Assignment : ClimateSight Globe

Mane Pooja Vinod & Surbhi
cs22btech11035 & cs22btech11057

1. Introduction

ClimateSight is an interactive climate visualization platform designed to provide an intuitive understanding of global weather patterns. It combines real-time meteorological data with advanced graphical visualization including a 3D animated globe, oscillating wind arrows, and detailed weather information for multiple countries and Indian states.

2. What is Open-Meteo?

Open-Meteo is a free, open-source weather service that offers high-resolution global meteorological data without requiring an API key. It aggregates predictions from multiple leading numerical weather models, providing accurate and frequently updated forecasts.

2.1 Supported Meteorological Models

Open-Meteo integrates data from major global and regional forecasting systems, such as:

- **ECMWF IFS** – One of the most accurate global atmospheric models.
- **NOAA GFS** – A U.S. global forecasting model updated four times daily.
- **ICON** – High-resolution German atmospheric model.
- **MeteoFrance ARPEGE** – Regional climate and weather prediction model.

2.2 How Open-Meteo Works

The API allows clients to request customized weather variables for any latitude–longitude coordinate. When a request is made, the API:

1. Identifies the closest model grid point for the given coordinates.

2. Retrieves forecast or historical data for selected weather parameters.
3. Formats the response into structured JSON for easy client integration.
4. Handles timezones, hourly/daily aggregation, and interpolation automatically.

2.3 API Endpoints Used in ClimateSight

- **Weather Forecast Endpoint:**

  `https://api.open-meteo.com/v1/forecast`

  Provides:

  - Hourly temperature and humidity
  - Wind speed and wind direction
  - Daily max/min temperature and rainfall

- **Air Quality Endpoint:**

  `https://air-quality-api.open-meteo.com/v1/air-quality`

  Provides key air pollution metrics:

  - **PM2.5**: Particulate matter smaller than 2.5 micrometers; these fine particles penetrate deep into lungs and impact cardiovascular and respiratory health.
  - **PM10**: Coarse dust particles below 10 micrometers; can irritate airways and reduce air quality.
  - **US AQI**: A standardized 0–500 index that summarizes air pollution levels and associated health risks.

3. Features Implemented in ClimateSight

ClimateSight is designed not as a simple weather checker, but as a **complete visual climate analysis tool**. The major features are summarized below.

3.1 3D Interactive Globe Visualization

- Orthographic 3D globe projection.
- Smooth camera rotation centered on the selected country or Indian state.
- Country and state markers with temperature labels.

3.2 Animated Global Wind System

- Wind arrows.
- Oscillating arrow animation simulating natural wind vibration.
- Color-coded arrows based on wind speed intensity.

3.3 Real-Time Weather Information

For every selected location, the following live data is retrieved from Open-Meteo:

- Current temperature and humidity
- Wind speed (m/s) and direction (degrees + compass label)
- Exact latitude and longitude

3.4 Forecasting System

- **48-hour temperature chart** with a real-time vertical indicator.
- **7-day weather summary** including:
  - Maximum and minimum temperature
  - Predicted rainfall

3.5 Global + Indian State Coverage

- 50+ major countries across all continents.
- 15+ Indian states including Hyderabad, Mumbai, Delhi, Bengaluru, Chennai, etc.
- Auto-centering globe to the selected region.

4. Conclusion

ClimateSight demonstrates the integration of modern meteorological APIs with advanced visualization tools to produce a comprehensive climate-monitoring system. The project showcases how open-source technologies like **Open-Meteo, Plotly, and Streamlit** can be combined to create an interactive and educational tool for climate awareness.

By offering wind animations, air quality metrics, short-term forecasts, and a global 3D perspective, ClimateSight enables users to gain meaningful insights into real-time weather behavior and atmospheric patterns.