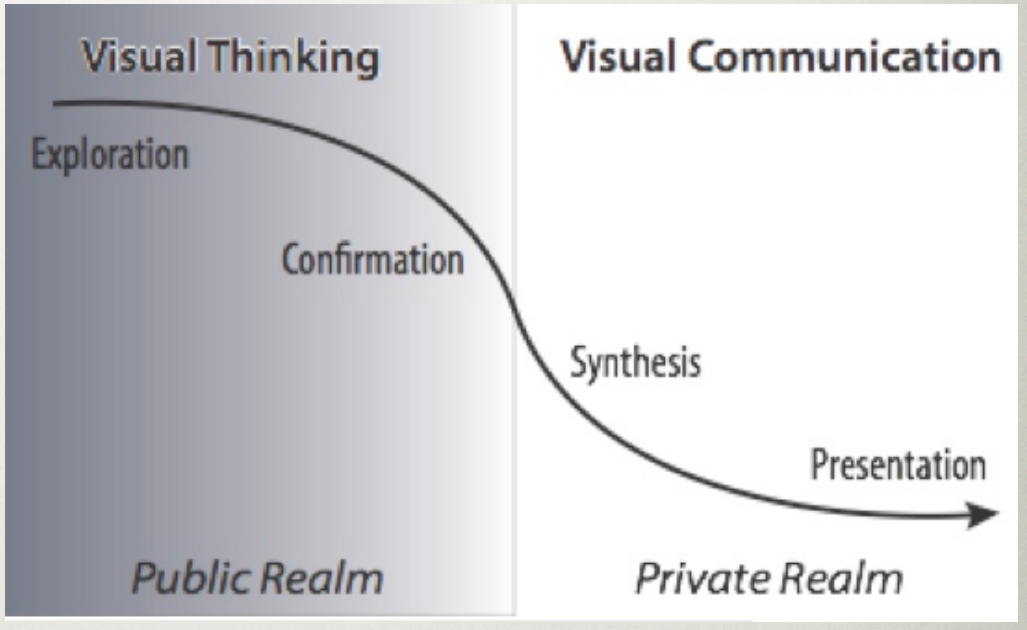




What is Geovisualization?

Leveraging the pattern-recognition and information-extracting abilities of the eye-brain system.

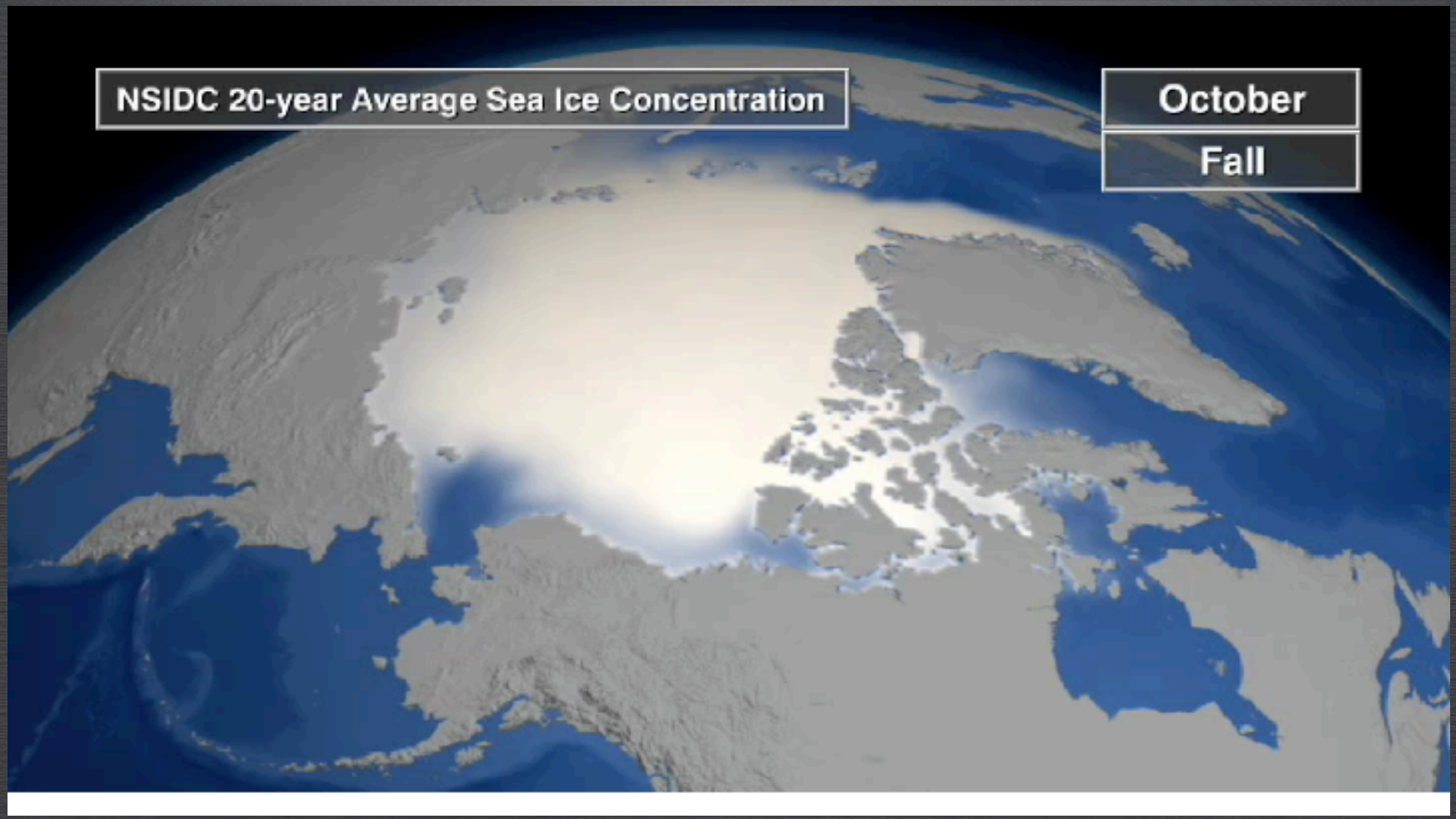
"Visual Thinking" - tools to 'see' and explore complex geospatial data sets in the hopes of discovering new insights



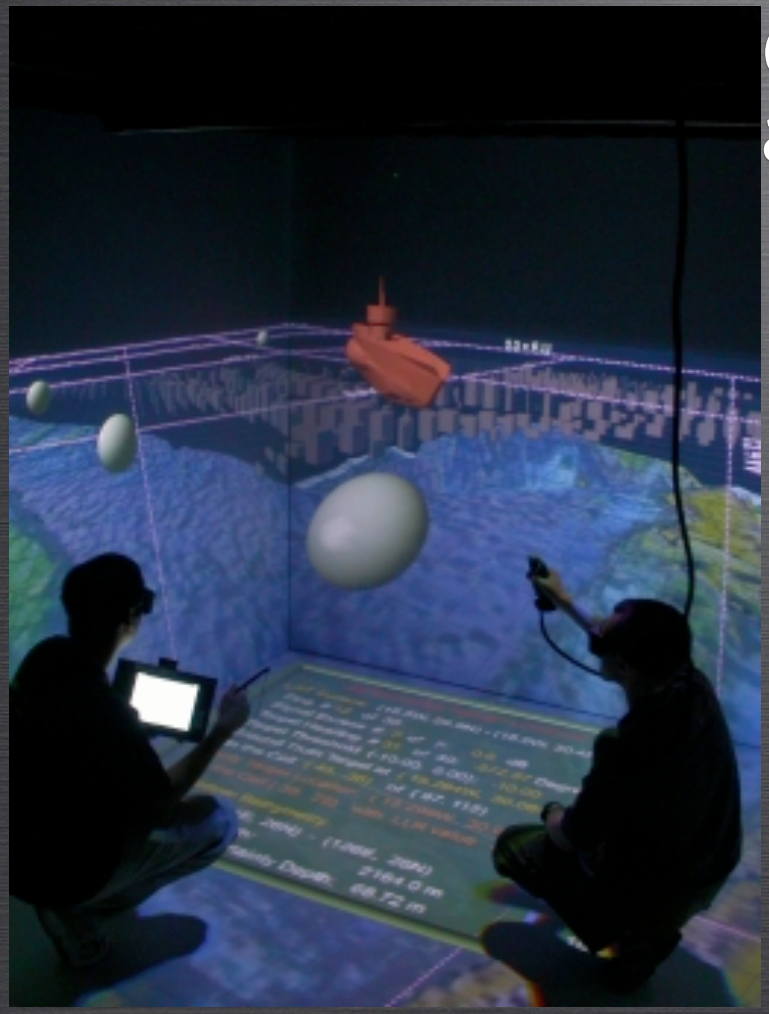
Vision is a high bandwidth sensory channel….we're "hardwired" for visual information (perceptual) and good at abstract visual thinking (cognitive)

Research Frontiers...

Map Animation



Research Frontiers...



Collaborative Visualization
and Immersive Technology

Research Frontiers...

Geocomputation and Database Semantics

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                <p><font color="#FFFFFF" size="5" face="Arial, Helvetica, sans-serif">Database
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            4</a></font></p>
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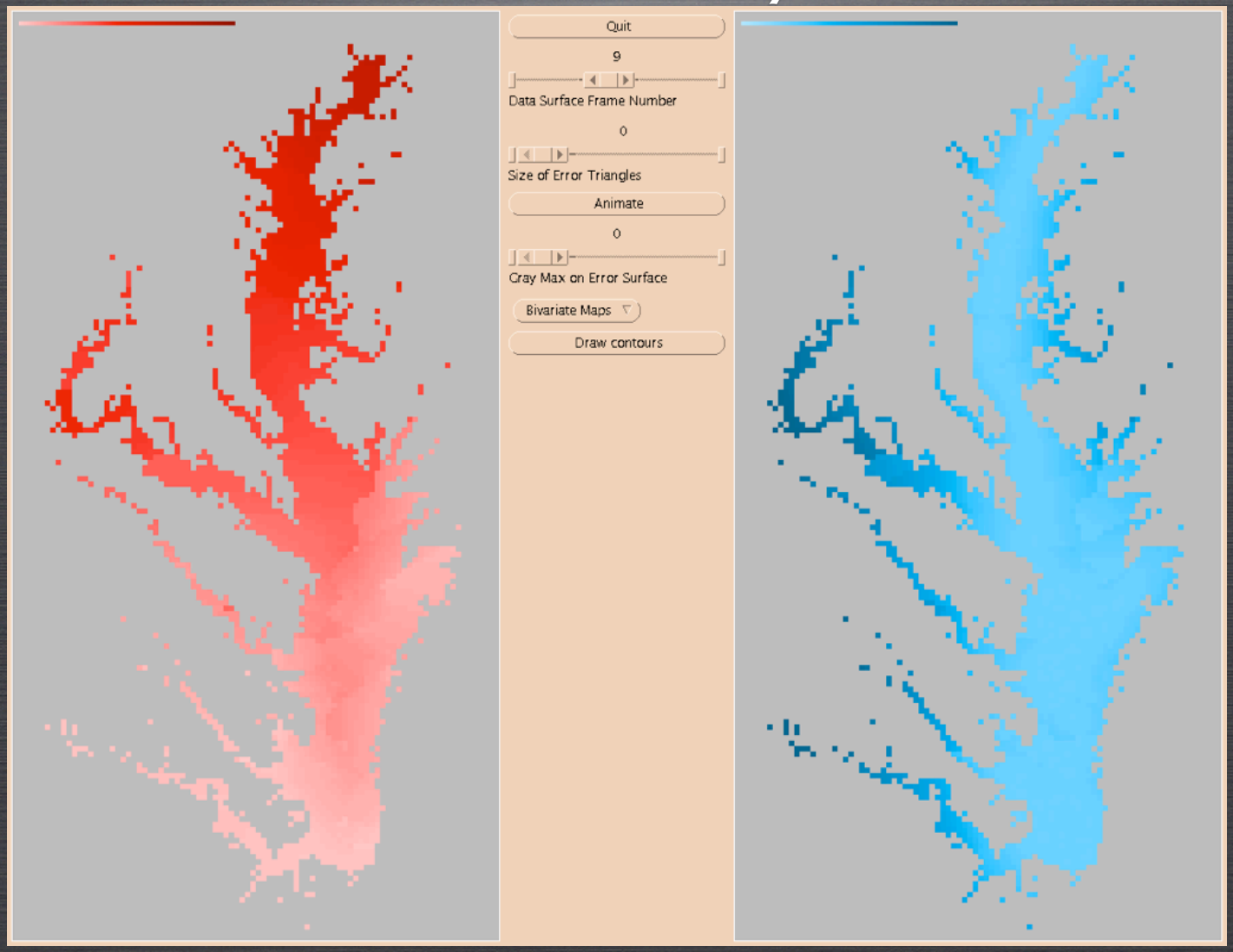
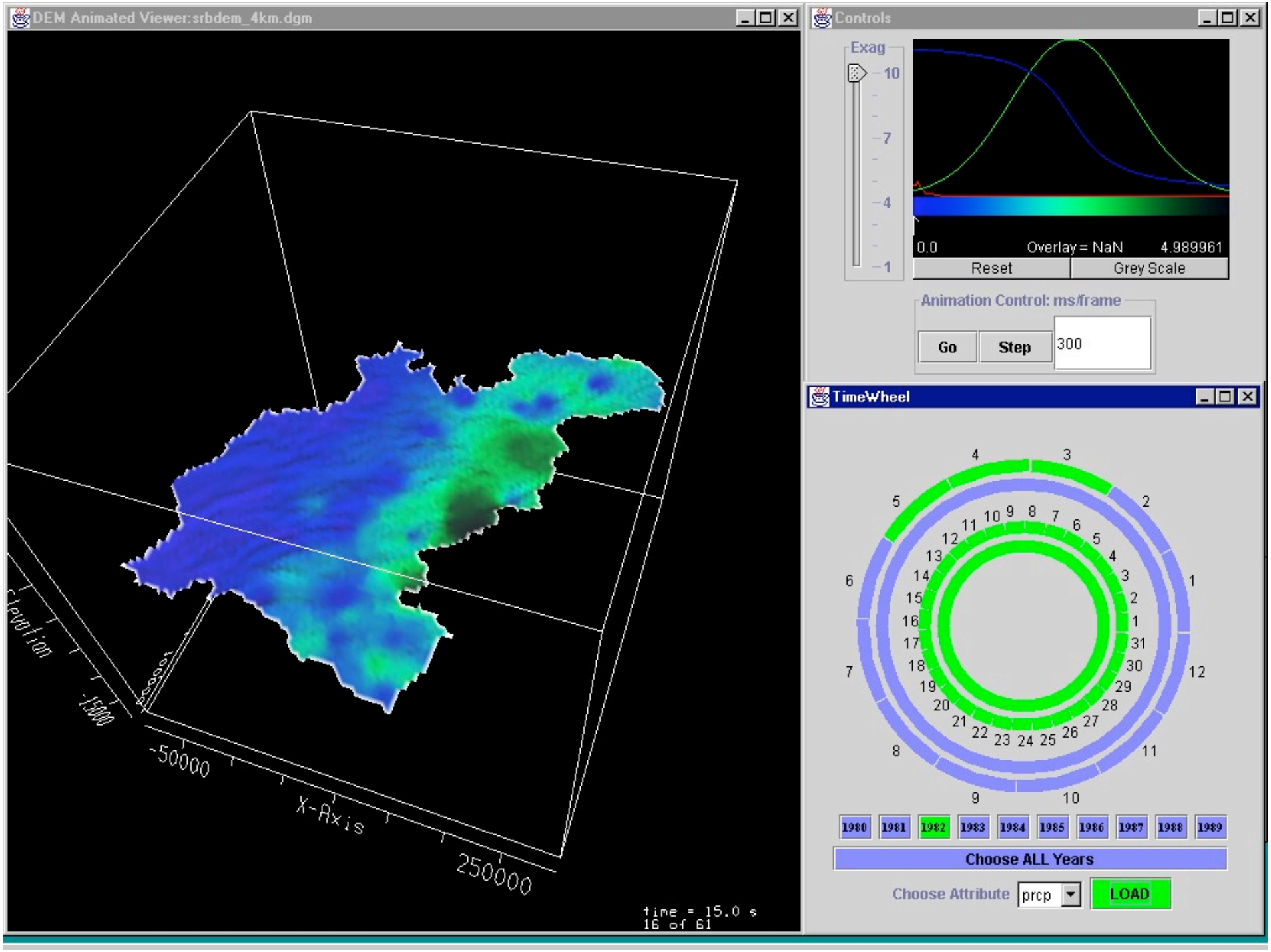
Research Frontiers...

Uncertainty and Data Quality

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Elevation
-15000
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X-Axis
250000
time = 15.0 s
16 of 61
Controls
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Reset
Grey Scale
Animation Control: ms/frame
Go
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300
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1980
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Choose ALL Years
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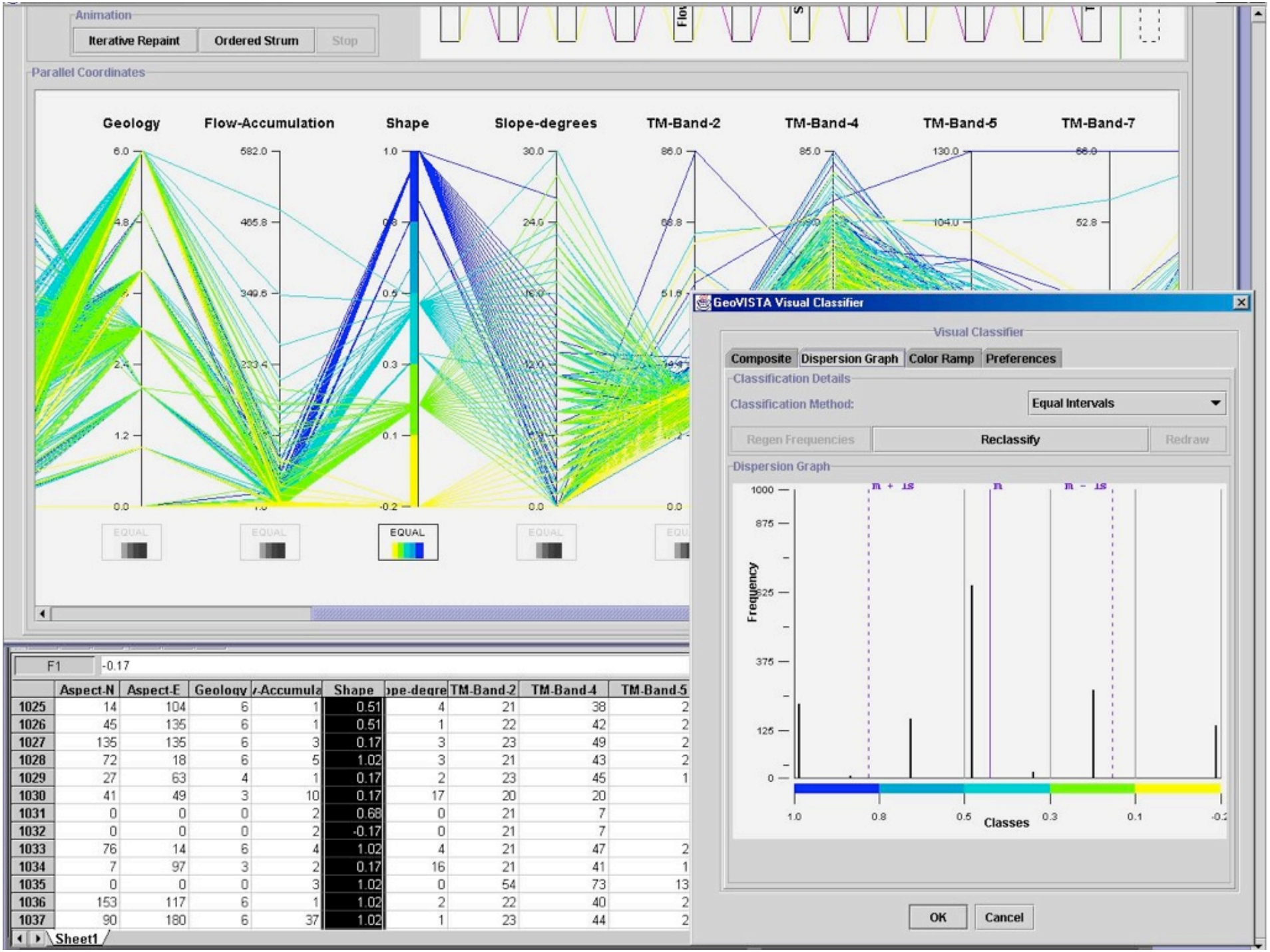
prcp
LOAD


Animation
Iterative Repaint
Ordered Strum
Stop
Parallel Coordinates
Geology
Flow-Accumulation
Shape
Slope-degrees
TM-Band-2
TM-Band-4
TM-Band-5
TM-Band-7
EQUAL
GeoVISTA Visual Classifier
Visual Classifier
Composite
Dispersion Graph
Color Ramp
Preferences
Classification Details
Classification Method:
Equal Intervals
Regen Frequencies
Reclassify
Redraw
Dispersion Graph
Frequency
Classes
OK
Cancel
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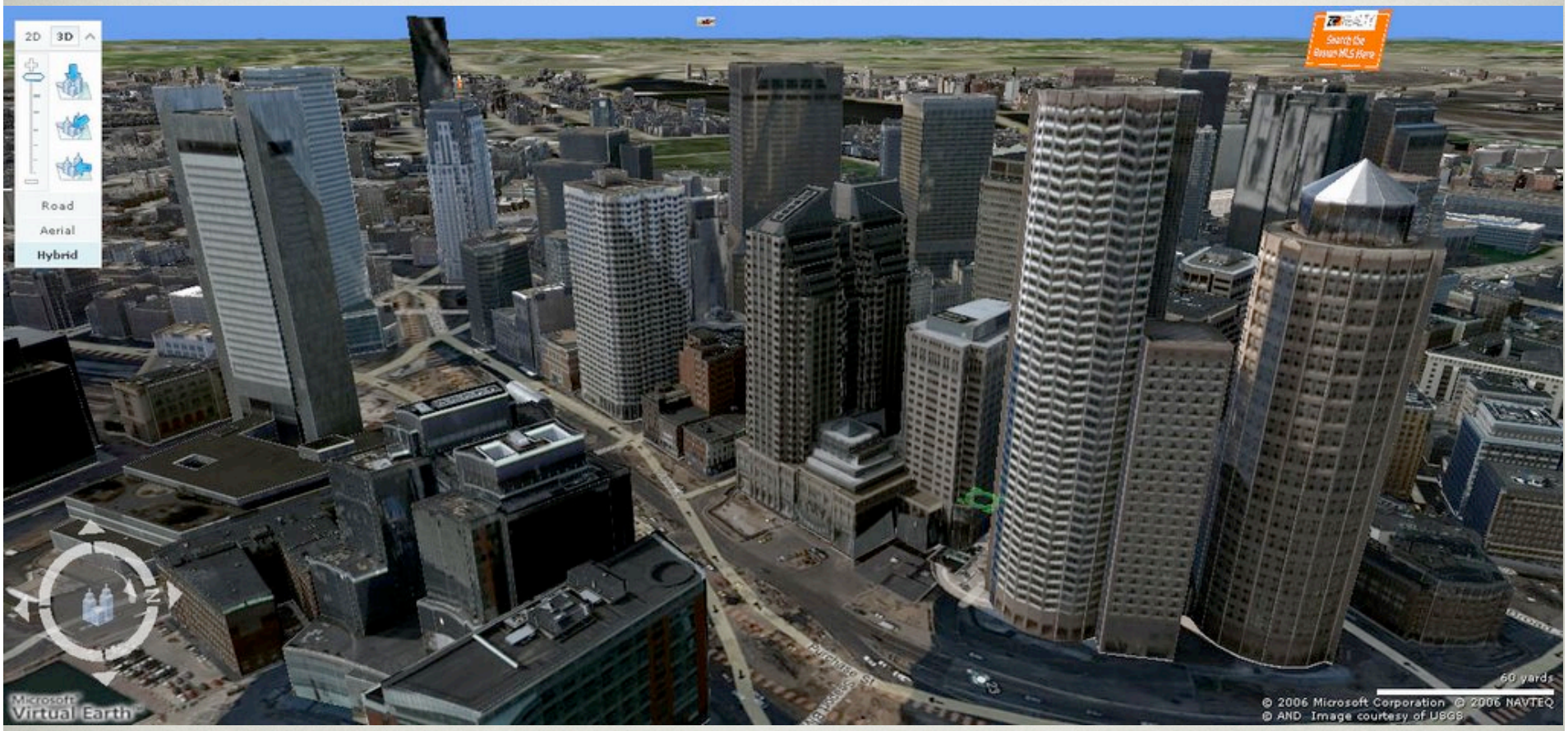
TM-Band-5
Sheet1


2D
3D
Road
Aerial
Hybrid
Search the Reuser MLS Here
Microsoft Virtual Earth
60 yards
© 2006 Microsoft Corporation © 2006 NAVTEQ
© AND Image courtesy of USGS

Why does this matter?

just techie stuff, right?

an example

Issue #1

How we think about the world influences how we make maps. In turn, how we make maps influences how we think about the world.

Issue #2

Turning ***data*** into ***information*** (and ultimately ***knowledge***)

Massive amount of digital space-time data: *How do we make use of it?*

Issue #3

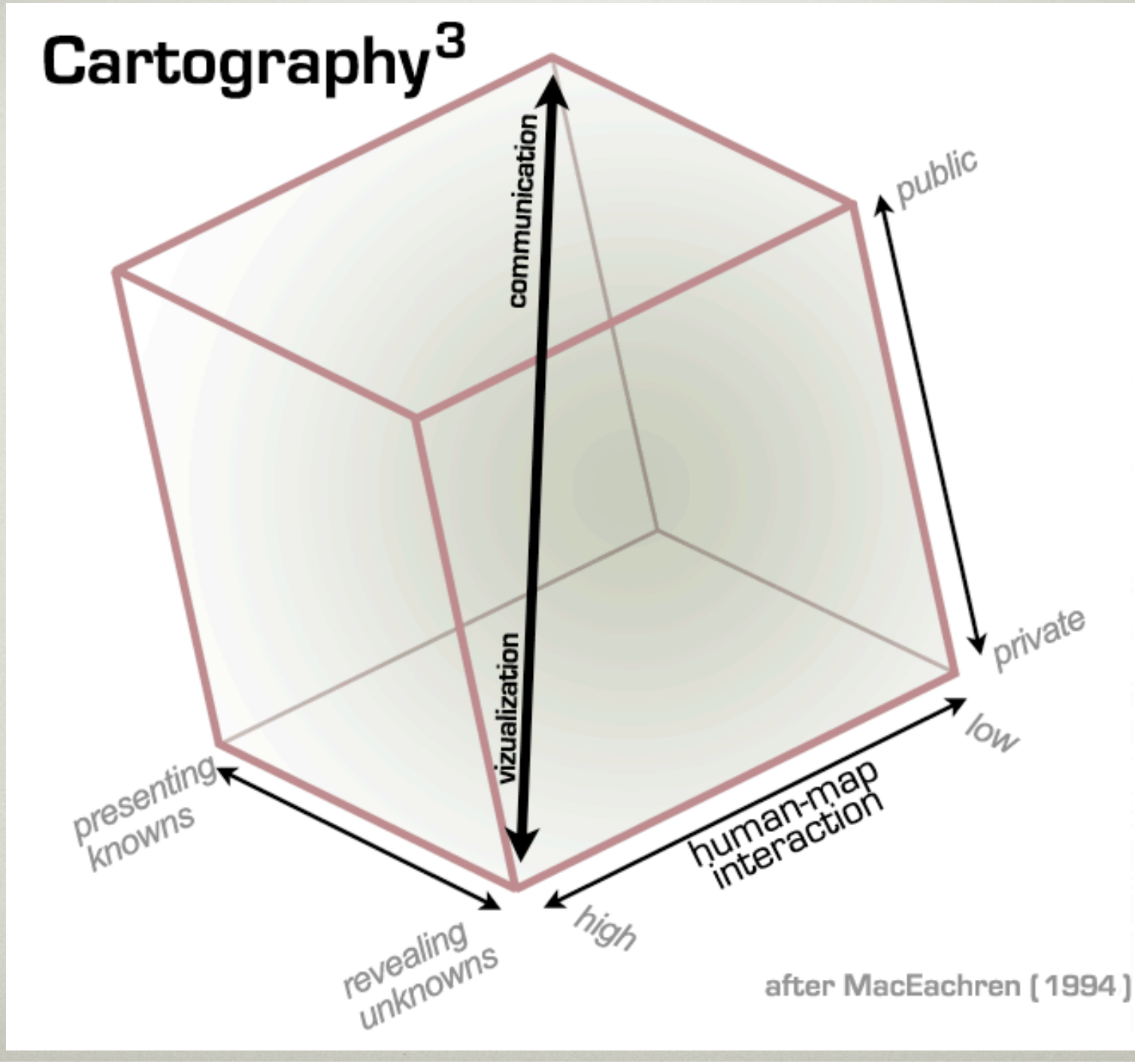
Time and Process - Hard to Represent

A shift from PATTERNS to PROCESSES

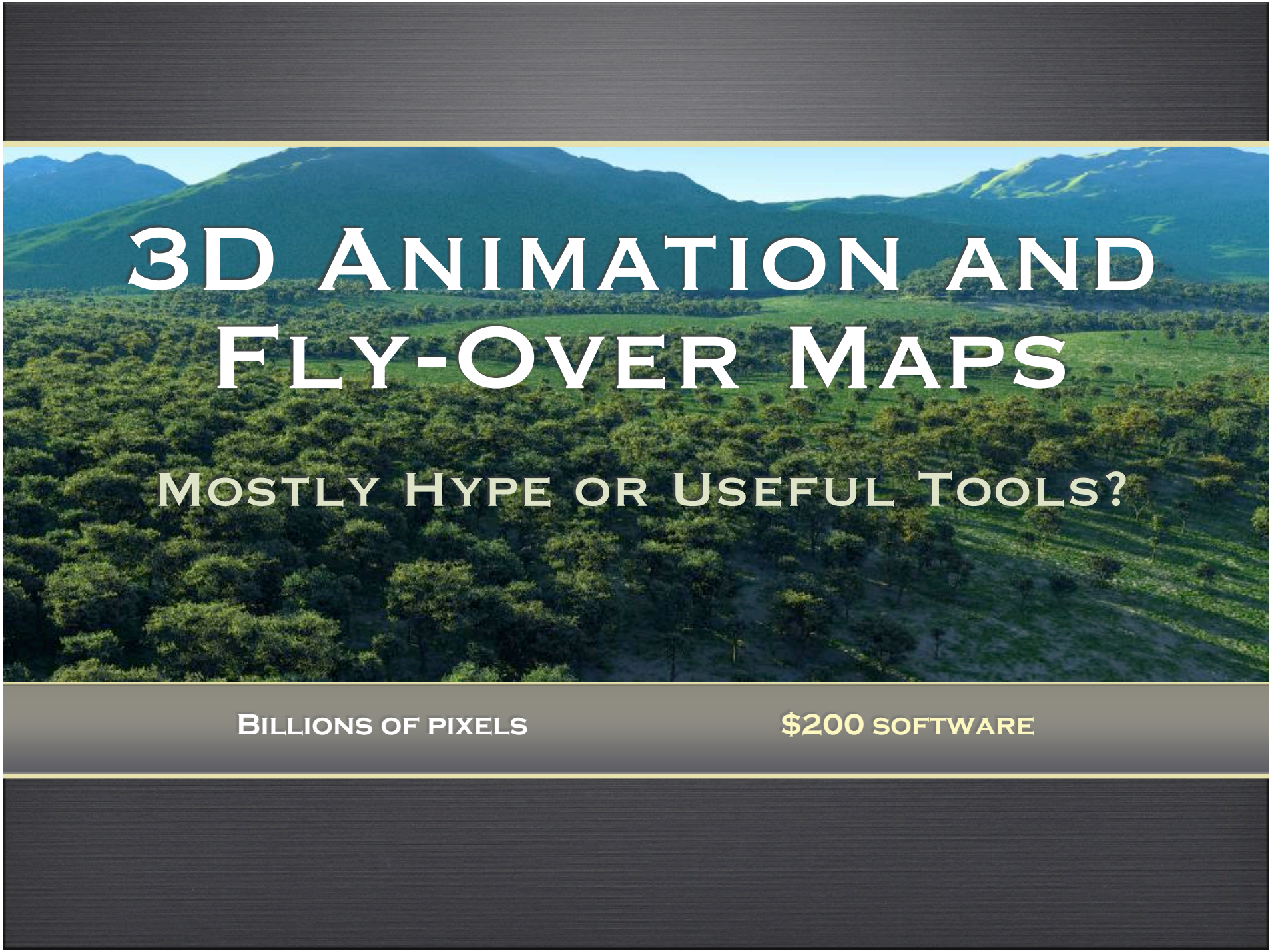
Knowledge Construction

Early in the research process: Help to form hypotheses about geographic systems when formal hypotheses my be lacking.

Later in the research process: May be used to confirm, synthesize, and ultimately present ideas and information.


Cartography3
communication
vizualization
public
private
low
high
human-map interaction
presenting knowns
revealing unknowns
after MacEachren (1994)

Demos


3D Animation and Fly-Over Maps
Mostly Hype or Useful Tools?
Billions of pixels
$200 software

We all-too-often assume 3-d is better than 2-d, that animation is superior to static graphics, and that realism is more powerful than abstraction.

Ben Shneiderman

aim to be clear, not cool.

The trouble with 3D Fly-overs

(1) Scale is not constant (x, y, or z)

(2) Information Overload

(3) Visual occlusion

(4) People Love Them (and then promptly forget them)

(5) Folks Get Lost!

Oh really?

Pen and paper at the ready...

Q1: Trace your path!

Q2: How far have you travelled?

Q3: How high is the final climb?

Q4: How many villages did we fly over?

...all answerable with a 2D topo!!

HOWEVER!...

(1) *Not* anti-flyover (they're too cool, and they're here to stay)

(2) So...How and When to best use them!

(3) And what can we do improve them?

HOWEVER!...

(1) *Not* anti-flyover (they're too cool, and they're here to stay)

(2) So...How and When to best use them!

(3) And what can we do improve them?

This is one of my research foci

It's not the technology, it's how you use it.

Mike Gleischer

choropleth not so good for elevation

What Problems?!

(1) **Non-constant scale?** = Info filtering + mix 2d and 3d + how realty works

(2) **Visual occlusion?** Just fly around + transparency + roll-up earths

(3) **Judging distance?** Grids + new measuring tools + 2d inset

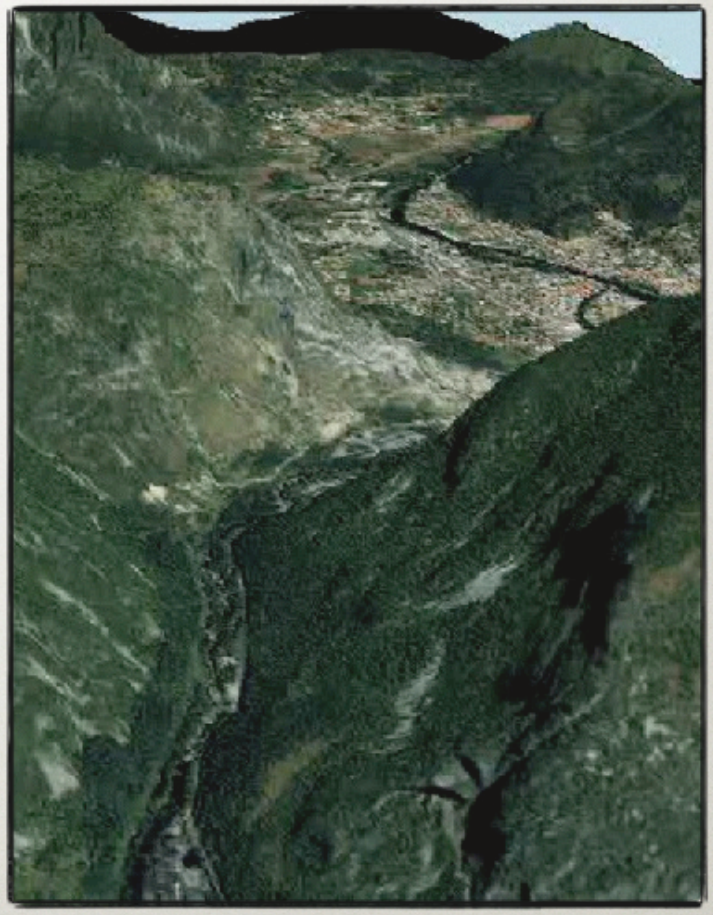
BUT... Most of these are INTERACTIVE SOLUTIONS

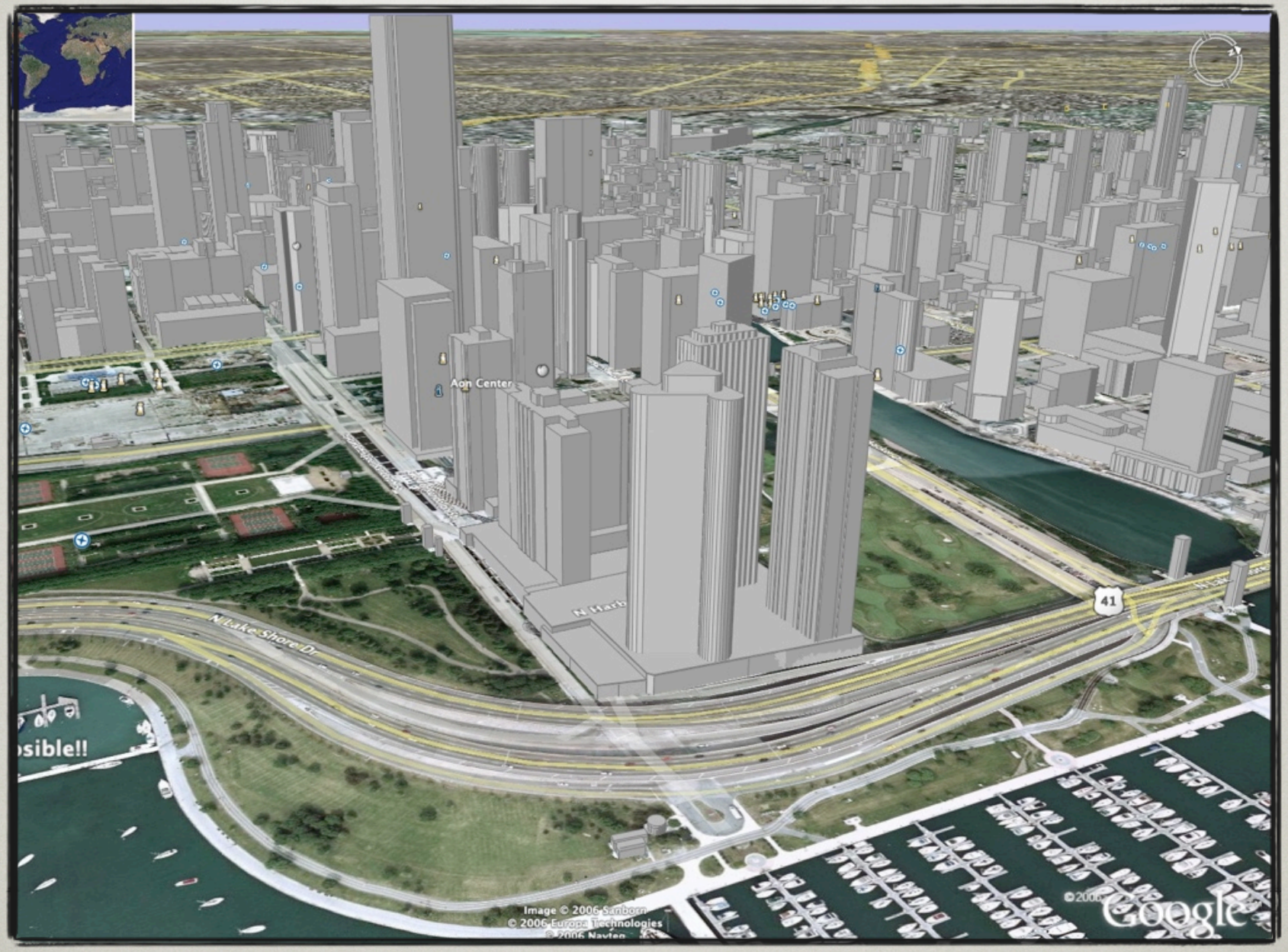
Fly-overs (low interactivity)

vs.

VEs (high interactivity)

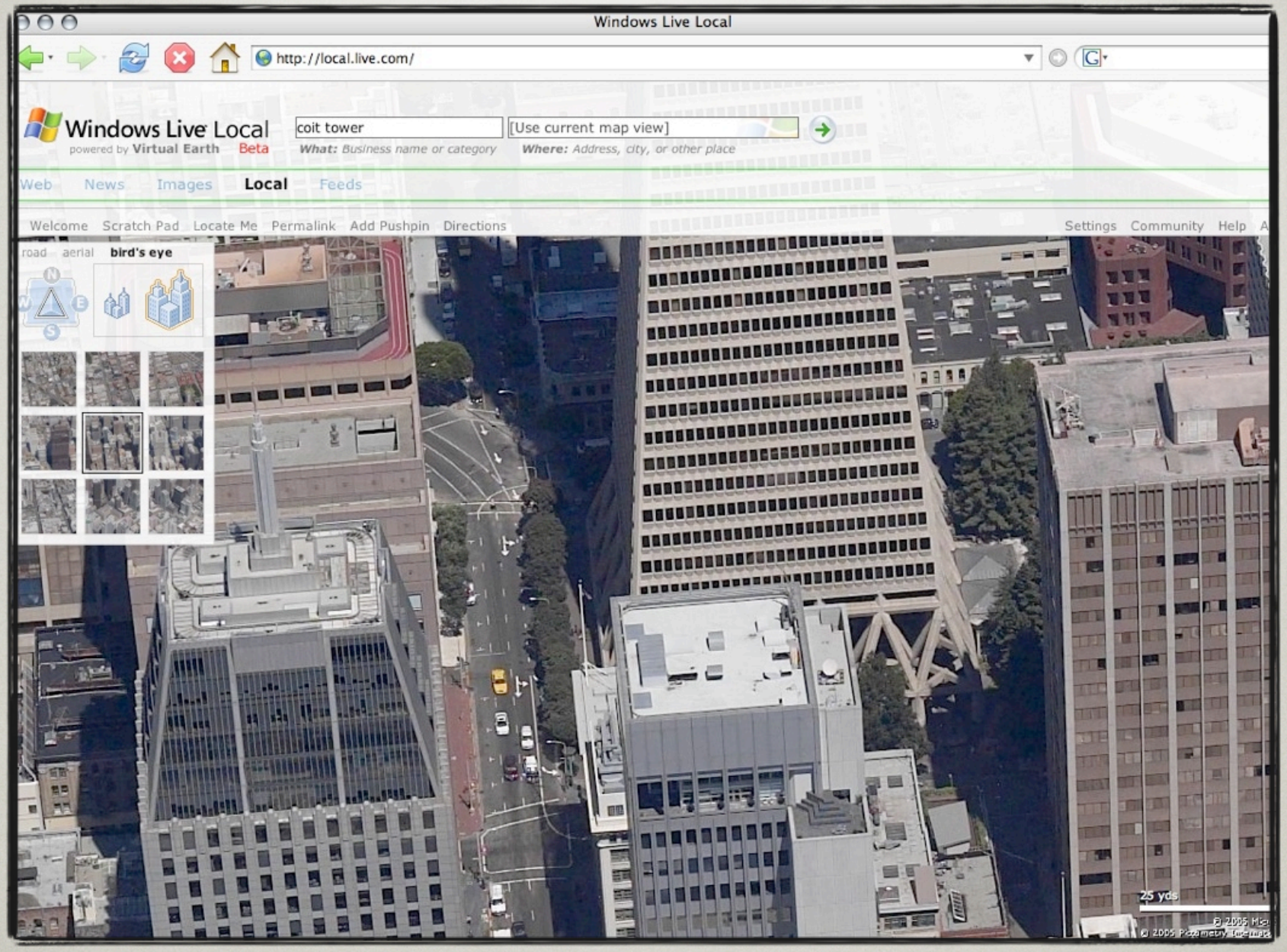
Used often as overview/reference map to create "survey knowledge"





Google Earth

Most research has focused on VEs, **not** fly-overs.



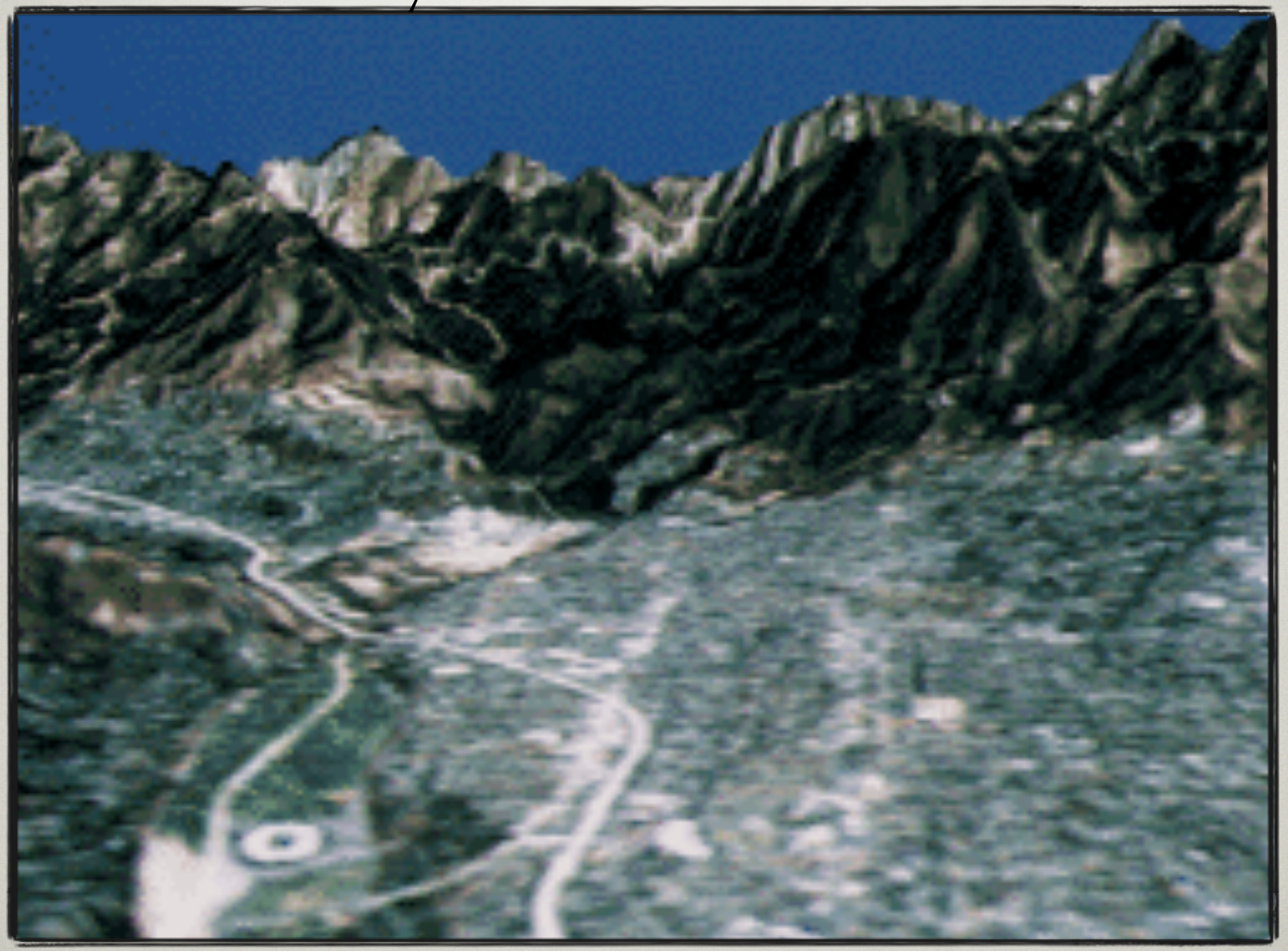
So how did we get here?

A Brief History

A Brief History

ILM 1983

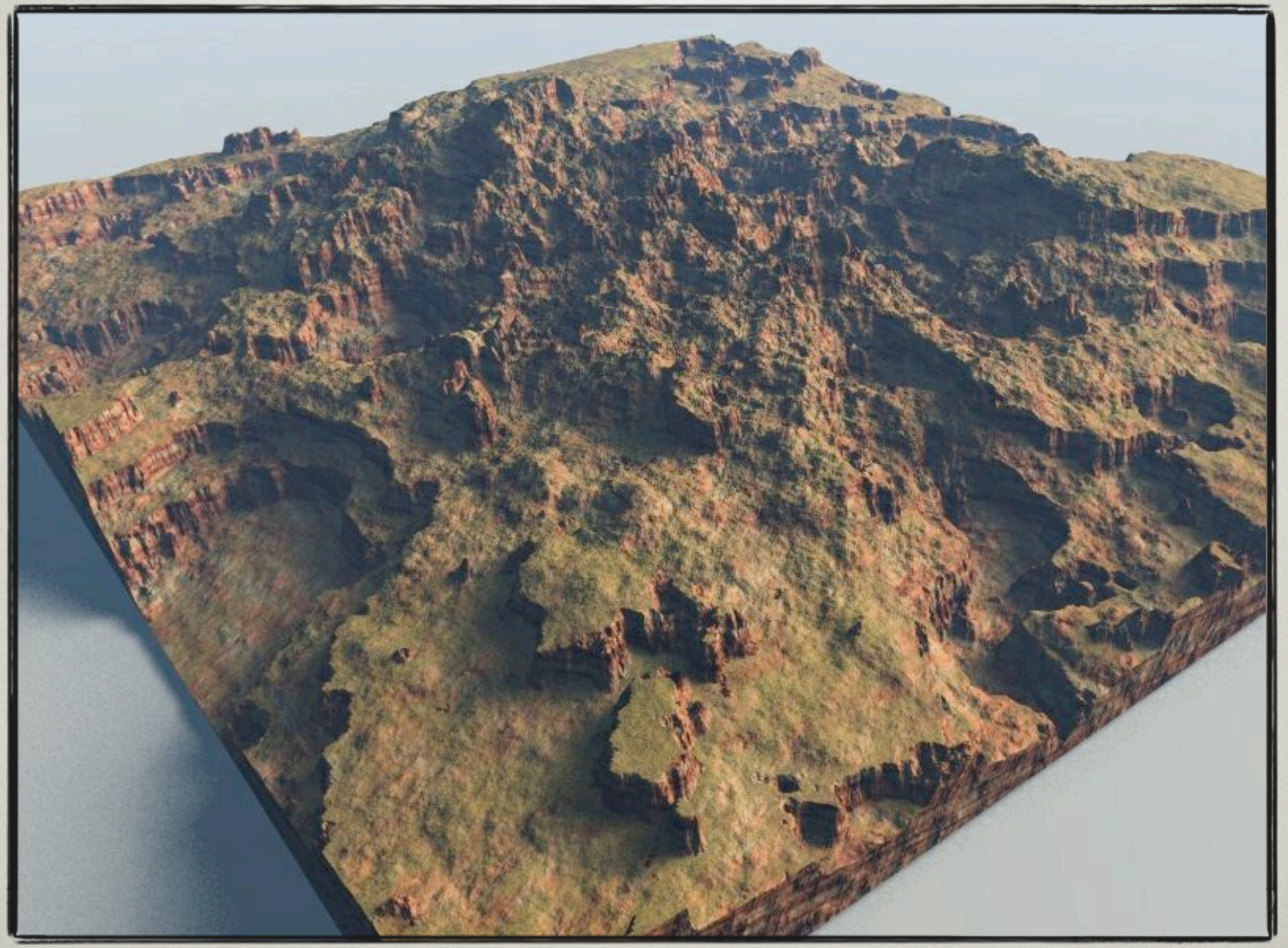
A Brief History

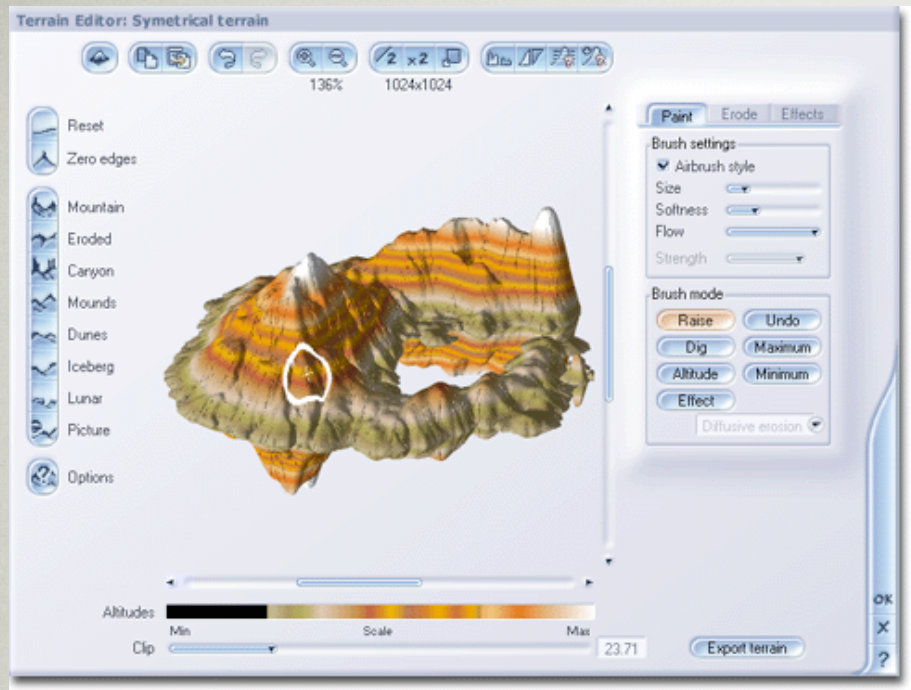


JPL 1987

A Brief History

TerraVision 1994

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136%
1024x1024
Reset
Zero edges
Mountain
Eroded
Canyon
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Airbrush style
Size
Softness
Flow
Strength
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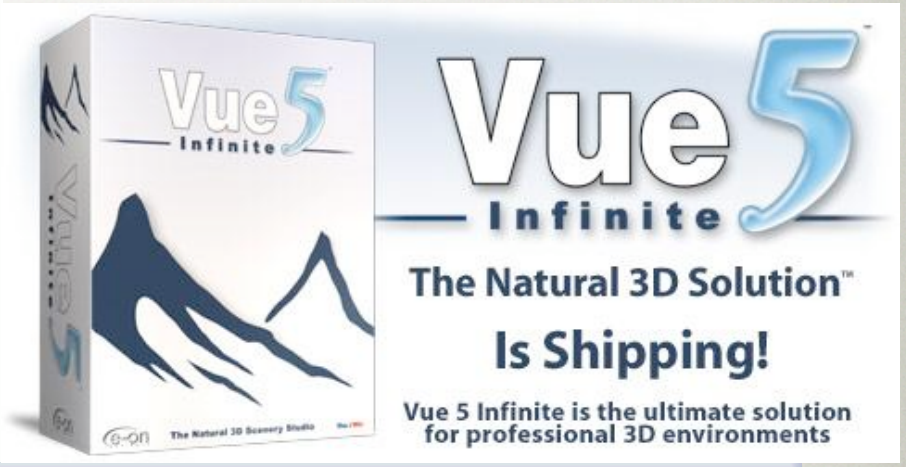
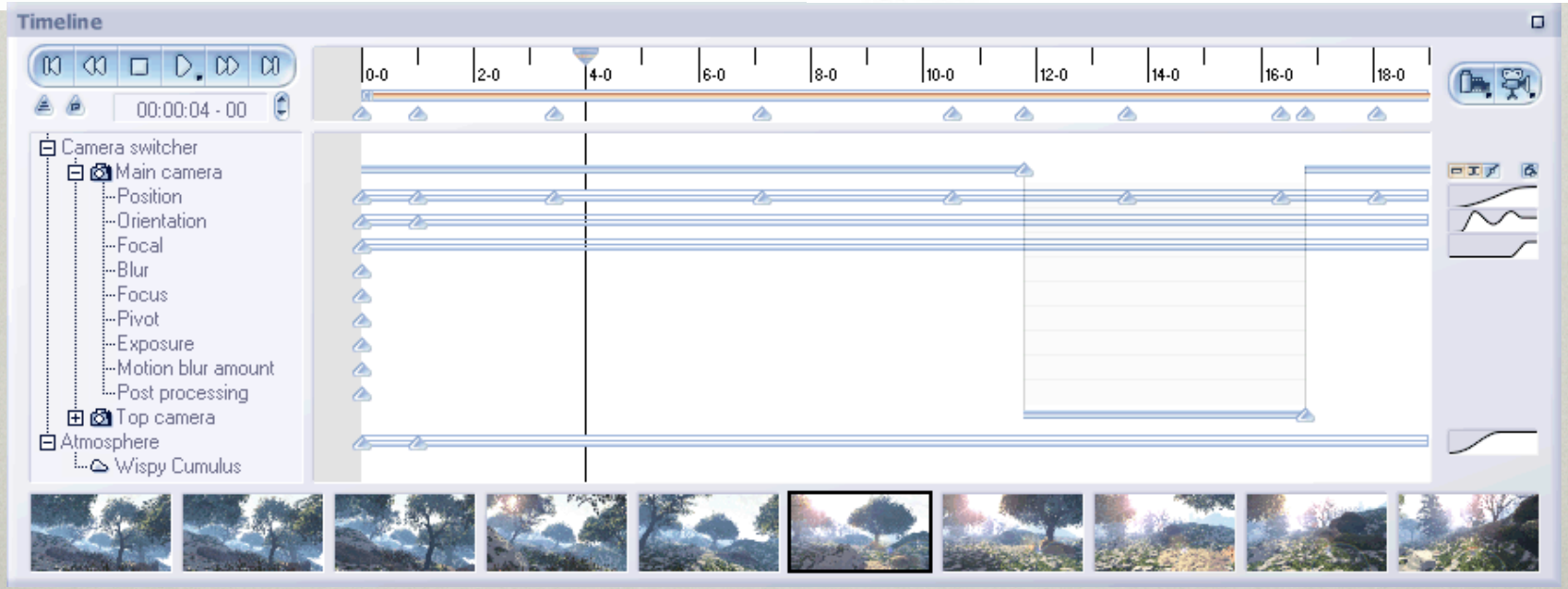
Export terrain
OK


Vue 5
Infinite
The Natural 3D Solution™
Is Shipping!
Vue 5 Infinite is the ultimate solution
for professional 3D environments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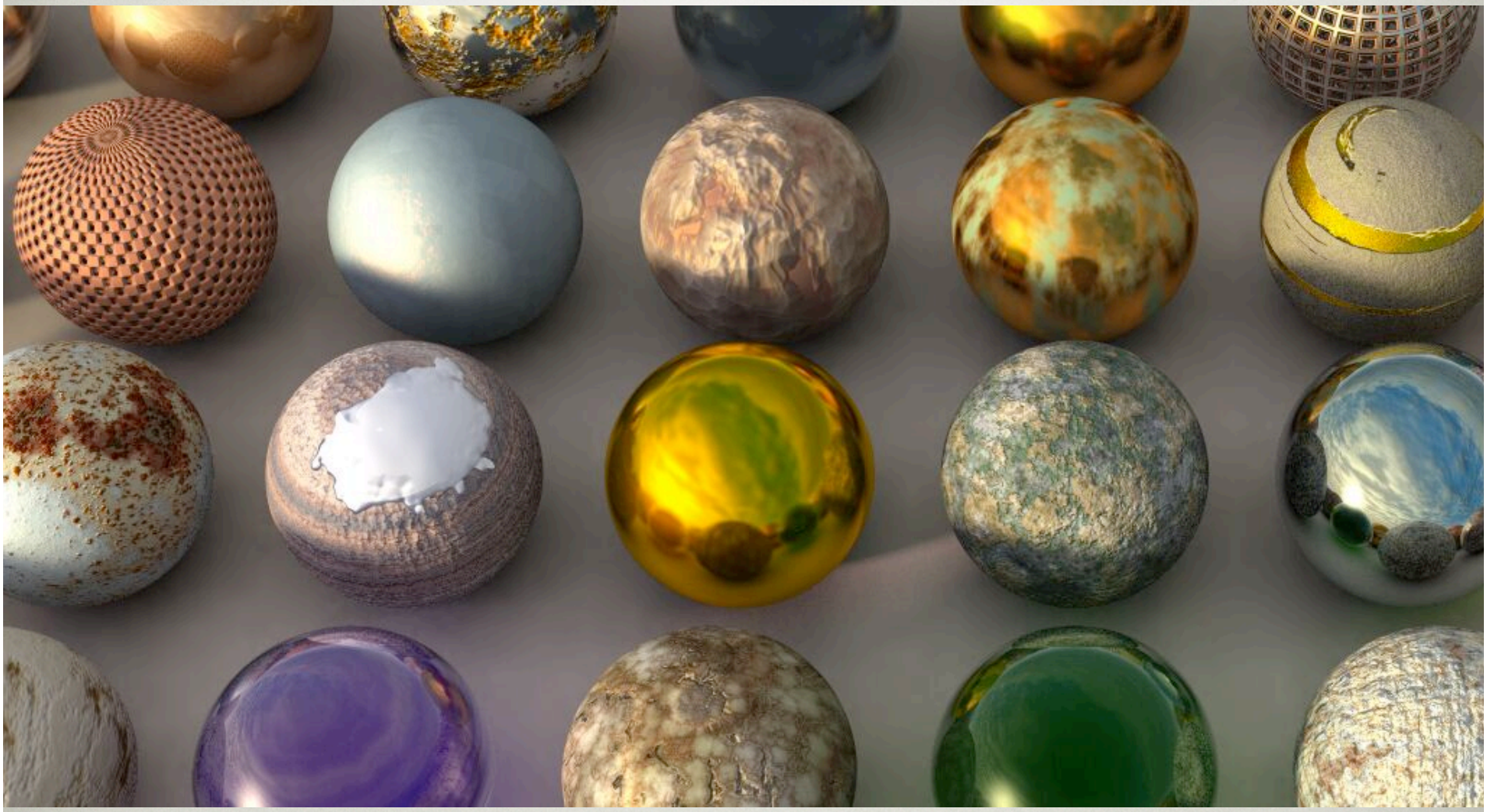
Camera switcher
Main camera
Position
Orientation
Focal
Blur
Focus
Pivot
Exposure
Motion blur amount
Post processing
Top camera
Atmosphere
Wispy Cumulus



http://www.e-onsoftware.com/

25 years on...

...better software BUT still many unknown questions in fly-over cartography:

path complexity
flight speed / height
look-ahead / angle / fixed?
fixed vs. variable fly height
animation length
banking
scene complexity
orientation cues, etc.

To date...

Some research in GISci, mostly in HCI / VE communities ...

Is our technology ahead of our theory?

Problem #1
Disorientation

People get lost / disorientated / overwhelmed!

Again, and again this is shown in research

(Darken and Sibert 1996, Elvins 1997, Vinson 1999, Chittaro and Burigat 2004, Bowman et al. 2005)

Why?

Problem #1
Disorientation

Why?

People don't know where they are

People don't know where they've been

And they don't what they're looking at

Core Problem

Fly-overs need to better foster development of the basic components of a **mental map**

#1 Survey/Configural Knowledge: Legible environment is one whose parts can be recognized and organized into coherent patterns (Lynch 1960, Thorndyke 1983, Elvins 1997)

#2 Procedural Knowledge: e.g., driving directions

#3 Landmark Knowledge: e.g., relational

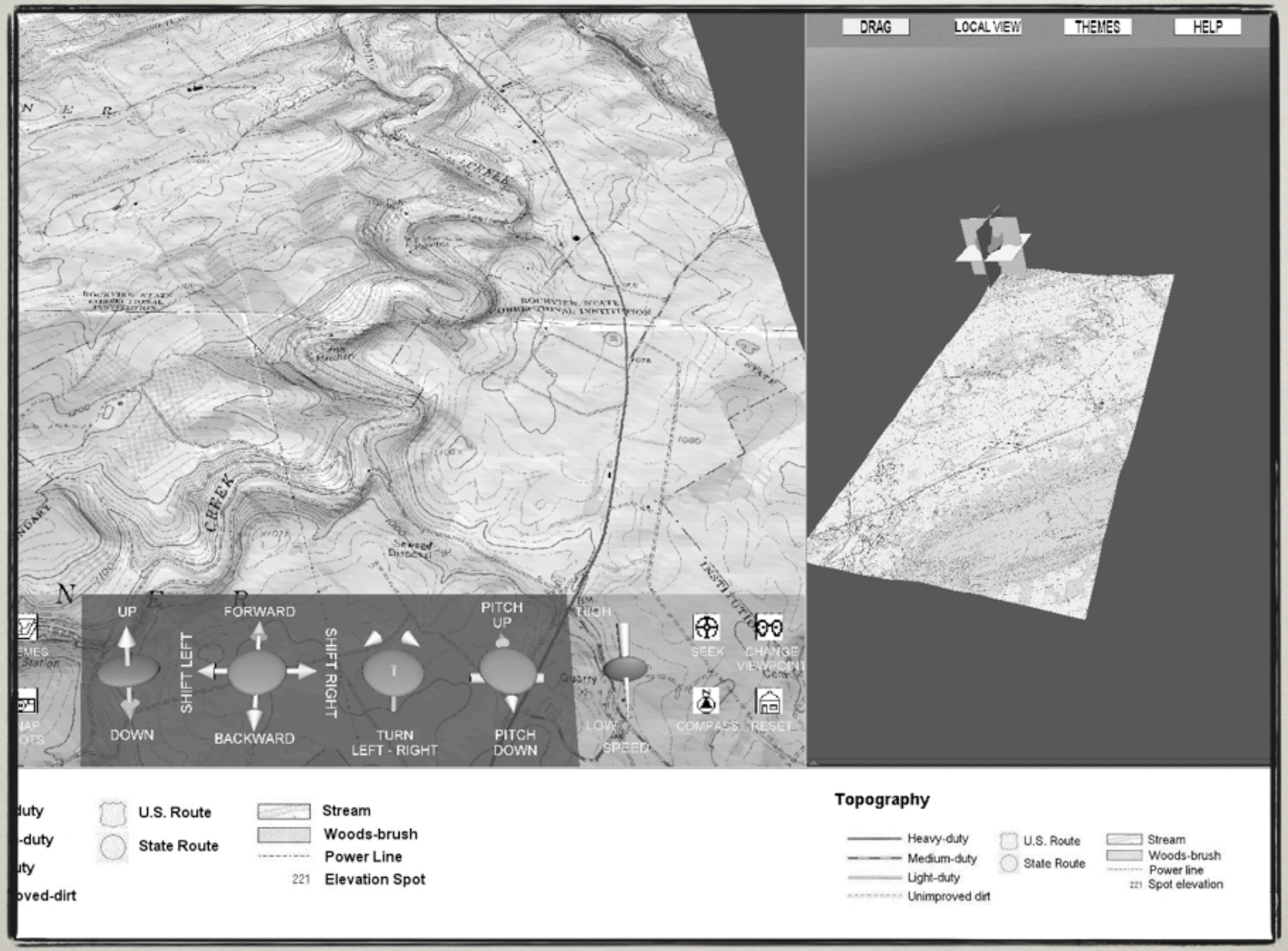
Enhancing Fly-over Maps

Starts with a labeled overview map
(map mixes ego- and exo-centric views)

Previews flight path

Soundscape creates increased sense of immersion

Linked Ego- and Exo-centric Perspectives



Fuhrmann, Sven (2003). Supporting Wayfinding in Desktop Geovirtual Environments.

Linked Ego- and Exo-centric Perspectives

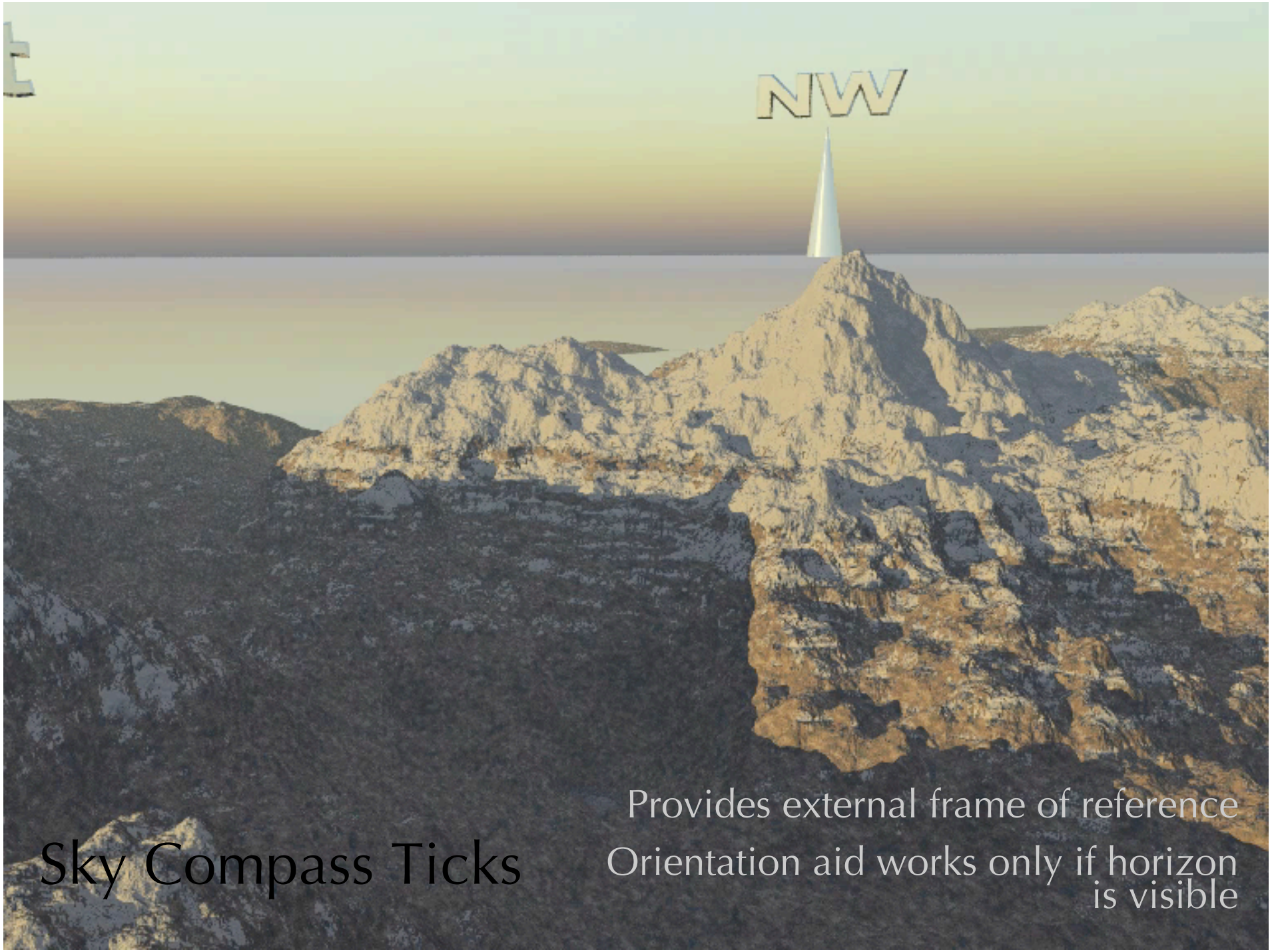
PRO: It really helps

CON:

Split attention

Screen space

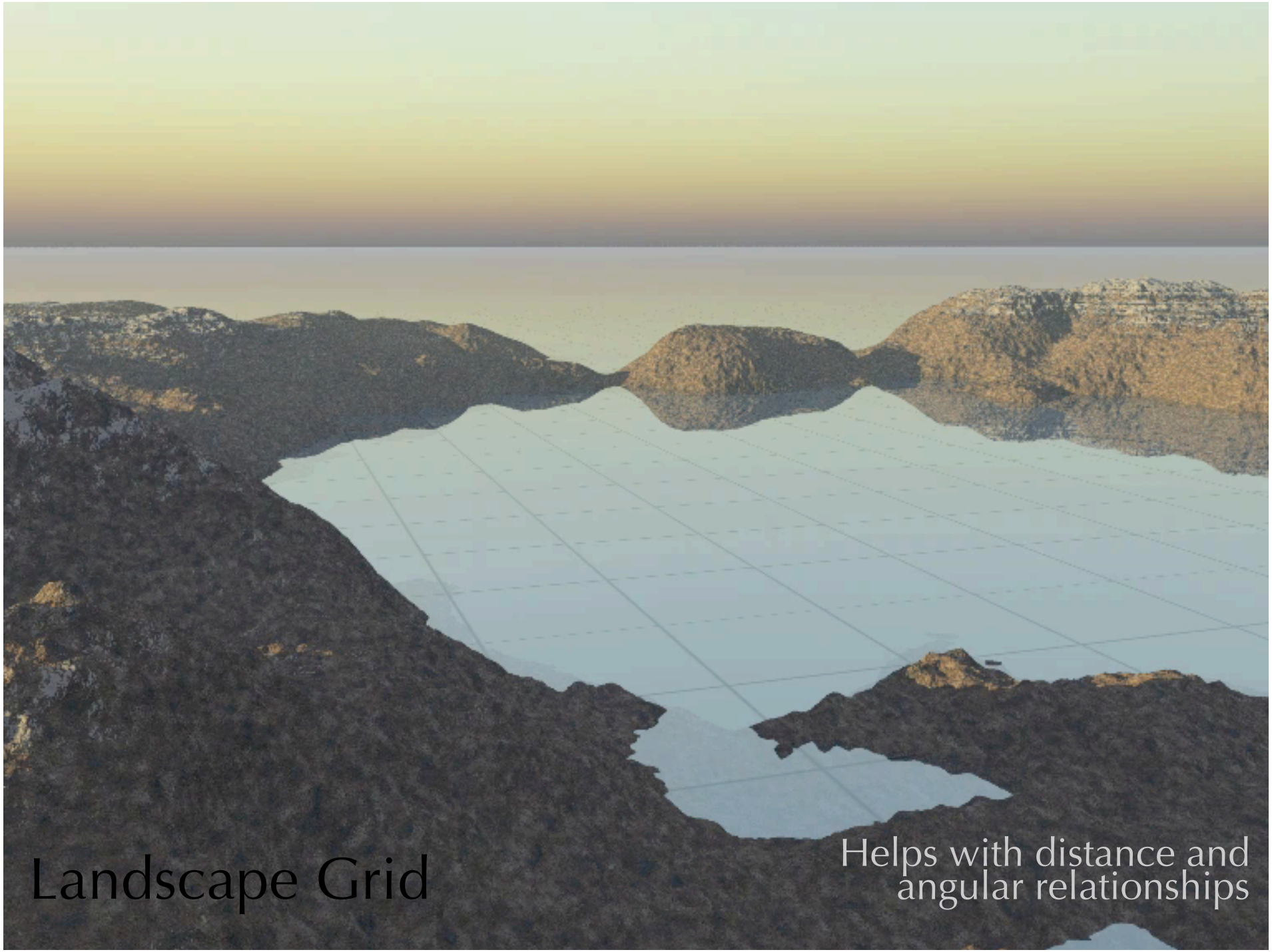
Inspiration:
Heads-Up Display / Augmented Realty

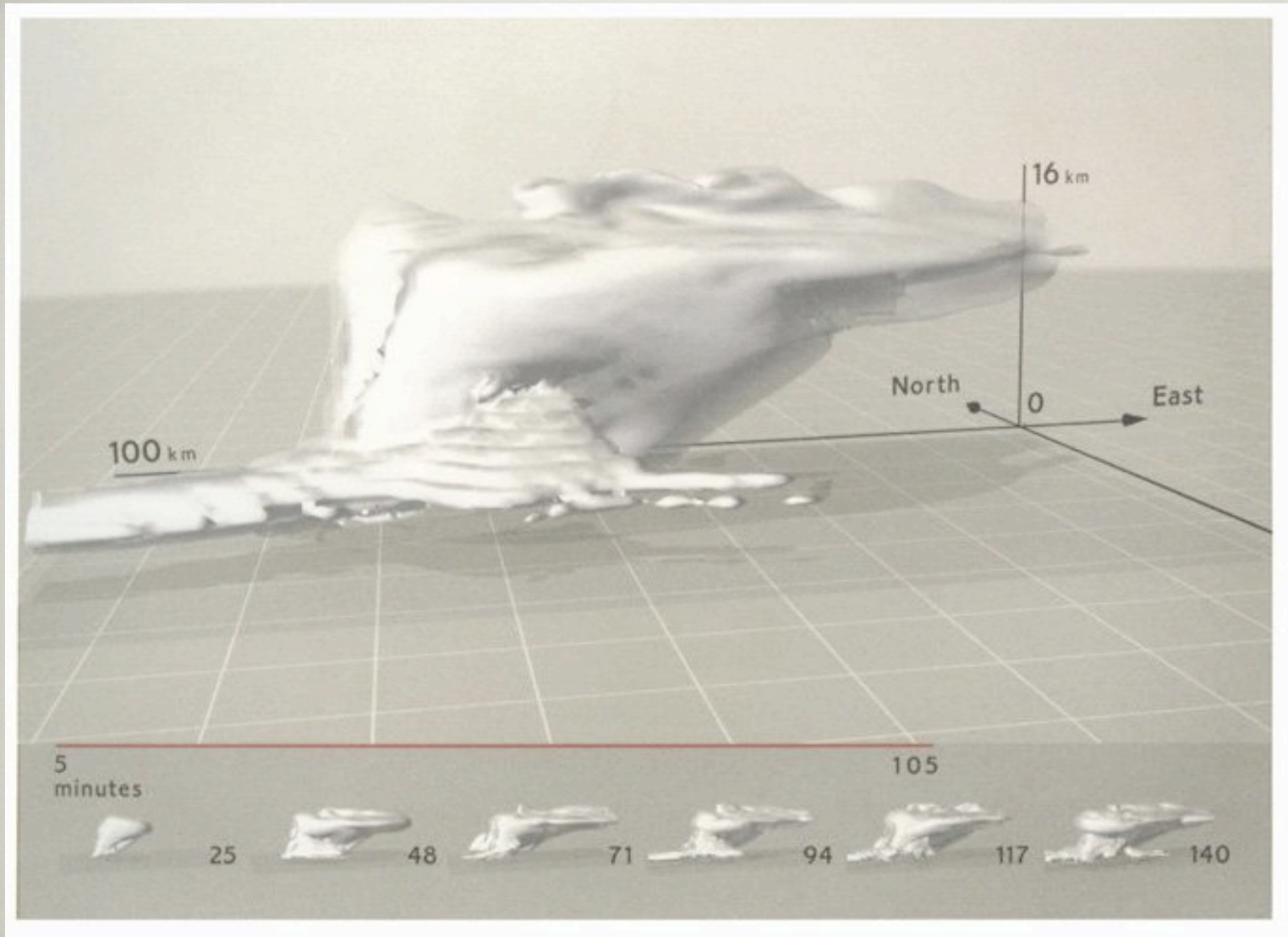


Sky Compass Ticks

Provides external frame of reference

Orientation aid works only if horizon is visible

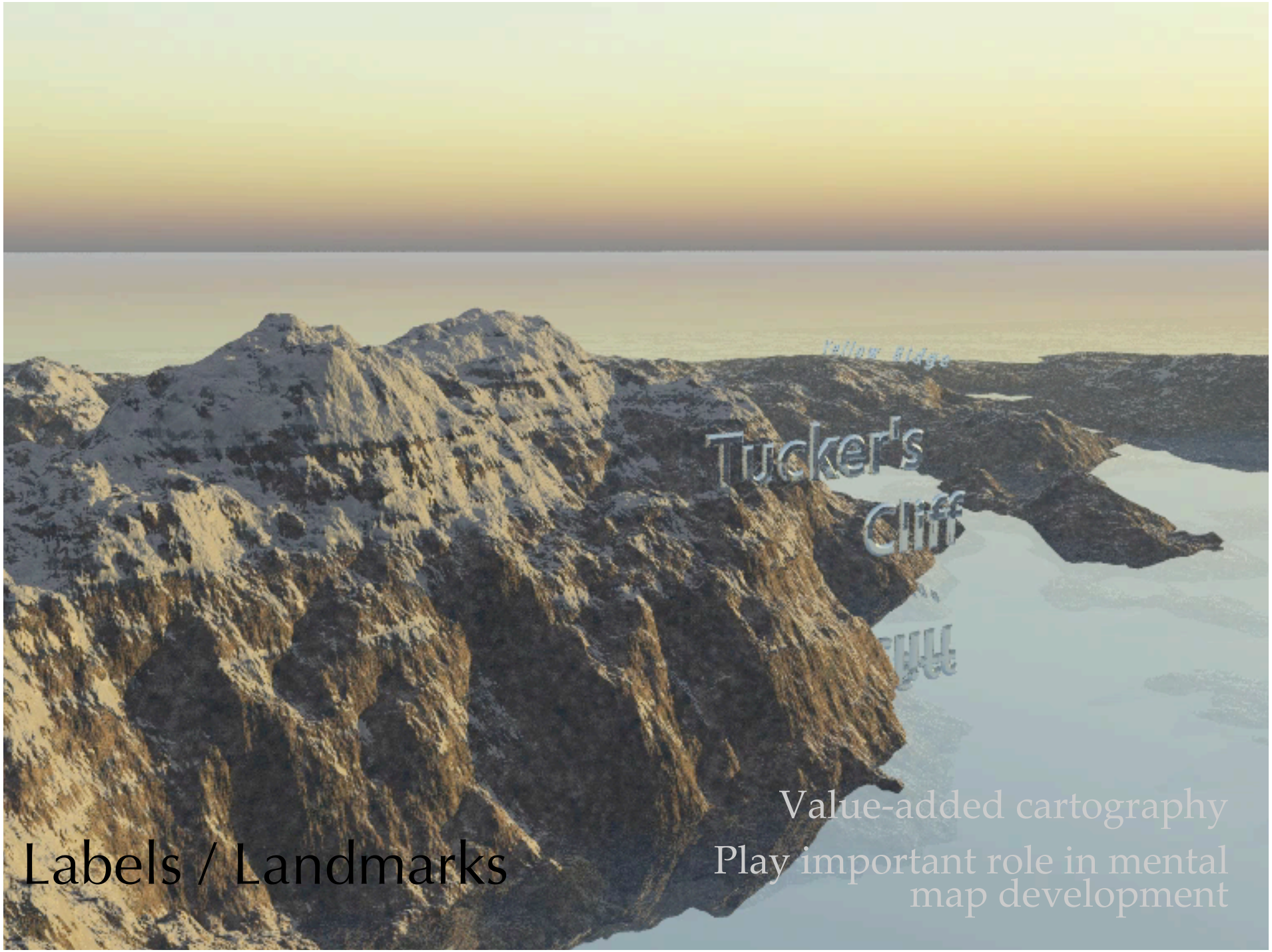

Landscape Grid
Helps with distance and
angular relationships



Landscape Grid

Should decrease split attention

Z scale needed with vertical exaggeration



Labels / Landmarks

Value-added cartography

Play important role in mental map development

Monorail
Previews motion ahead
Answers “have I been here before?”

Experimental Findings: Directional Errors

Avg Directional Error = 45°

Monorail and Grid halved that

Compass eliminated it

Labels made it worse

Experimental Findings: Survey Knowledge

Path Drawing

Monorail most successful, followed by Grid

Compass no help

Labels made it worse

Harrower, M. and B. Sheesley (2007). Utterly lost: Methods for reducing disorientation in 3-D fly-over maps. *Cartography and Geographic Information Science*.

Harrower, M. and B. Sheesley (2005). Moving beyond novelty: Creating effective 3-d fly-over maps. Proceedings of the XXII International Cartographic Conference (ICC2005). A Coruña, Spain, 11-16 July 2005.

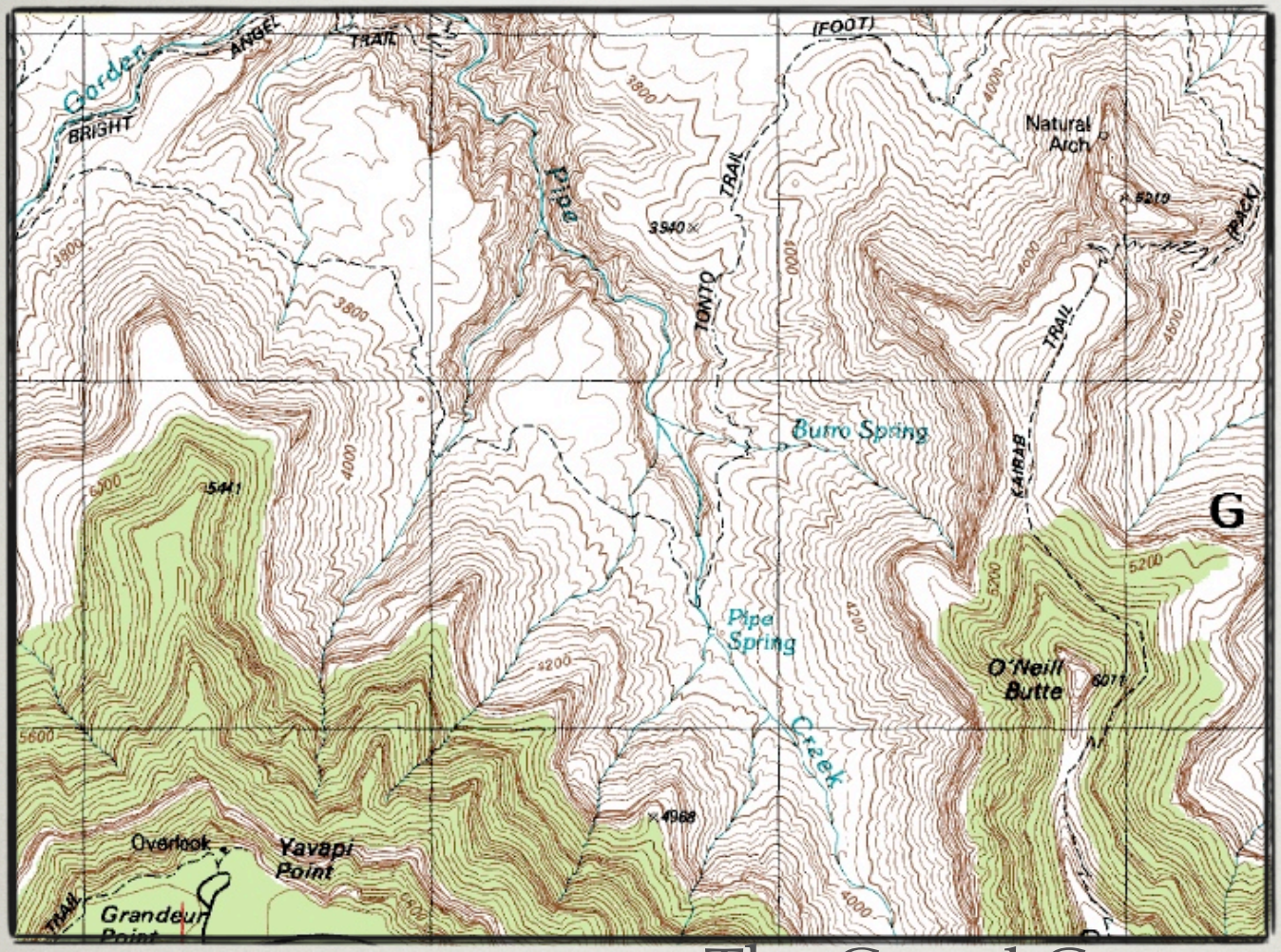
Important Distinction:
Analytical vs. **Subjective** Map Reading Tasks

1: Engendering a sense of place
"Experiential Cartography"

2: Grabs our attention

3: Bridges our lived experience and map data

...all good things



The Grand Canyon

The Grand Canyon

The Grand Canyon - Google Earth Demo

Thank you!

maharrower@wisc.edu