Data Imaging and Visualization Analysis

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Overview

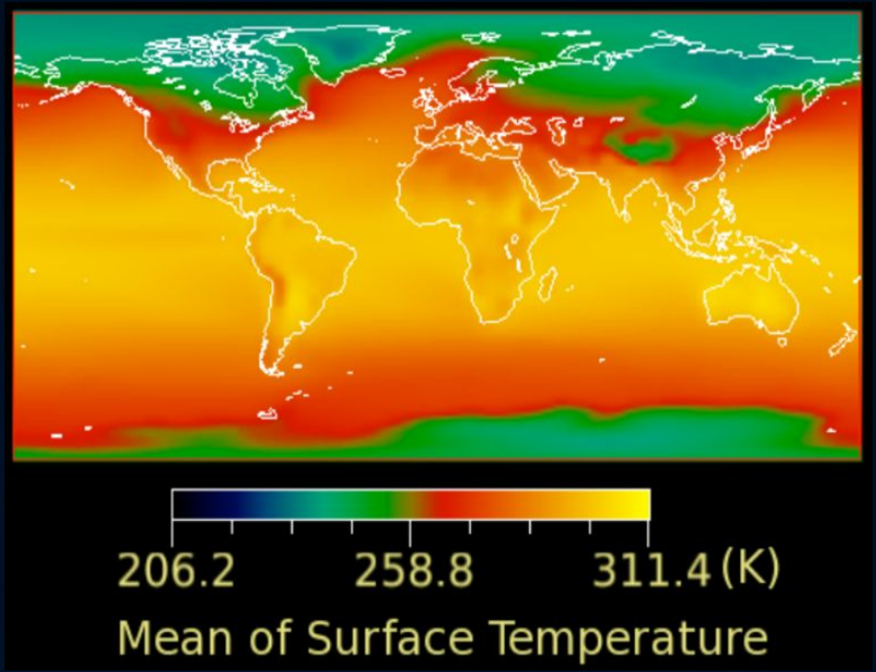
- Background
- Past Research
    - 2-D maps ⟶ 3-D maps
    - Our solution: Virtual Reality
- Research Questions
- Methodology (3 Phases)
    - Product Development (current)
    - Product Improvement
    - Product Evaluation

Motivation for Our Project

- Terabytes of climate data
- Current visualization and analysis methods are inadequate and not interactive.
- Difficult to…
    - View multiple variables
    - Observe correlations
    - Zoom in on areas of interest

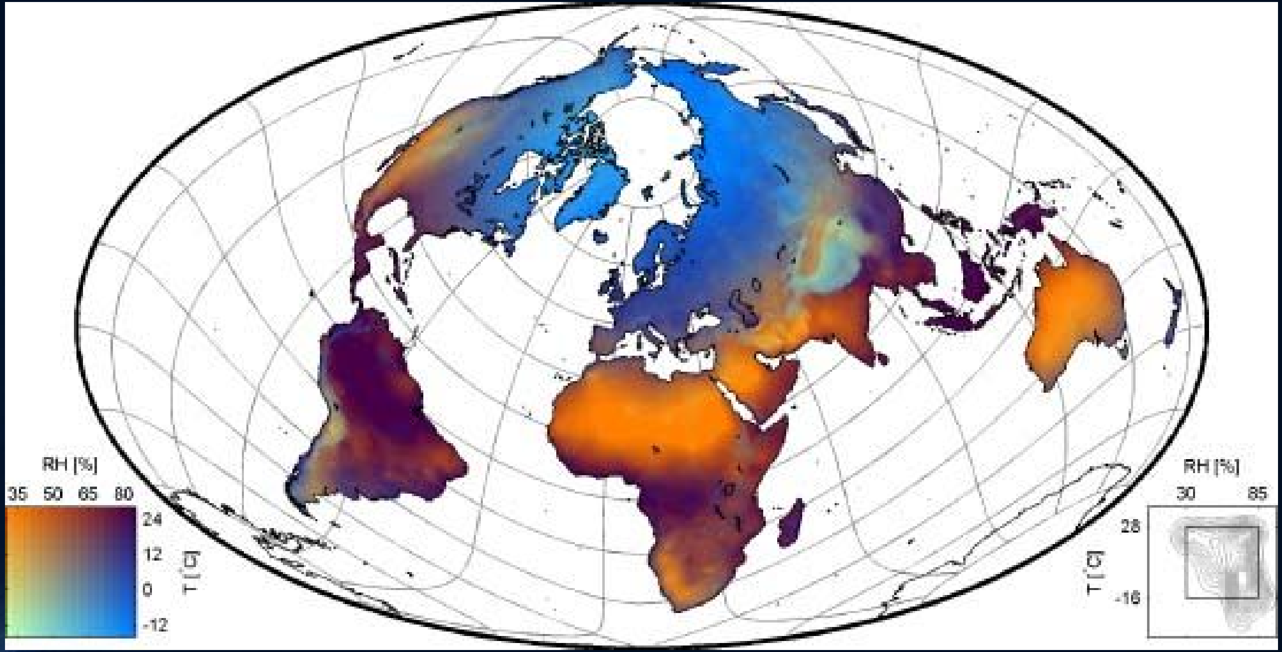
Past Research: Current Visualization Methods

2-D Color Maps



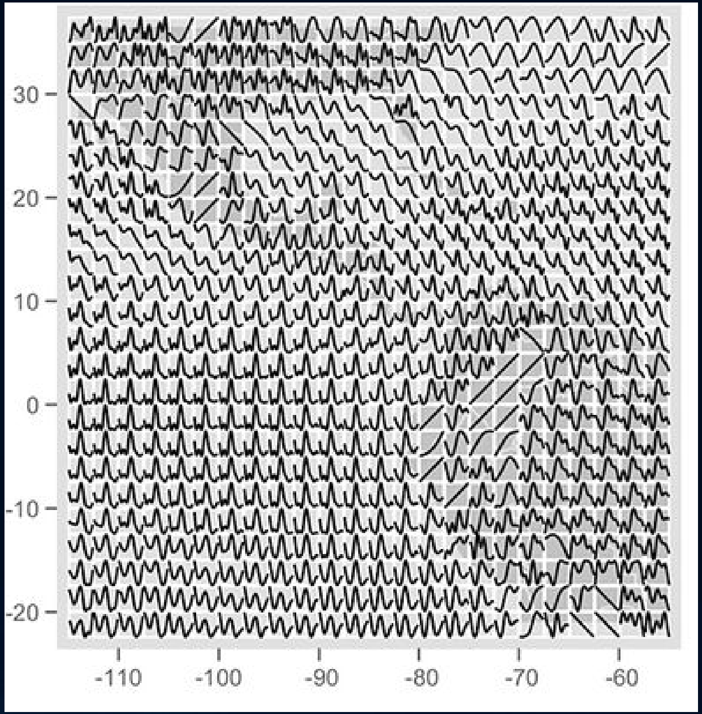
Mean Surface Temperature. TImeframe unknown (Potter at al., 2009).

Two-variable Colored Maps



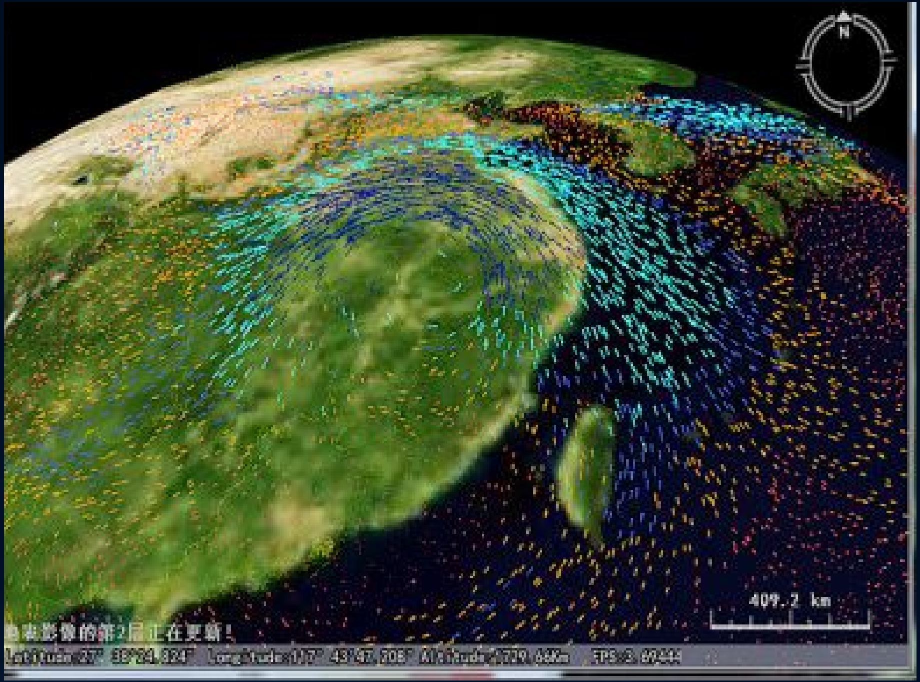
2-D map of relative humidity and temperature (Teuling et al., 2011).

Glyph Maps



Glyph map of temperature across a region (Wickham et al., 2012).

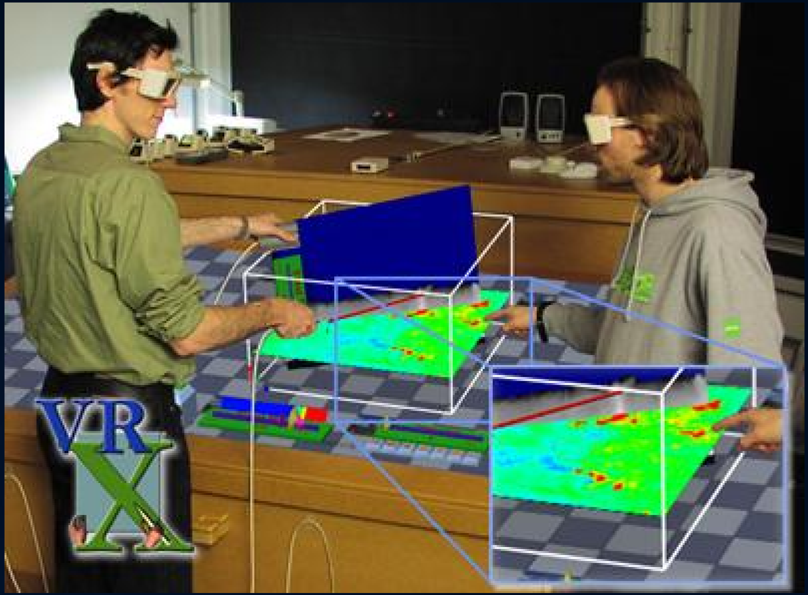
3-D Globes



Tropical cyclone visualized in World Wind globe API (Liu et al., 2015).

Solution

Visualize and Analyze Data with Virtual Reality (VR)



(Koutek, M., & Post, F., n.d.)

Research Questions

Research Questions

- In terms of computation time, feature selection, and storage, how can we most effectively design and create a Virtual Reality climate data visualization tool?

- What are the most user-friendly, aesthetically pleasing and informative ways for scientists and the general public to visualize climate data through VR?

Methodology

Phase I - Product Development: Oculus Rift Overview

- Most widely used VR device with cutting-edge capabilities
  - Head- and Position-tracking
- Enhanced interactivity of Oculus Touch
- ReactVR web interface

(Turbosquid,. 2015)

Phase I - Product Development: System Overview

Control Flow for Cloud-based Climate Data Visualization Tool

User's Oculus
Handles input from controller and output to screen.

User sends query (Climate data file, visualization parameters).

ReactVR sends this image to user's Oculus.

ReactVR web interface
Handles communications between user's Oculus and remote GPUs.

ReactVR forwards query to GPU cluster.

GPU cluster returns rendered image to ReactVR in real time.

GPU cluster
Handles processing of big data so that user's machine does not have to.

Unity 5 Overview

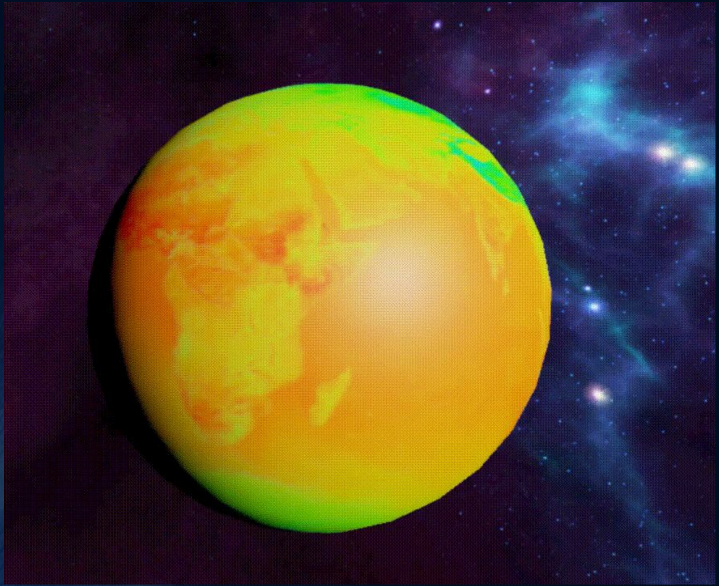
- Uses C# and own version Javascript - “Unityscript”
- Advantages:
  - Less resource intensive
- Disadvantages:
  - No netCDF library built natively in C#
  - Very low version .NET - Recently updated to .NET 3.5 but still not enough
  - “Unityscript” breaks from the norm of Javascript
- Bottom line: Must wait until a version of Unity which supports at least .NET 4.0 gets released

Unreal Engine 4 Overview

- Uses unmodified C++
- Advantages:
    - netCDF library written in C → simple integration
    - More potential for better graphics in visualization
    - “Blueprint” mode
- Disadvantages:
    - Resource intensive - especially processor speed and graphics
- Planning to utilize a supercomputer in the future and host Unreal Engine
- Our platform of choice for this project

Phase I - Product Development: Current Progress

Current Progress



Able to read in and display an entire netCDF file of one variable

Future Goals

- Ability to display multiple variables
- Volumetric 3D rendering for height fields
- Tools to identify meaningful correlations among data
- Interface with maps
- Adjustable color schemes

Phase II - Product Improvement: Focus Groups

- Three separate focus groups
- Two teammates leading a facilitated discussion with guided questions
- Will receive informed consent to record video of discussion

Phase II - Product Improvement: Focus Groups

First Focus Group

Who

5 graphics experts from UMD faculty

Goal

To refine aesthetics and user interface

Second Focus Group

Who

30 students from UMD

Broken into 5 groups of 6

Goal

To get broad feedback on usability

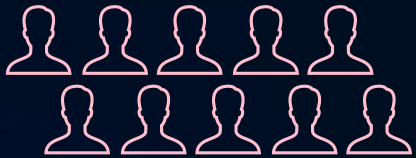
Third Focus Group

Who

10 climate experts from NOAA and UMD

Goal

To get feedback with respect to climate visualization



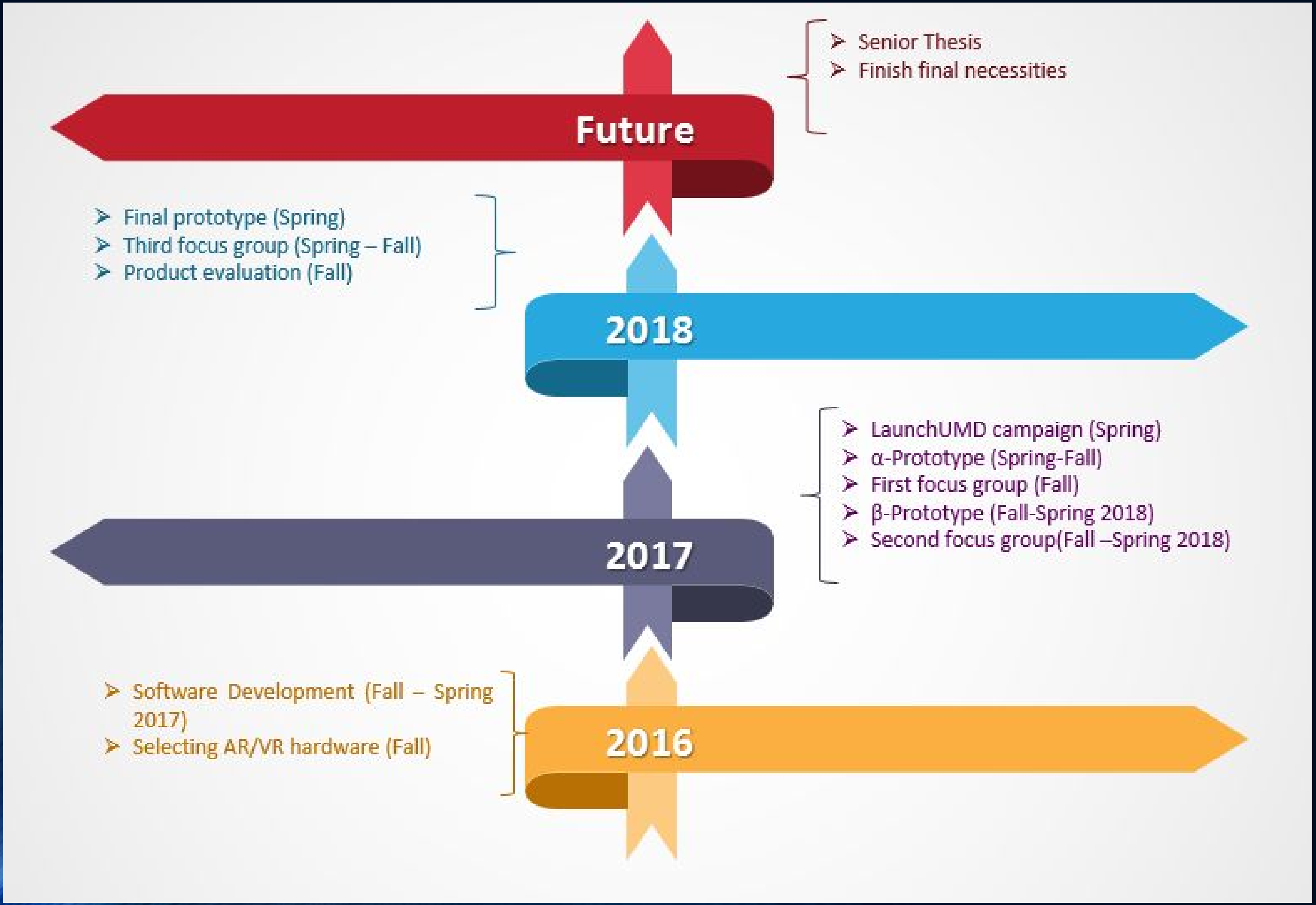
Phase III - Product Evaluation: Individual Surveys

- Convenience Surveys: Rate our product compared a traditional visualization
  - About 50 new participants from the general public
  - Record ratings on each tool and compare
- Targeted Surveys: Given a specific task, record time required
  - 10 research experts with experience in visualization software
  - Complete the same survey as the general public in addition to timed task
- Anticipated Results: ratings will be significantly higher, and times will be significantly quicker

Future Plans

Budget

	Name	Unit Price	Quantity	Costs	Date
Expenses					
	Oculus VR Device	$ 800.00	1	$ 800.00	Spring 2017
	Oculus VR Device	$ 800.00	1	$ 800.00	Fall 2018
	Student Survey Compensation	$ 5.00	50	$ 250.00	Spring 2018 / Fall 2019
	Student Focus Group Compensation	$ 15.00	30	$ 450.00	Fall 2017
	Graphic Designer Focus Group	$ 20.00	10	$ 200.00	Fall 2017
	Climate Expert Focus Group	$ 20.00	10	$ 200.00	Fall 2018 / Spring 2019
	Travel Expenses / Conferences	$ 1,000.00	3	$ 3,000.00	Spring 2019
Total				**$ 5,700.00**	
Revenue					
	Launch UMD	$ 4,000.00	1	$ 4,000.00	Spring 2017
	Gemstone Funding*	$ 600.00	1	$ 600.00	Fall 2016
	Gemstone Funding*	$ 600.00	1	$ 600.00	Fall 2017
	Gemstone Funding*	$ 600.00	1	$ 600.00	fall 2018
Total				**$ 5,800.00**	
	* goes away after every school year				


Senior Thesis
Finish final necessities
Future
Final prototype (Spring)
Third focus group (Spring – Fall)
Product evaluation (Fall)
2018
LaunchUMD campaign (Spring)
α-Prototype (Spring-Fall)
First focus group (Fall)
β-Prototype (Fall-Spring 2018)
Second focus group(Fall –Spring 2018)
2017
Software Development (Fall – Spring 2017)
Selecting AR/VR hardware (Fall)
2016

Acknowledgements

Dr. Stephen Penny (Mentor)

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Ruofei Du (VR Expert)

Questions?

(Turbosquid, 1. 2015)

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