Wind Data Visualization

This project contains two Python scripts, `Final.py` and `Final_GIF.py`, that visualize wind speed and direction data. Each script loads data from `.nc` files, processes it, and generates visualizations to analyze wind patterns for specific dates in 2005.

Scripts Overview

1. **Final.py** - Generates static wind direction and speed plots for specific days and displays them individually.
2. **Final_GIF.py** - Creates animated GIF showing wind speed and direction for specific days, displaying and saving the GIF after generation.

Prerequisites

Make sure you have the following dependencies installed before running the scripts:

- `numpy`
- `matplotlib`
- `xarray`
- `cartopy`
- `imageio` (only for `Final_GIF.py`)
- `IPython` (only for `Final_GIF.py` for displaying GIFs in a Jupyter environment)
- `os`

You can install these libraries using pip:

```
pip install numpy matplotlib xarray cartopy imageio ipython os
```

Dataset Requirements

Both scripts require wind data in `.nc` format:

- `vs_2005.nc`: Contains wind speed data.
- `th_2005.nc`: Contains wind direction data.

Ensure both files are located in the same directory as the scripts.

Scripts Description

1. Final.py

Purpose: This script generates static wind speed and direction visualizations for a set of selected dates and displays them individually.

How It Works:

- Loads wind speed (`vs_2005.nc`) and wind direction (`th_2005.nc`) data.
- Processes wind data for the following days: `2005-07-15`, `2005-08-25`, `2005-08-27`, `2005-08-28`, `2005-08-29`, `2005-08-30`, `2005-08-31`, `2005-09-01`, `2005-09-15`.
- For each selected day:
    - Calculates U and V components of the wind vectors.
    - Creates a quiver plot displaying wind direction and speed on a map.
    - Displays the plot with coastlines, borders, and a color bar indicating wind speed.

Usage:

```
python Final.py
```

This script will display each wind plot in a pop-up window. Each plot corresponds to a specific date listed above.

2. Final_GIF.py

Purpose: This script generates an animated GIF for wind speed and direction for specific dates, displaying the GIF and saving it as a `.gif` file.

How It Works:

- Loads wind speed (`vs_2005.nc`) and wind direction (`th_2005.nc`) data.
- Processes wind data for the following days: `2005-07-15`, `2005-08-25`, `2005-08-27`, `2005-08-28`, `2005-08-29`, `2005-08-30`, `2005-08-31`, `2005-09-01`, `2005-09-15`.
- For each selected day:
    - Calculates U and V components of the wind vectors.
    - Saves each plot as a PNG image in a temporary folder.
    - Combines saved images into an animated GIF with a 20-second duration.
    - Deletes temporary PNG images after each GIF is created.

Usage:

```
python Final_GIF.py
```

After running the script, a GIF will be saved to the working directory which can be viewed on the same.

Additionally, we have already run Final_GIF.py once to generate a GIF that is included in the project folder under the name wind_speed_direction_aug25_sep01_2005. You can still run the code as per the instructions to regenerate the GIF, which will automatically be saved to your working directory.

Example Output

1. **Final.py** - Displays a static map for each date, showing wind speed and direction.
2. **Final_GIF.py** - Saves and displays animated a GIF with wind speed and direction.

Notes

- **Running Environment**: `Final_GIF.py` is optimized for Jupyter Notebook or compatible environments due to inline GIF display functionality. In other environments, the saved GIF files can be viewed manually.
- **Map Projection**: Both scripts use the `ccrs.PlateCarree()` projection to ensure accurate geographical representation.
- **Data Sampling**: To avoid overcrowding in plots, data is downsampled (sampling every 30th latitude and every 40th longitude).
- **Seasonal Trends**: I have chosen `2005-07-15` and `2005-09-15`, for static Quiver Plots generated by running Final.py, which were not selected in the experiments conducted for contour and color mapping. This was done to highlight seasonal wind trends in the Gulf area, in addition to the focus on hurricane patterns.