VASE (Visualized Atmosphere Sounding Exploration)

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ABSTRACT

Despite atmospheric science and weather forecasting being relevant data to many fields and corporations, there has not been a lot of innovation incorporating the modern breakthroughs and methods of interactive visualization to the meteorological field. There is a plethora of free atmospheric information valuable on the internet that is being under-utilized. Having a more approachable way to present and explore the information in a browser based application could benefit individuals from a number of fields and make use of the avalanche of data available. Due to the complexity and scope of information from Soundings, VASE, like its predecessor the Skew-T chart, is still slanted towards individuals with meteorological training.
VASE is an attempt to utilize d3.js and visual variables to redesign the traditional Skew-T chart to be more intuitive and facilitate the comparison of multiple Sounding readings. Even for these experts, Skew-T charts are not particularly effective or efficient for many important forecasting tasks, as the presented format is difficult for comparing two readings side by side to view patterns. VASE attempts to present this information in a way that trained users can innately spot patterns to compare or contrast readings.

Keywords: Meteorology Visualizations, Sounding, Atmospheric data, Skew-T.

1 INTRODUCTION

Skew-T charts are formed from data "collected by launching a balloon with an attached sensor and transmission equipment called a radiosonde. The set of data from one balloon launch is called a sounding" [1]. These soundings provide meteorologists with the information required to make weather forecasts by providing 6 variables and 5 derived variables.

Weather forecasts have a large audience built up of more than just meteorologists including but not limited to farmers, government authorities, and the military [4], but a traditional Skew-T reading takes a great deal of specialized training to be able to extract information from. There is a vast amount of atmospheric sounding data is widely available for free, but the data tables or Skew-T formats it is available in are only useful to trained specialists. Even for these experts, Skew-T charts are not particularly effective or efficient for many important tasks, as the presented format is difficult for comparing two readings side by side to view patterns. Additionally, many other experts require the use of weather data for predictive modeling [5].

During a two-year long design study involving meteorologists in decision making contexts, Quinan and Meyer found that design flaws in visualizations can lead to misinterpretations and inaccuracy, but that there was very limited support for working with ensemble forecasts (two or more simulation outputs that cover an overlapping geographic area or time frame).
Challenges visualizing weather and climate data specifically are: users come from a wide array of skill levels, ages and disciplines, so tools must account for a range of task variation; alternative visualization techniques are required for analyzing large time-dependent data sets; the heterogeneity of climate data requires many types of visualization to present; and it requires sophisticated technologies to bridge the gap between hefty complex data sets and the users [2].

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2 RELATED WORK

I uncovered two previous documented attempts to rework a static Skew-T chart, THETAPLOT during the 1980s and most recently AtmosView [1] AtmosView is a very intuitive and creative rework of the Sounding data, with a strong foundation in psychological and design principles. It is able to present a lot of visual data using a small static image, and has been designed to accommodate for all common types of color blindness. In addition to creating interactive components for the climate data, three aspects of the chart are in need of a rework: it relies on some text that may be difficult to read at the small font size it is displayed in when comparing more than one graph, the graduation of color in the small red glyphs is difficult to discern, and certain aspects aren't initially visible or intuitive. Using two different values to represent factors indicating atmospheric stability within the size chart readings was very well conceptualized and provides much more data than would be expected at an initial glance. Such visual components facilitate visual comparisons between two or more charts.

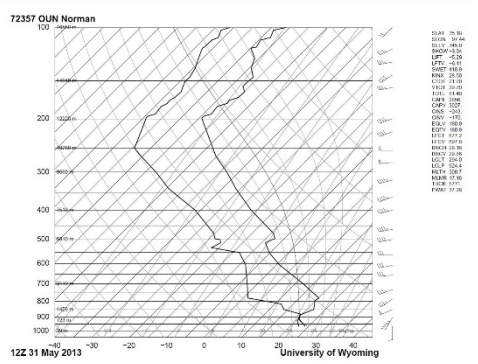

Figure 1: Traditional Skew-T Chart (Same data as Figure 3)

3 DESIGN ELEMENTS

Soundings take readings from the same geographic location at many different altitudes. Each bar represents one geographic location, with the elevation increasing the closer it is to the top of the bar chart. The idea of data-vases combine with AtmosView drove the design, but with altitude being depicted with vertical space rather than time. This design was implemented using D3.js (data driven documents). To facilitate identifying patterns between readings, it was decided to provide most details on demand so that the viewer can focus comparing Soundings then be able to find specific numbers. Altitude is the variable that all of elements of the Glyph are positioned by.

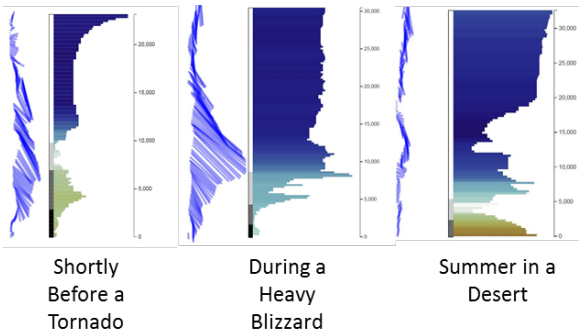

Figure 2: Data Vase Examples

3.1 Temperature and Dew-Point Depression

Many studies have been conducted as to how to best use color to represent temperature in Meteorological data. In a 2015 study completed by Quinan & Meyer they propose an optimal color scheme for representing temperature which I utilized in my design. Their color scheme was selected because a) it has been scientifically studied at a greater scale than I had the resources to accomplish and b) their paper mentions the importance of industry standards for colors, cold in particular to determine when a temperature is below freezing. For my color scheme 0*c or freezing, is displayed in white. Not only is the color hue distinct from the rest of the readings, the tonality is noticeable as well. The color scheme used becomes more saturated at extreme temperatures. After consultation with my meteorological source I refined my color scheme to convey more nuance at the lower altitudes that were much more important for weather forecasting, at the cost of subtler variation at extremely cold temperatures. The temperature for the altitudes of the reading is indicated by color to show trends, but the exact temperature is available on mouse over. I concur with AtmosView that the lengths of the bars are best used to represent dew-point depression as it is a vital variable that doesn't have a natural variable fit, and size is unused. The larger the bar is, the greater the difference in the absolute value between temperature and dew point at any given altitude, the larger bars represent dryer spaces.

3.2 Pressure Bar

According to my pre-design interviews with a meteorologist, the atmospheric pressures relevant to common forecasting needs are between 500 and 1000 hPa. For purposes of easy comparison, to the left of the temperature and dew-point depression graph the pressure/ thicknesses for commonly referred to pressure ranges are denoted. The range between 1000 and 850 is denoted in light grey, between 850 and 700 in medium grey and between 700 and 500 in black.

3.3 Wind Glyph

The angle of the line display is the angle and direction of the wind from the data. It made sense to use angle as the variable for wind, given its nature as a strong visual variable for quantitative data, and the benefit of being intuitive. This is the area of the glpyh to the far left in azure. The length is represented at 1 px per knot. The partially transparent color of the wind glyph makes it easier to see the direction and speed of the variables nearby as well. Additionally, it seemed like a strong stylistic choice to represent the nature of wind and differentiate it from the rest of the chart. Most users instantly identify the temperature glyph because of the color scheme, so I wanted to create something else that conveyed the information while being simultaneously familiar and unfamiliar.

3.4 Design for Next Phase

Future plans include the ability to search by city and day (or the averages of several days), as well as the data table featured on Skew-T charts that includes data derived from these variables. Meteorologists rely on those for short cuts to easily interpret the chart data and identify areas of interest. In the current design plan, all information to the right of the glyph will be presented as information on demand, so it doesn't distract from comparing multiple visualizations.

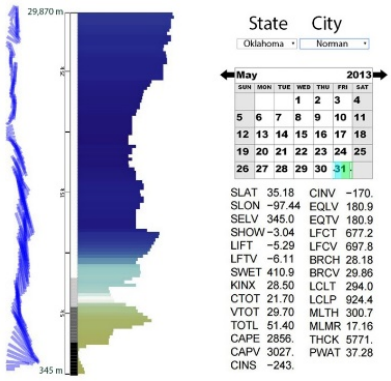

Figure 3: Interface Design

4 Scope and Limitations

Due to the small sample size of experts I have worked with so far, it is entirely possible VASE would not be as widely appreciated as hoped, as VASE is tailored to their decision making processes. Further insights into forecasting would be helpful to refine the design of VASE and ensure maximum efficiency. In its current state VASE is a proof of concept, that there are more approachable ways to present weather data while maintaining its complexity. The goal is not just to provide a tool to make the forecasting more efficient and effective for experts, but also to make the field a bit more approachable for novices. My hope is that having Sounding data presented in a more colorful, interactive and intuitive way will encourage more people to learn about weather science.

The learnability suffers from the same shortcomings as its predecessors. Making meaningful connections from Sounding data requires a great deal of training. In a matter of minutes, the average user could learn to extract variable values from the Glyph, but it is only meaningful in the hands of a trained expert. Whereas, the handful of subject experts found the system easy to learn, their suggestions for improvement mainly centered around including more information in the design, mainly the derived variables featured on the Skew-T chart tables. Their feedback was overwhelmingly positive, indicating there may be a desire for more interactive and visual tools for meteorological data.

References

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