CW3E Summer Internship 2021
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Project Title: CW3E Observational Database and Interactive Dashboard

Introduction

Since 2017 the Center for Western Weather and Water Extremes (CW3E) field team's observed meteorological data has not had an efficient way to analyze and interact with the data. The data is currently stored in NetCDF files which have no active and easy interaction with. In regards to visualization of the data, the CW3E website currently presents static images for data examples. It is important to have accessibility and visualization of data in order to verify results and other scientific and operational uses.

The goal of this project was to create a way to store and interact with the data easily. The two component project was the creation of the database, the "backend" of the project, and the development of an interactive dashboard, the "front end" of the project. The data used for this project is provided by the measurements of reflectivity and vertical velocity from the Micro Rain Radars (MRR) installed by the CW3E field team in various locations throughout California.

Database

Two Python programs were written in order to create the database using Spyder IDE. The first program aggregated the MRR data from NetCDF file format to CSV file format, in order to be able to translate the information into a database more easily. The second program created was in combination with PostgreSQL, which would make the structured tables in the SQL database in order to ingest the CSV files created by the first program. PostgreSQL was used because it was a popular open source relational database and it was efficient for the creation of the database.

The database is formatted as follows: there is a table for every variable in every location, each table contains a measurement by the time and date by the height, and each time measurement is on a five/ minute increment. The variable measurements (i.e. the vertical velocity at 500 m on 01/08/2020) are stored as a numeric type and the date and time is stored as a character type. The date and time are stored in the ISO 8601 format. Each table is labeled with the ID of their location (i.e. BBY = Bodega Bay, CA) and the abbreviation for the measurement (i.e. W = Vertical Velocity).

By creating a database it was possible to translate the data into a visual aspect on the dashboard.

Dashboard

The database was implemented into Tableau in order to create a dashboard in order to visualize and work with the data. The dashboard (Fig.1) is a connected dashboard that includes a map location selection section and a comparison by location and measurement section. The map section contains six dots that indicate the location of the MMRs, by selecting a dot the graphs underneath the map show the reflectivity and vertical velocity of that location based on the date selector between the map and the graphs. The date selector can be changed by the user whenever it seems fit and will affect the graphs if data is available during those dates. The Comparison by Location And

Measurement section is controlled by a Type, Location, and date selector. The date selector in this section of the graph does not affect the graphs in the map section. The type selector allows the user to display between the measurements. The location selector is similar to the map location selector, only that in this case the location selector is a dropped down menu with location names only.

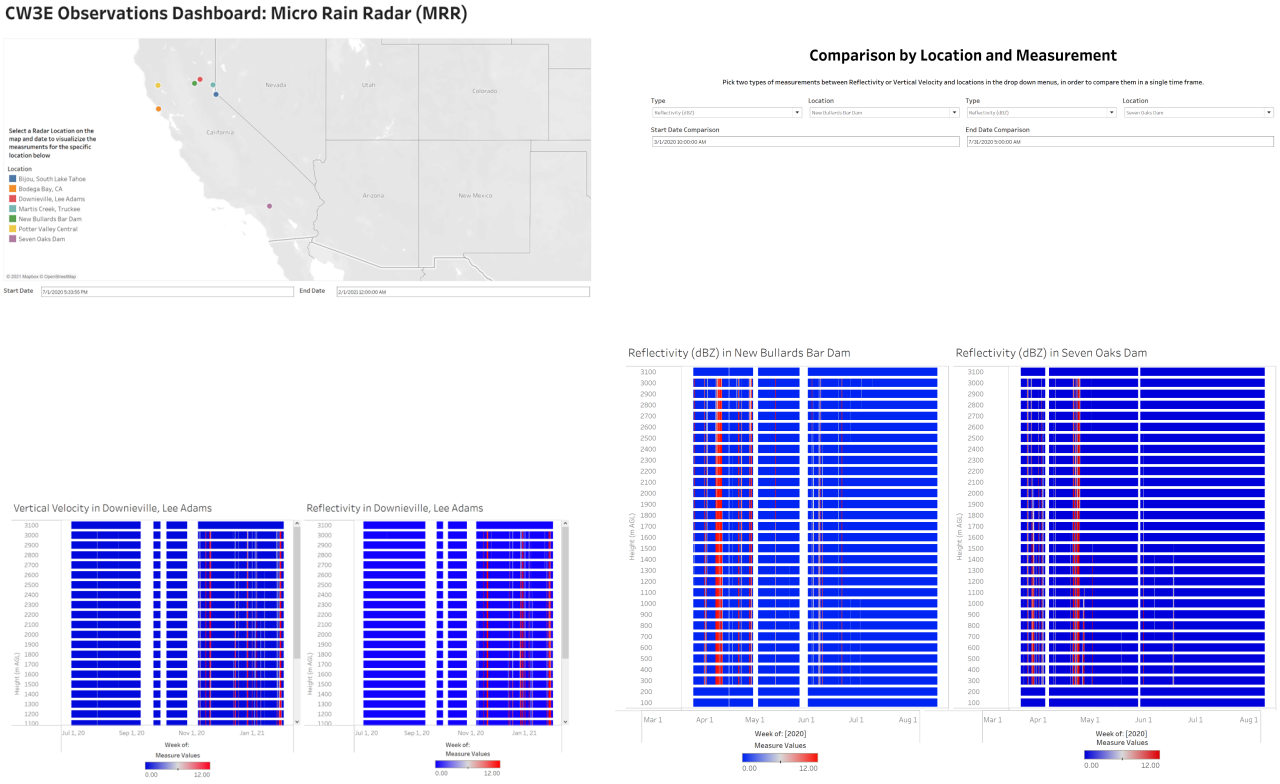

Fig.1 CW3E MRR Dashboard: Map Selection and Comparison by Location and Measurement

There are two tooltips on the map in order to show the user more information about the data displayed. For the map selection, the tool tip shows the location's: name, ID, site, Watershed, Year of Installation, latitude and longitude, and elevation(m). The graphs also have a tooltip which shows the date and hour and the name of the measurement and its corresponding label.

Applications

The database and dashboard gives us a way to interactively visualize, compare, and filter our observational data collected by the CW3E field team. We anticipate that the database and the dashboard will be used by researchers such as members of the field team and the modeling teams of CW3E. It will also allow CW3E to show stakeholders and partner agencies the progress the center has had, and also allow them to interact with data. The dashboard is currently a template as to what future CW3E data may look like and in that sense will see continuous addition of various features over time, which makes its applications a variability over time.

Challenges Faced

Before the internship, I did not have any experience with Python, SQL, or Tableau. Understanding and creating a database was the longest part of the internship, as this section of the project had several different elements I had to understand in order to get it correct, such as understanding the organization methods of a database. While not as difficult as learning Tableau was also a learning experience, as the program was much different from anything I had used before.

Next Steps

Next step for this project would be to host the dashboard on the CW3E website and expand the dashboard to include Brightband heights, ability to filter values and graph the chart AGL (above ground level) vs MSL (above mean sea level). In the future the dashboard could be automatically connected to a self actualizing database, which would show the data at it's latest instead of having to update it constantly. The next instrument added to the dashboard will most likely be the disdrometer. The dashboard is a template to what CW3E data could be displayed as in the future.

Bibliography

The COMET Program. "MetEd Weather Radar Fundamentals "
https://www.meted.ucar.edu/radar/basic_wxradar, August 16, 2021.