Data Imaging and Visualization Analysis

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We pledge on our honor that we have not given or received any unauthorized assistance on this assignment/examination.

Overview

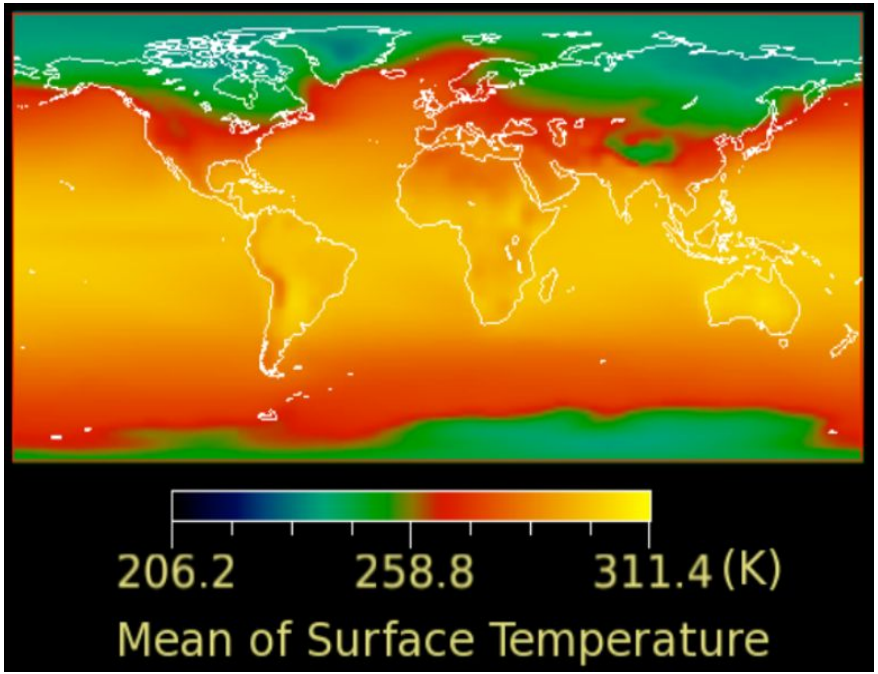
- Background
- Past Research
  - 2-D maps → 3-D maps
  - Our solution: Virtual Reality
- Research Questions
- Methodology
  - Product Development
  - Product Improvement
  - Product Evaluation

Motivation for our Project

- Lots of new climate data collected every day
- Current visualization and analysis methods are inadequate, and not interactive
  - Difficult to view multiple variables
  - Difficult to observe correlations
  - Difficult to zoom in on areas of interest

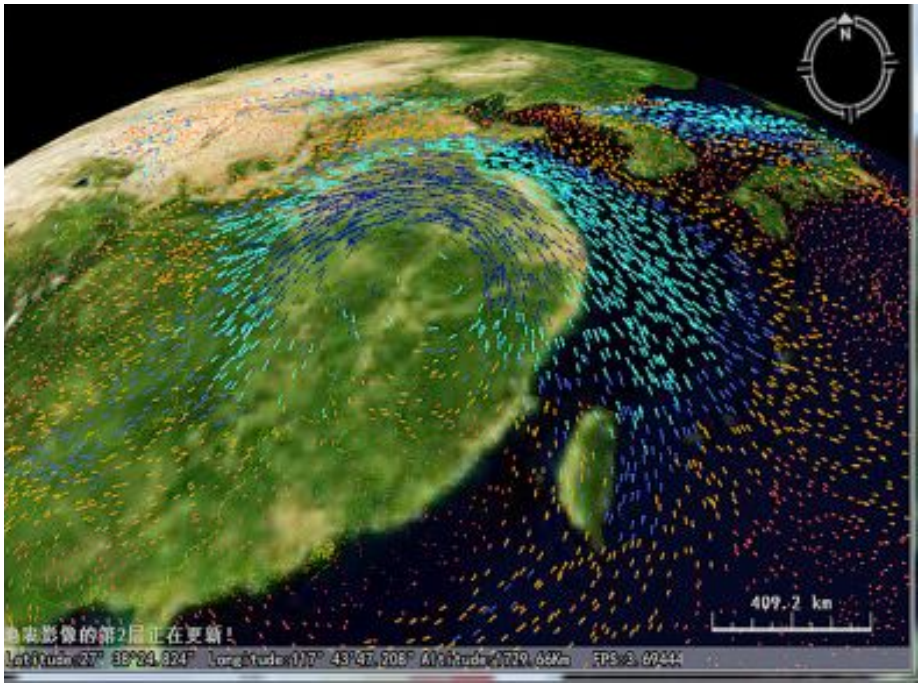
Past Research:
Current Visualization Methods

2-D Color Maps



Mean Surface Temperature. Timeframe unknown (Potter et al., 2009).

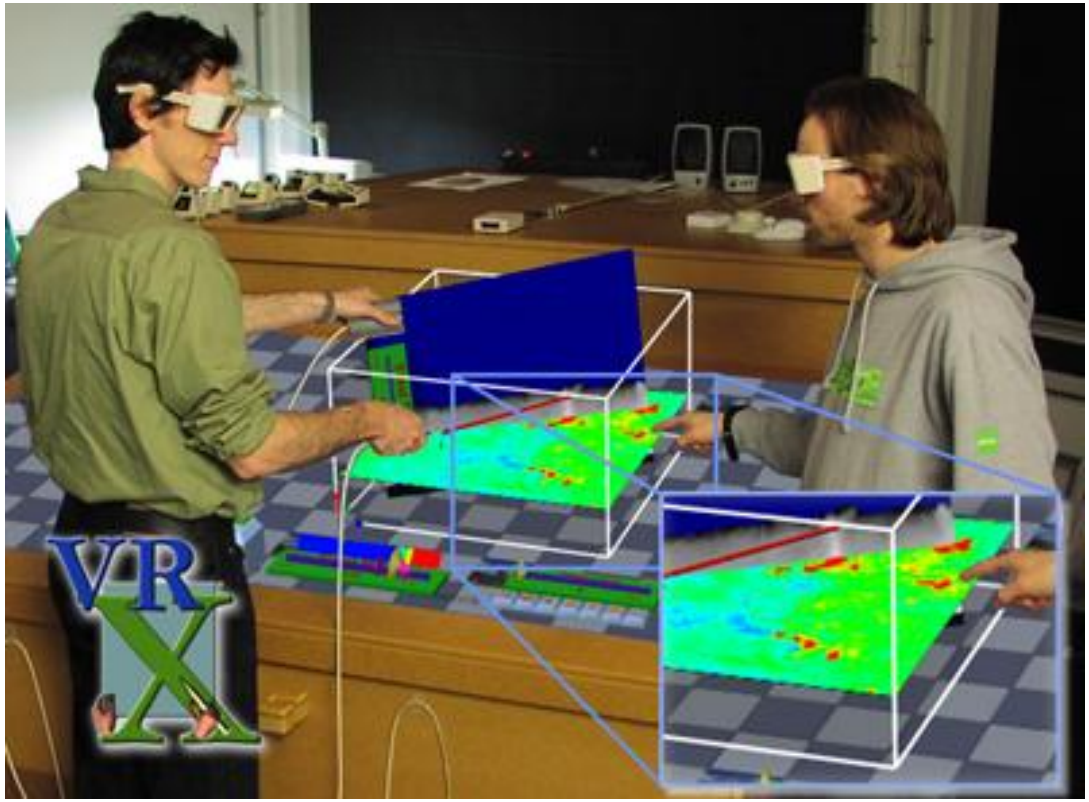
3-D Globes



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

Our Solution

Visualize and Analyze Data with Virtual Reality (VR)



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

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?

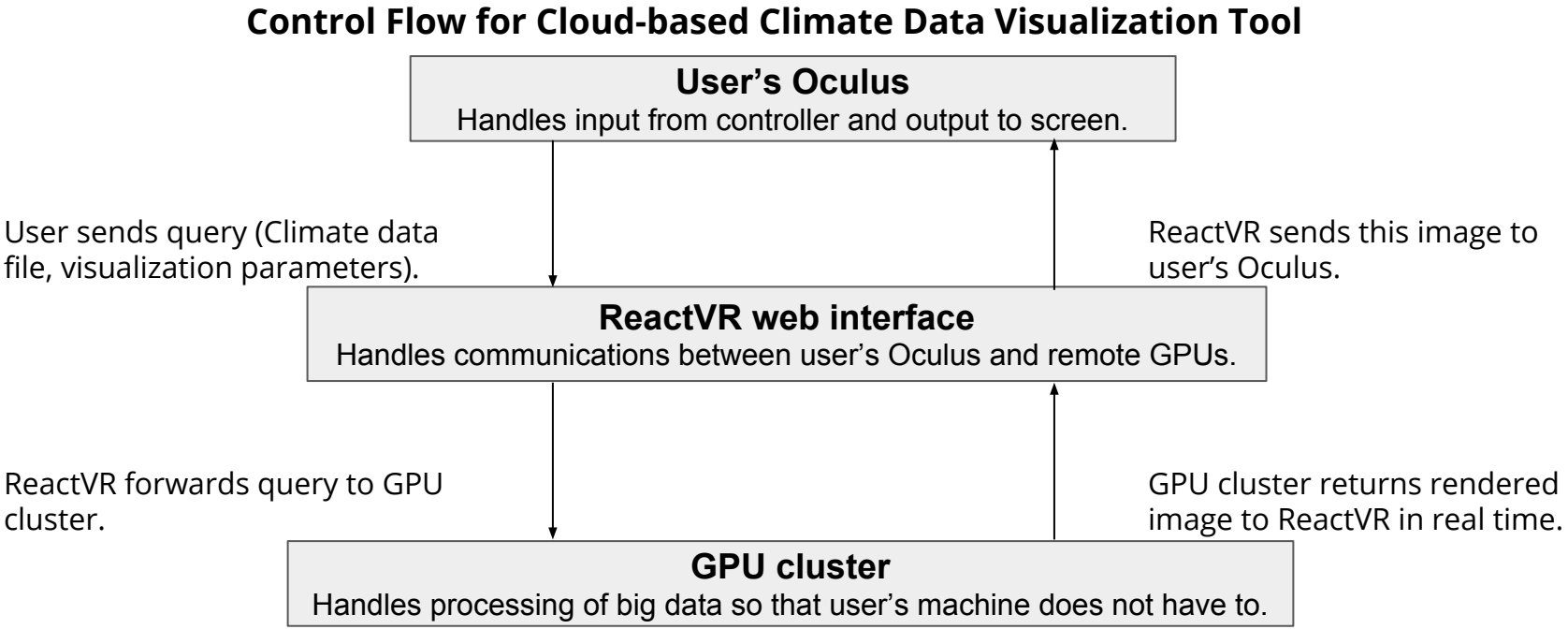
Methodology

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



Phase I- Product Development: Platform Overview

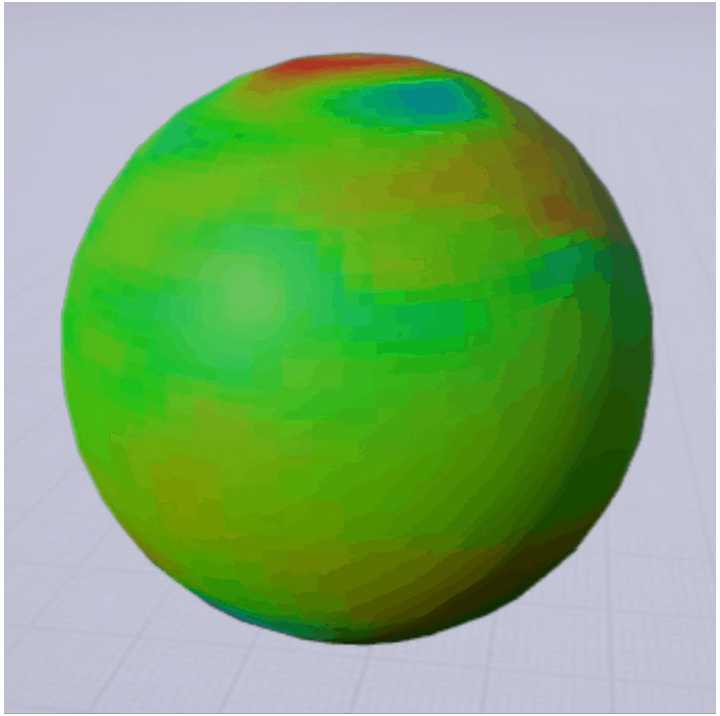
Unity 5

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

Unreal Engine 4

- Uses unmodified C++
- Advantages:
  - netCDF library written in C so simple integration
  - More potential for better graphics in visualization
  - “Blueprint” mode
- Disadvantages:
  - Resource intensive - especially processor speed and graphics
- Planning to obtain supercomputer in the future to host Unreal Engine

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 and location services
- Adjustable color schemes

Phase II - Product Improvement: Focus Groups

- Three separate focus groups
- Two teammates leading a facilitated discussion with guided questions
- Video recording 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

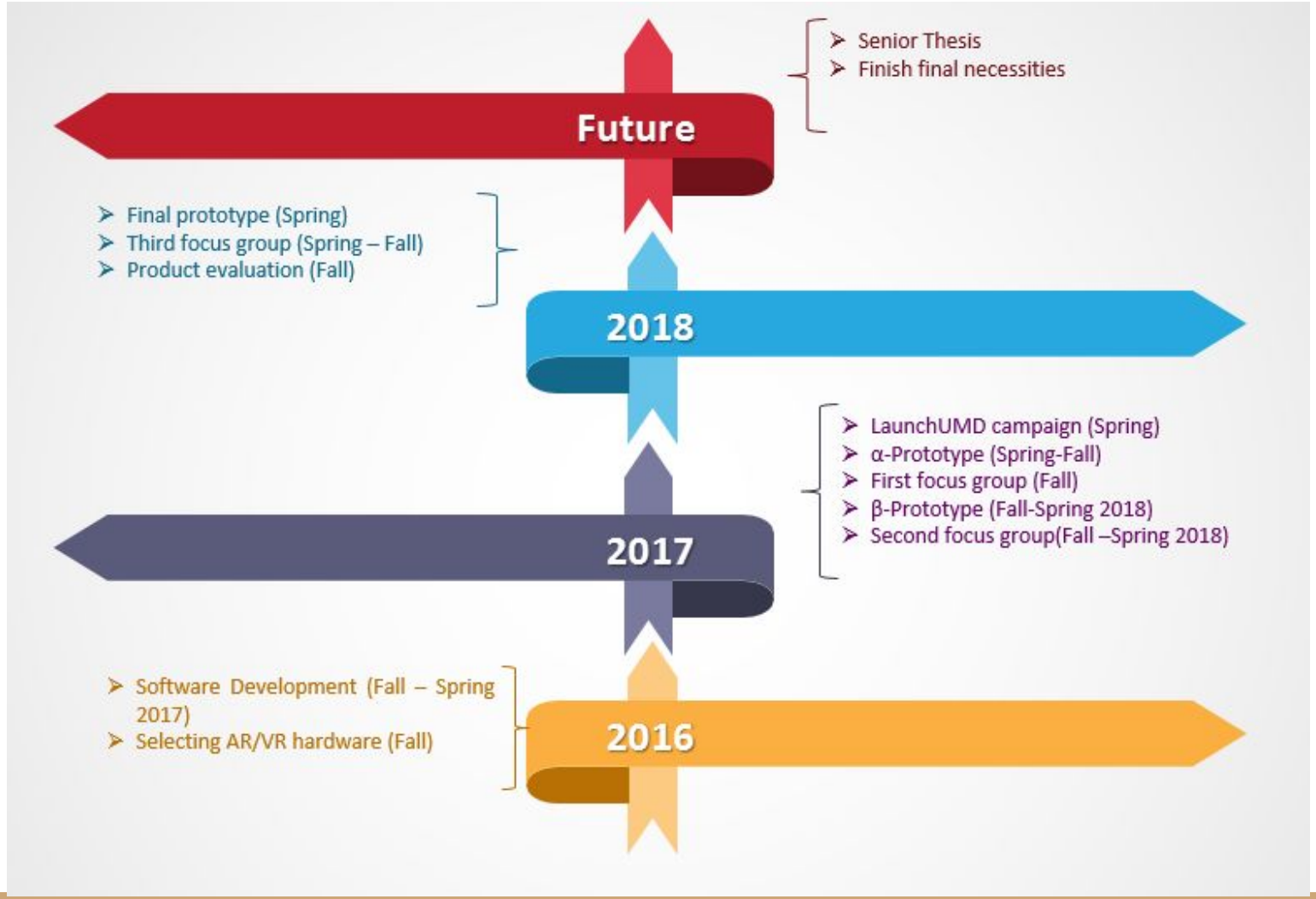
Goal

To get feedback with respect to climate visualization

Phase III - Product Evaluation: Individual Surveys

- Convenience Surveys: Rate our product compared to traditional methods
  - 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


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

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	$ 1,200.00	3	$ 3,600.00	Spring 2019
Total				**$ 6,300.00**	
Revenue					
	Sustaiability Fund	$ 2,000.00	1	$ 2,000.00	Spring 2017
	Launch UMD	$ 4,500.00	1	$ 4,500.00	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				$ 8,300.00	
	*** goes away after every school year**				

Acknowledgements

Dr. Stephen Penny (Mentor)

Dr. Kelley O’Neal (Librarian)

Dr. Kristan Skendall and Dr. Frank Coale (Instructors)

Jill Smith (Section Leader)

Questions?

(Turbosquid, 2015)

References

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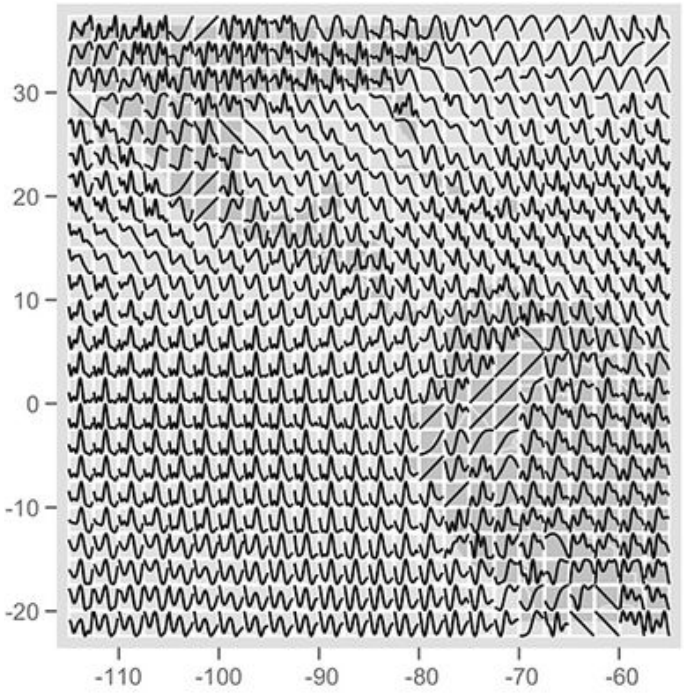
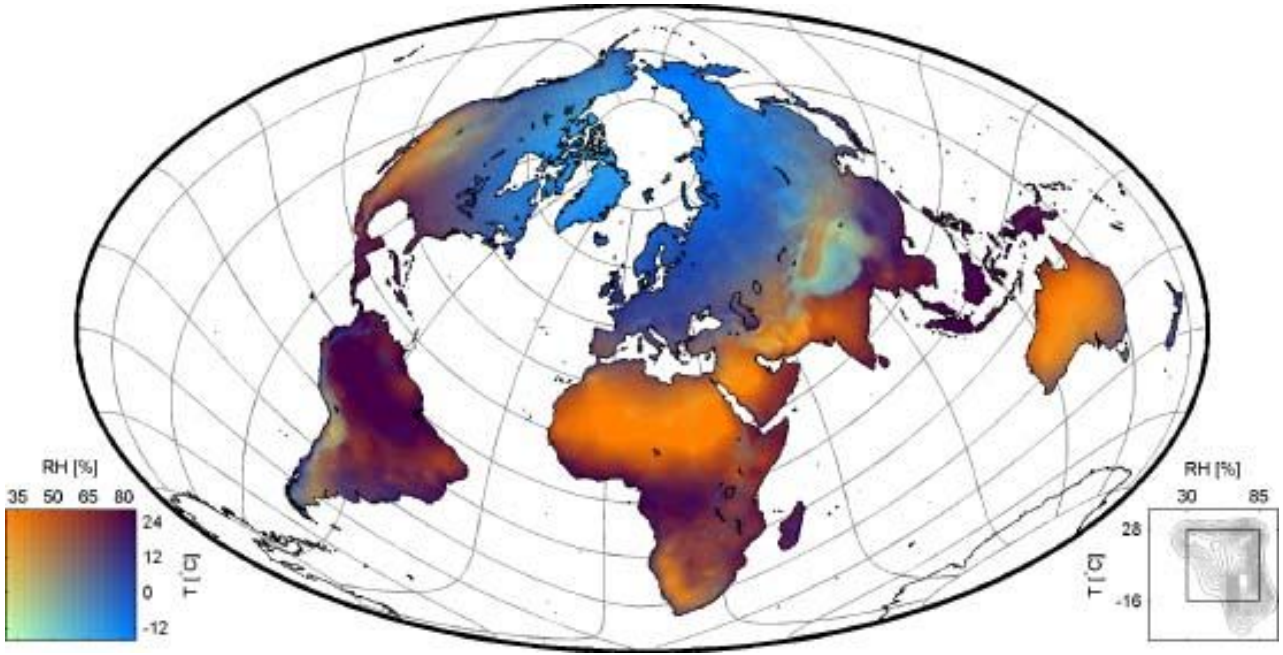
Wickham, H., Hofmann, H., Wickham, C., & Cook, D. (2012). Glyph-maps for visually exploring temporal patterns in climate data and models. Environmetrics, 23(5), 382-393.

Appendix A: Glyph Maps



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

Appendix B: Two-variable Colored Maps



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